Library

of the

University of Toronto

Digitized by the Internet Archive
in 2013

http://archive.org/details/modpowerengin1920toro

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 1. Publication Office, Toronto—January 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

You can patch up holes in your Boiler Furnace Lining

in a Jiffy

with

PYRO-PUTTY TRADE MARK REG U.S. PAT OFF

FIRE BRICK IN PUTTY FORM

The World's Best Furnace Lining Material

PYRO-PUTTY comes to you in a stiff, moist, pliable, "ready to use" condition. PYRO-PUTTY enables unskilled labor to make furnace lining repairs in less time and at less expense than would be possible with standard fire bricks. Simply clean out the breaks in the walls, pound in PYRO-PUTTY with a mallet, smooth it off with a trowel and you'll have a patch that will out-wear the rest of the furnace lining.

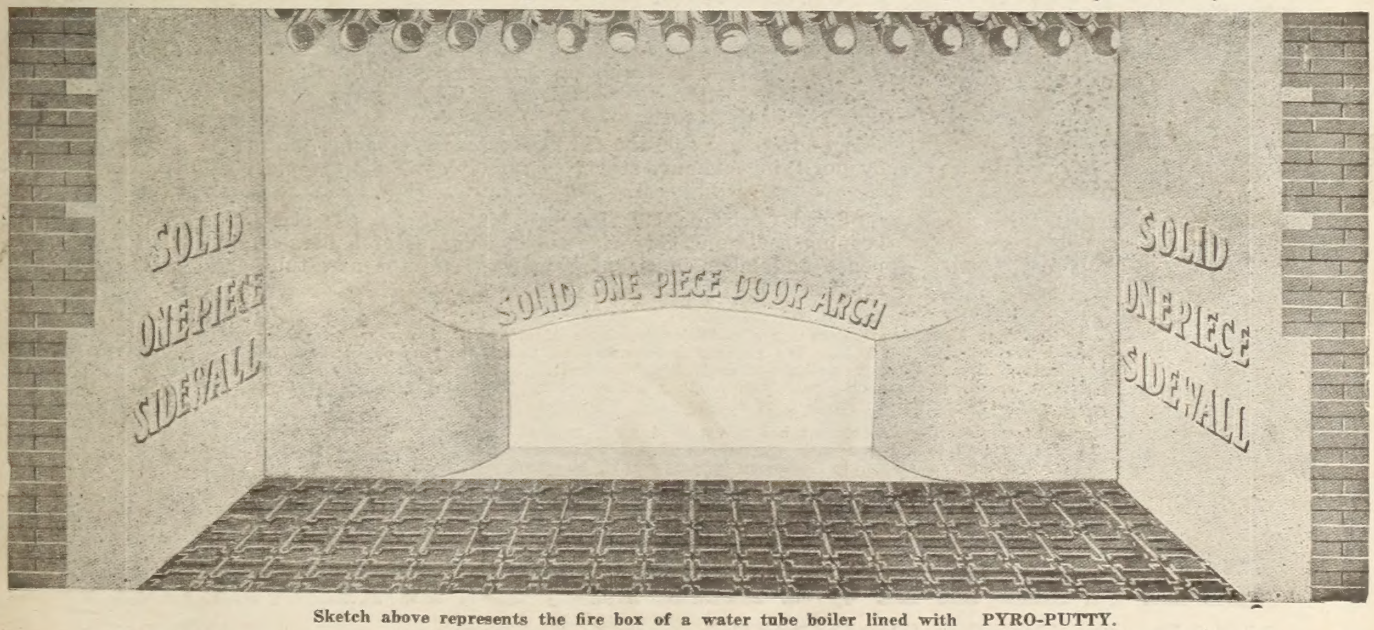
Pyro-Putty is far more durable than standard Fire Bricks for making New Furnace Linings

PYRO-PUTTY should be used, in preference to standard fire bricks, for making complete furnace linings because it is far more durable. And furnaces lined with PYRO-PUTTY are both efficient and economical because there are no joints to let the hot air out or the cold air in.

PYRO-PUTTY is put up in 700-lb. barrels, a barrel being equivalent to 100 standard fire brick. Sketch below represents the fire box of water tube boiler lined with PYRO-PUTTY. Compare it with your own fire box linings—then

ORDER A FEW BARRELS OF PYRO-PUTTY NOW!

"A few barrels of Pyro-Putty should be part of the emergency equipment of every steam power plant"



Sketch above represents the fire box of a water tube boiler lined with PYRO-PUTTY.

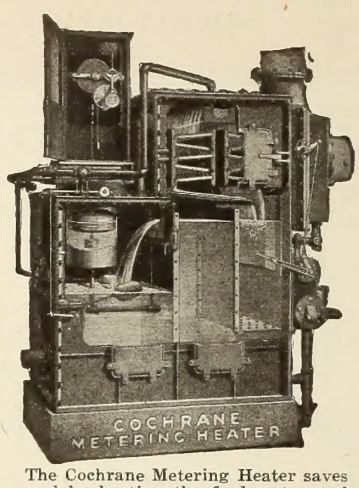
Write to-day for further information and prices

PYRO PRODUCTS COMPANY

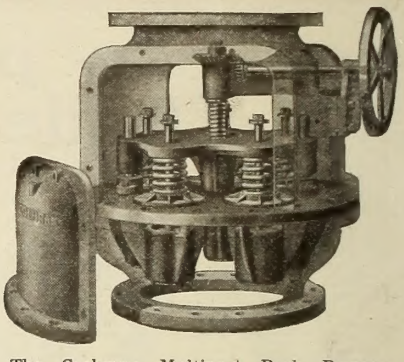
P.O. Box 685, Toronto, Ontario

COCHRANE
COAL SAVERS

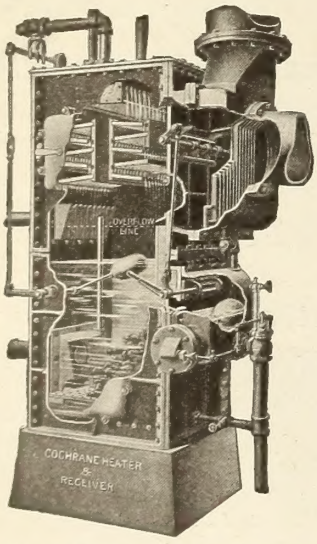
The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Metering Heater saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.



The Cochrane Multiport Back Pressure Valve saves coal by preventing leakage of exhaust steam and by making it easy to adjust the back pressure whenever desired. The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Open Feed Water Heater saves coal by utilizing exhaust steam to heat the feed water; 1% saving for each 11° F. rise.

Canada is Saving Many Thousand Tons
of Coal Per Year by Using Cochrane Heaters

Here are the figures:

The **horsepower** of Cochrane Heaters in use is about 10,000,000 boiler horsepower.

The corresponding amount of **coal burned** is 35,000,000 lb. per hour.

Considering an average of 10 hours' operation per day, 300 days per year (many heaters run 24 hours per day, 365 days per year), this amounts to 105,000,000,000 lb. of coal per year, or 50,000,000 tons, worth at $5.00 per ton, **$250,000,000.**

The saving due to the use of **Cochrane Heaters** is 1% to each 11° F. rise in temperature. On the average, the water is raised from 100° F. to 210° F. using steam at atmospheric pressure, 10% or a saving of 10%. Cochrane Heaters are thus saving **about $25,000,000** per year, which is vastly more than the heaters cost.

In addition, Cochrane Oil Separators are saving millions of tons of coal by **purifying exhaust steam** so that it can take the place of live steam in heating and drying coils, low pressure turbines and industrial processes.

Sorge-Cochrane Hot Process Water Softeners are saving millions by **keeping scale and corrosive substances out of boilers** and thus saving expense and labor in cleaning boilers, and for new tubes and other boiler repairs.

Cochrane Metering Heaters are also telling hundreds of **steam-plant owners,** managers and operators how much **they are gaining in economy** by using different coals, different methods of firing, different methods of controlling the draft, stopping up air leaks in boiler settings, cleaning soot and scale from heating surface, etc. The total gains realized in this manner often amount to 25% or more.

Our engineering department has given hard study to fuel economy for over 25 years. It will be glad to aid you with suggestions if you will describe your present boiler feed water heating, softening, or metering arrangements, the amount of exhaust steam you have available and what you are using it for.

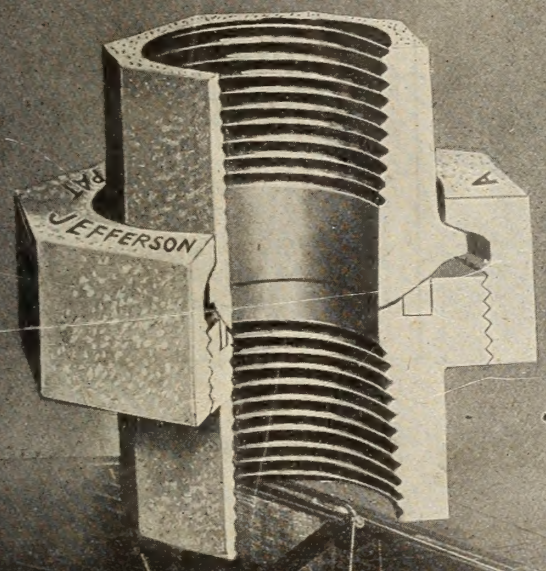
Ask for a book on "The Profitable Utilization of Exhaust Steam."

CANADIAN ALLIS-CHALMERS
HEAD OFFICE: TORONTO LIMITED

Branch Offices: MONTREAL, QUEBEC, HALIFAX, SYDNEY, ST. JOHN, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE, WINNIPEG, CALGARY, EDMONTON, NELSON, VANCOUVER and VICTORIA

JEFFERSON

"Look for the Name on the Nut"



The Power behind the Hoist

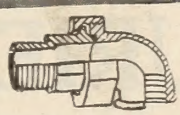
HOISTS must make their long heavy pulls without faltering, but with absolute certainty. The power behind the hoist must be sure and certain—steam pressure in the great cylinders must be constant and steady.

JEFFERSON UNIONS play a mighty part in the safe operation of hoists and other machinery. Their uniform perfection insures against breakdowns and dangerous steam losses.

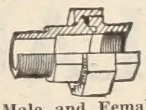
The name "JEFFERSON" protects you from the "just-as-good" variety of unions which might involve a costly shutdown or loss of life at a critical moment.

Ask your jobber about JEFFERSON'S
Also write to-day for our Catalog "UNIONS."

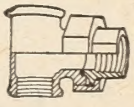
The Jefferson Union Co.
Lexington, Mass.



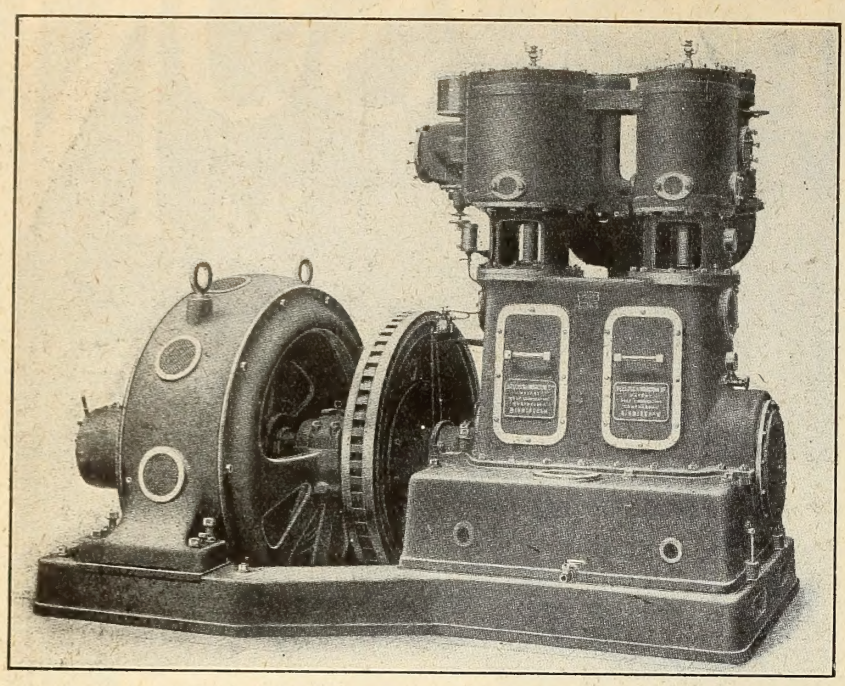
Union Elbow, an economizer of the most pronounced type. Also made all female.



Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.



Union Tee, with union on the outlet. Made also with male end on outlet.



BELLISS & MORCOM

LIMITED

Engines and Air Compressors

Illustration shows a Belliss & Morcom Motor Driven Air Compressor

"Quality" Power-House Equipment

Steam Engines
Gas Engines
Oil Engines
Diesel Engines
Steam Turbines
Air Compressors

Condensing Plants
Centrifugal Pumps
Boiler Feed Pumps
Water Meters

Hydraulic Pumps
Pressure Filters
Gravity Filters
Water Softening Plants
Refuse Destructors

ENQUIRIES READILY ANSWERED

Complete Power Plants Designed and Erected

LAURIE & LAMB

ENGINEERS

211 Board of Trade Bldg. MONTREAL, QUE.

POWER HOUSE, January 5, 1920, Vol. XIII., No. 1. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

The New "Emco" A332
Stop and Waste Cock

A "Two in one Fitting."

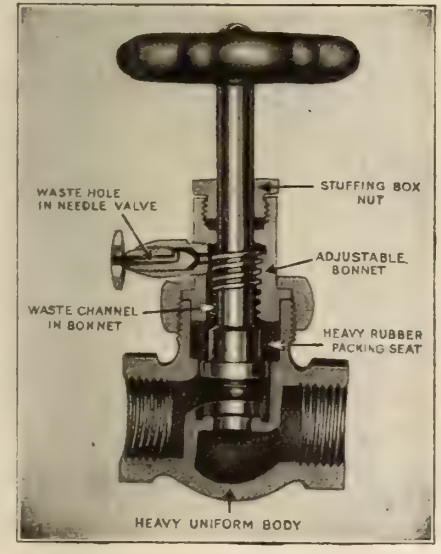
With five points of Superiority——

——five selling points in addition to the prestige that goes with the word "Emco," the trademark of its makers.

As a straight Stop-Cock or a Stop and Waste Cock it is equally adaptable.

Study the marked points in the cross sections. Pay particular attention to the arrangements for waste water :

FIRST——the adjustable bonnet which allows the needle waste valve to be placed in proper position for catching waste water.



Cross Section
"Emco" A 332 Stop and Waste Cock

SECOND——the needle valve which may be shut off independently to prevent a rush of water out the waste tube, when turning water on and off.

Every "Emco" is thoroughly tested before leaving our factory.

Write for our catalogues.

Order direct.

Empire Manufacturing Co., Limited

London and Toronto, Canada

UEHLING WASTE METER

COMBINED

CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO_2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

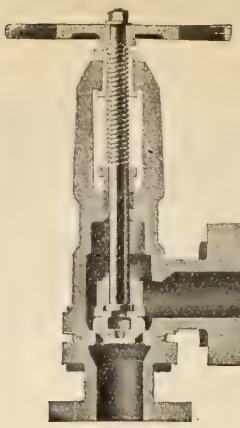
CO2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company

2 Empire Building New York City



A Safe and Economical Combination

"HOVALCO"
Renewable Blow-Off Valve

"HOMESTEAD"
Quarter-Turn Valve

Leak Proof!

HERE is a money-saving combination. Designed to give a clear passage—absolutely tight when closed; consequently leak-proof.

The nickel alloy seats and discs of the Hovalco can be reversed, reground or renewed without shutting down the boilers.

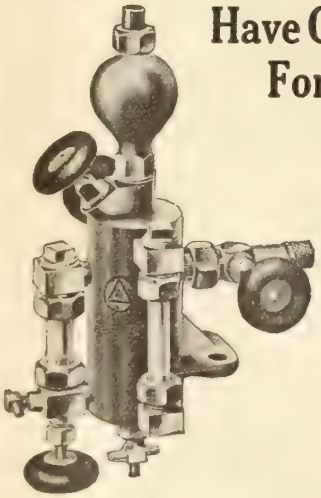
Write for our bulletin giving the full details.

Homestead Valve Mfg. Company

HOMESTEAD, PA.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

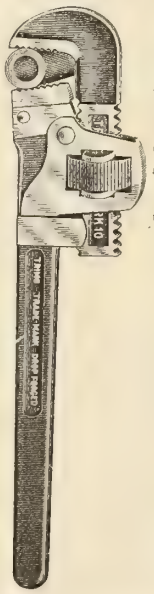
Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.

WALKERVILLE, ONT.

TRIMO

THE WORD TRIMO



Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

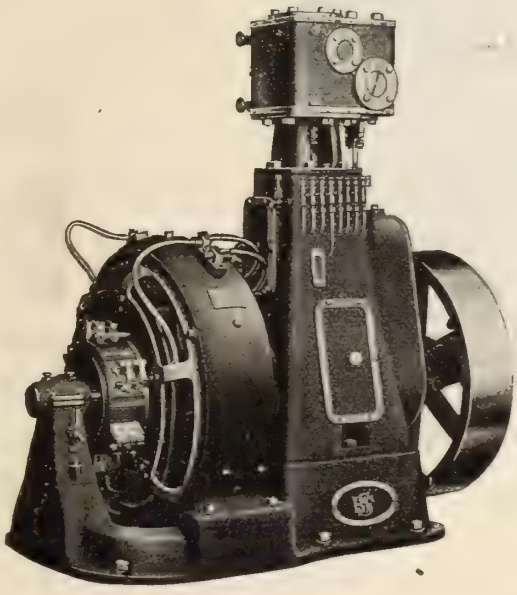
Trimont Mfg. Company

Roxbury (Boston), Mass.

Sturtevant

TRADE MARK

Electric Generating Sets



Designed and Built to U.S. Navy Specifications!

—which fact forcibly indorses their efficiency, design, dependability, and quality of construction. Have close regulation and are suitable for all light and power purposes. Specially adapted for isolated power plants, and as auxiliaries in large plants, as well as on shipboard. They are compact, self-contained units, consisting of a Sturtevant steam engine direct connected to a conservatively rated Sturtevant electric generator. Are made with automatic lubricating systems, either gravity or forced feed. All reciprocating parts of the engine are entirely enclosed within the engine frame, which is provided with oil- and dust-proof covers. All parts are readily accessible by removing these covers. Write us for Bulletin No. 239U which details the merits, design, and construction of Sturtevant Electric Generating Sets.

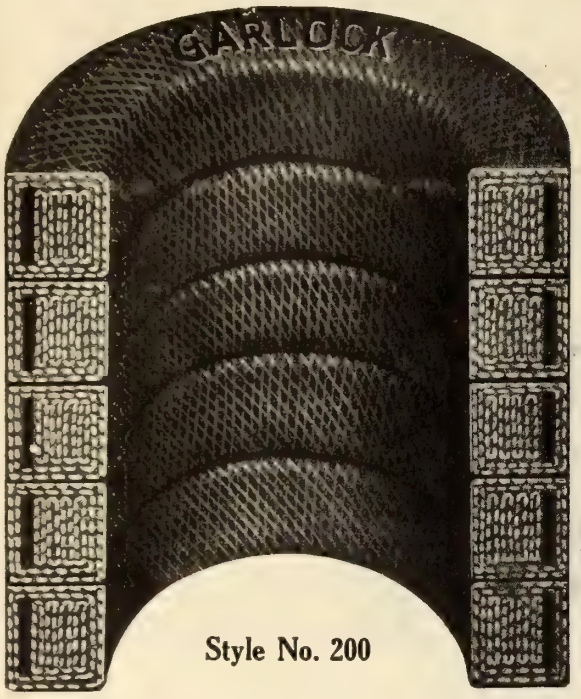
B. F. STURTEVANT CO. OF CANADA, LTD.

HEAD OFFICE AND WORKS: GALT, ONT.

SALES OFFICES: MONTREAL AND TORONTO

Sturtevant PUTS AIR TO WORK

Garlock High Pressure Piston Rod Packing



Style No. 200

Is built up on a core consisting of several flattened tubes.

The tubes are braided from the highest grade of asbestos yarn, and are cemented together with the best rubber friction.

The tubes are cemented only on the outside, therefore the packing is lighter per linear foot than other types of high pressure packing.

In service the tubes open under pressure and expand the packing against the piston rod.

The core of flattened tubes is backed with a cushion of high-grade rubber, so compounded as to retain its resiliency under heat.

The tube-core and rubber cushion are covered with cloth woven from the highest grade of long fibre asbestos.

Our high pressure packing is not merely smeared on the outside with graphite and grease.

Every fibre of it is saturated with a specially prepared lubricant, which does not affect the rubber cushion or friction.

The outside of the packing is coated with the best grade of floating stock graphite.

The best materials we can buy are used in the manufacture of our high pressure packing.

It is built up in rectangular form and uniform shape, and exact sizes are thereby obtained.

Asbestos packing, rolled around a rubber core and afterwards distorted by running through a square die, does not retain its shape or size.

Our high pressure packing is made by experts who have done nothing else for years but make that one type of packing.

The length of service obtained from it is greater than that secured from other makes, therefore the labor cost of applying and adjusting is less.

Our packings are sold at net weights; weights of cartons or boxes are not included.

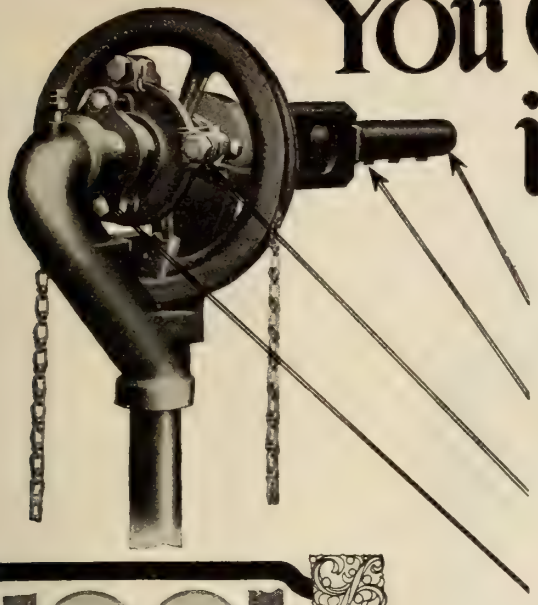
Every pound of our high pressure packing carries with it the Garlock guarantee of satisfactory and economical service.

We will promptly replace or refund the cost of any of our packings which may prove unsatisfactory to our customers.

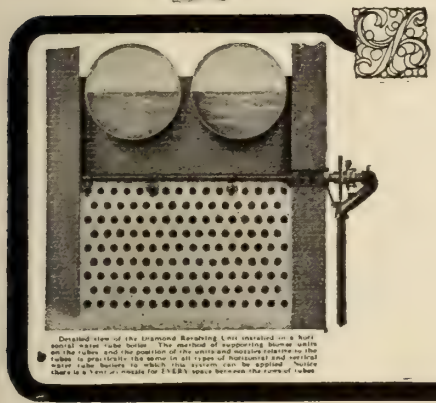
The Garlock Packing Company, Hamilton, Ontario

Branches:

Montreal, Quebec.....409 Shaughnessy Bldg.
Toronto, Ontario.....Continental Life Bldg.
Winnipeg, Manitoba.....Galt Building
Calgary, Alberta.....211 8th Ave. W.



You Can Buy Them in Confidence



WHY?

BECAUSE:

CALORIZED METAL—Blower units are constructed of metal treated by the calorizing process. This process renders the metal capable of withstanding continuous temperatures of 1800 deg. F., whereas untreated iron and steel begin to oxide rapidly at 1100 deg. F. This means that Diamond units can be placed in portions of the boiler otherwise inaccessible for cleaning.

VENTURI NOZZLES—The nozzles from which the steam issues are designed on the principle of the Venturi tube. With identical pressures steam is emitted at three times the velocity possible from a straight-walled nozzle, thus insuring the absolute maximum in cleaning efficiency.

AUTOMATIC STOPS—The range of action of the steam jets is absolutely controlled. At no time can they be directed against baffles or brick work, with consequent deterioration of the latter.

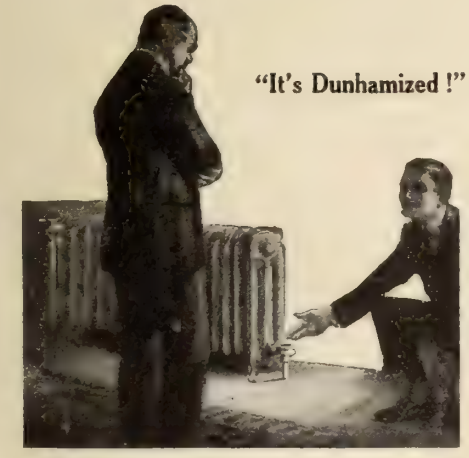
GENERAL CONSTRUCTION—Stanch, rugged, mechanically correct, Diamond Soot Blowers are noted for their dependability under all conditions of service. Mechanics, material, design have all been carried as far as they can be carried, but having been carrier that far, they merge into the soot blower itself, and there the equipment stands complete, a single unit, not a list of features. Ask for Bulletin 192.

DIAMOND SPECIALTY CO.
Windsor Ontario

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

"It's Dunhamized!"



The DUNHAM HEATING SERVICE

Radiators are made quiet, hot all over, and trouble-free by the Dunham Radiator Trap. Automatically it removes the air and water—but shuts tight against steam. It has only two parts; no sliding contacts and is permanently adjusted at the factory.

Dunham Heating Service extends far beyond the installation period. It is of equal interest to the engine room and front office. Until it can prove of value it asks no obligation. Bulletin No. 112, "Data on Dunham Heating," should be in your file.

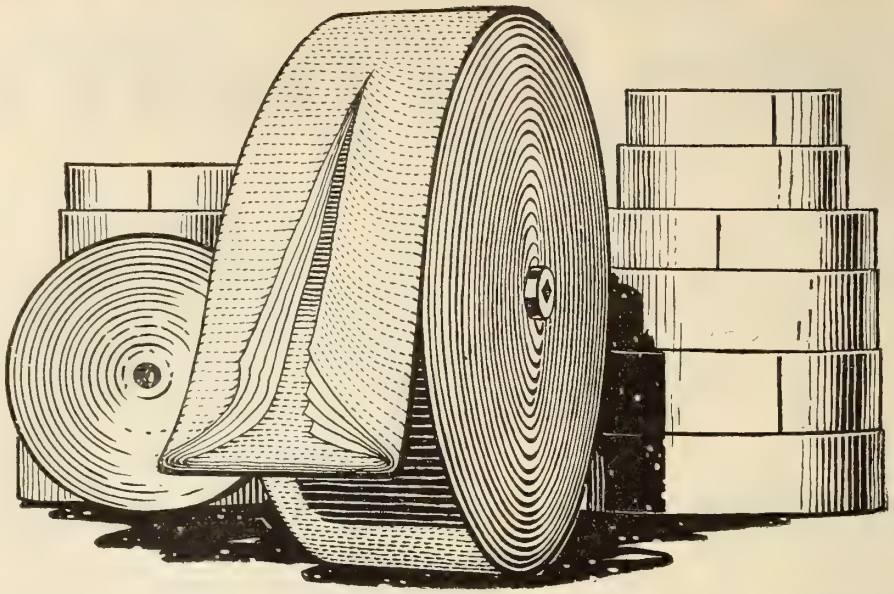
The first thermostatic disc trap. Standard since 1903.

C. A. DUNHAM COMPANY, LTD.

Toronto, Ontario

London: 64 Regent House
Regent Street, W.1

Halifax Vancouver Winnipeg
Ottawa Montreal Calgary



Ten-Ply Economy

You can eliminate entirely the element of guess-work in purchasing belting by specifying Dominion Friction Surface Belting, for it embodies every factor necessary in satisfactory transmission belting.

Dominion Friction Surface Belting

Conserves power by preventing slippage.
Increases production, thereby reducing cost.
Prevents idle machines and employees.
Has an extremely low upkeep cost.
Gives long and continuous service.
Careful selection of materials insures absolute dependability.
Our process makes every foot uniform.
Keeps operators contented by enabling them to produce maximum output.
Guaranteed by Canada's largest manufacturers of rubber goods.
Backed by an incomparable service of belting engineers.
Dominion Friction Surface Belting has justified every claim by more than fifty years of satisfactory performance.
Our engineers are ready to show you, without charge, how *your* transmission equipment can be put on a ten-ply economy basis.
Phone or wire our nearest branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Makers of
Dominion Hose, Packing and Industrial Rubber Goods and Dominion Tires, the GOOD Tires for every purpose.

Service Branches:

Halifax,
St. John,
Quebec,
Montreal,
Ottawa,
Toronto,
Hamilton,
London,
Kitchener,
North Bay,
Fort William,
Winnipeg,
Brandon,
Regina,
Saskatoon,
Edmonton,
Calgary,
Lethbridge,
Vancouver,
Victoria.

GOODYEAR
MADE IN CANADA

EXTRA POWER BELTING

You can find no safer guide in selecting your belting equipment than the experience of others.

In over one thousand of Canada's plants Goodyear Extra Power Belting is being used with marked success. Scores of these have written us telling of their experience with Extra Power Belting.

Read this letter from The Dominion Steel Products Co., Limited, of Brantford, a concern noted for its progressive methods. It tells of a belting experience which must impress you.

Price was a minor factor with Dominion Steel Product, but on this alone they made a saving of $4,000.

Length of service, general efficiency, continuous operation and power saving were the determining factors in their decision to use only Extra Power Belting in their plant.

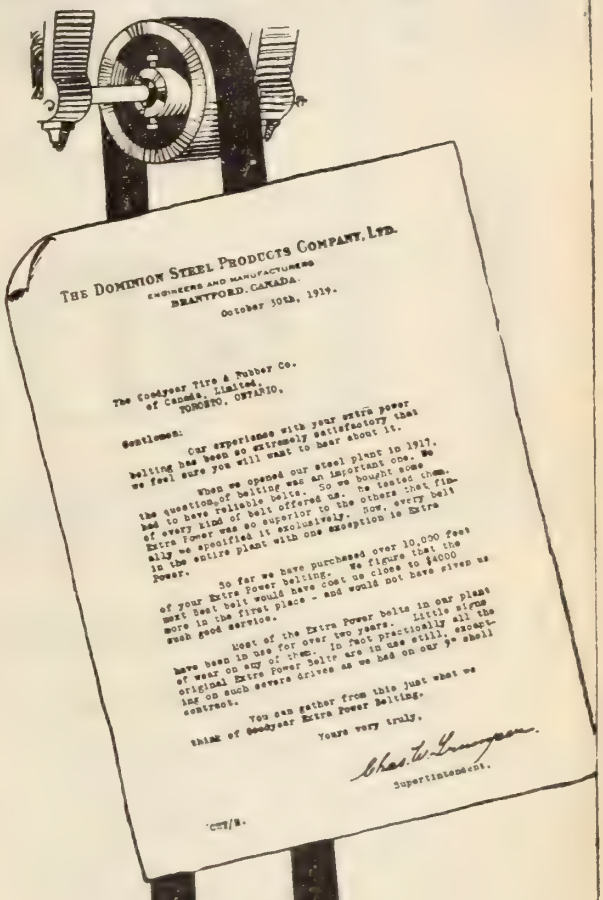
It may be that your plant is much smaller; that your saving would only be $400, but even this plus the greater efficiency of Extra Power Belting is too important for you to disregard.

You can easily prove to your own satisfaction that Extra Power would serve you as faithfully as it has the Dominion Steel Products Co.

Phone, wire or write our nearest branch, so that a man carefully trained in belting problems by Goodyear may call on you and present further evidence of the superiority of Extra Power Belting. No obligation other than fair investigation.

THE GOODYEAR TIRE & RUBBER CO. OF CANADA, LIMITED

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, Vancouver. Service Stocks in smaller cities.



THE DOMINION STEEL PRODUCTS COMPANY, LTD.
ENGINEERS AND MANUFACTURERS
BRANTFORD, CANADA.
October 30th, 1919.

The Goodyear Tire & Rubber Co.
of Canada, Limited,
TORONTO, ONTARIO.

Gentlemen:

Our experience with your extra power belting has been so extremely satisfactory that we feel sure you will want to hear about it.

When we opened our steel plant in 1917, the question of belting was an important one. We had to have reliable belts. So we bought some of every kind of belt offered us. We tested them. Extra Power was so superior to the others that finally we specified it exclusively. Now, every belt in the entire plant with one exception is Extra Power.

So far we have purchased over 10,000 feet of your Extra Power belting. We figure that the most best belt would have cost us close to $4000 more in the first place - and would not have given us such good service.

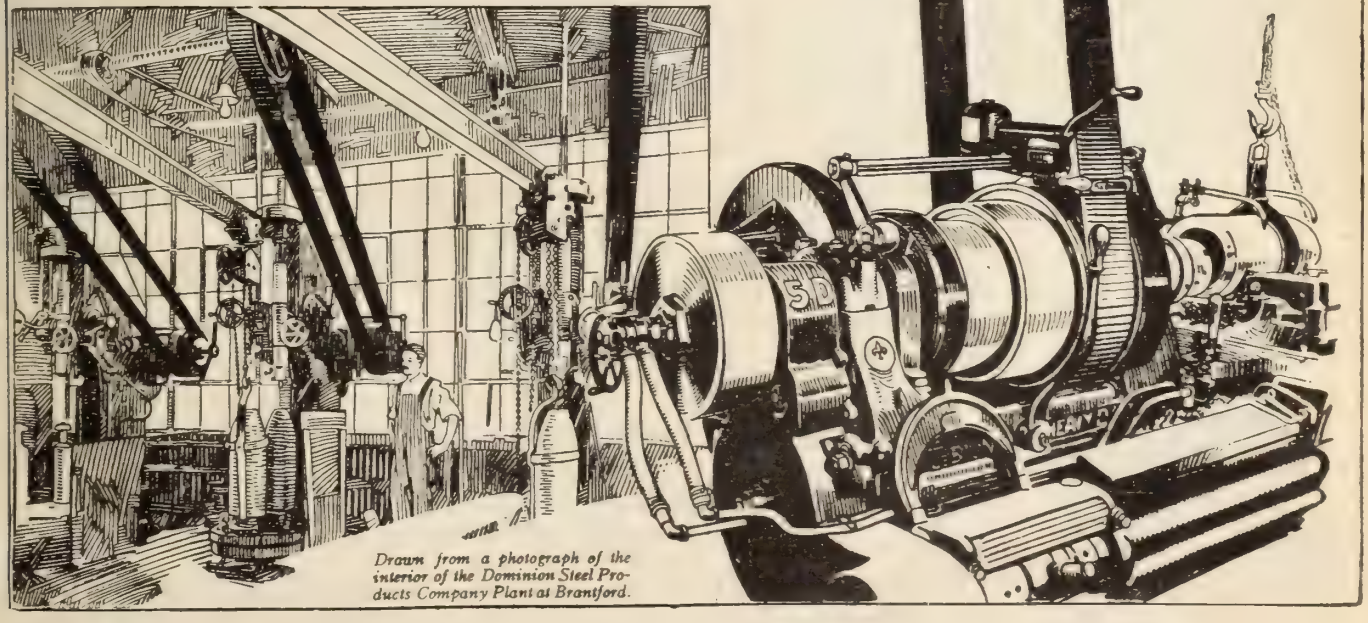
Most of the Extra Power belts in our plant have been in use for over two years. Little signs of wear on any of them. In fact practically all the original Extra Power belts are in use still, excepting on such severe drives as we had on our pickling machines.

You can gather from this just what we think of Goodyear Extra Power Belting.

Yours very truly,

Chas. W. Simpson
Superintendent.

cwt/s.



Drawn from a photograph of the interior of the Dominion Steel Products Company Plant at Brantford.

LINDE

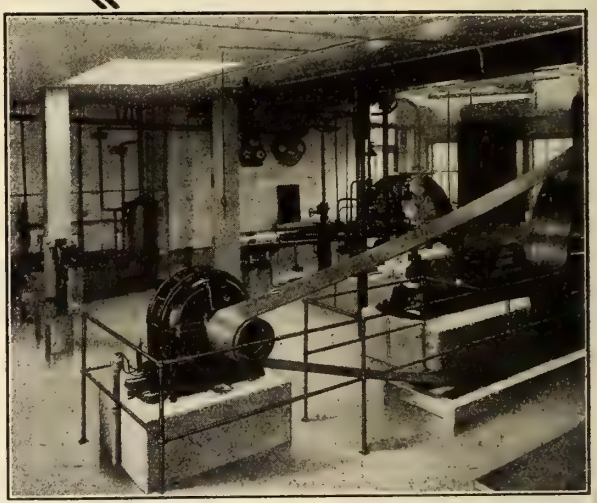
Sets the Standard for

ICE-MAKING MACHINERY

FOR EVERY PURPOSE

Economical - Efficient

100 ton Linde Refrigerating Plant in Operation.



Is your refrigerating system thoroughly efficient? If not it will pay you to install LINDE equipment. We can meet all requirements. Our new vertical enclosed type machines are suitable for plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other refrigerating equipment on the market.

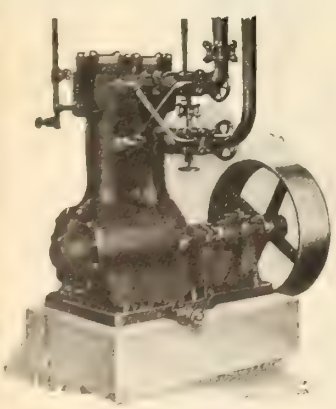
By adopting Linde equipment in the place of old and insanitary methods you increase your profits. Write to-day for information.

Makers of Quality Machinery in Canada Since 1896

The Linde Canadian Refrigeration Co., Limited

37 ST. PETER STREET, MONTREAL, QUE.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Every Part of Every FRICK INSTALLATION Must Be Perfect in order to maintain

FRICK SUPERIORITY

That is why Frick Refrigerating and Ice Making Equipment proves a profitable investment wherever installed.

The entire Frick line, from the smallest to the largest plant, from the smallest part to the largest part in each plant, is designed to meet our strict standard of Durability—Efficiency—Economy. Every part must be perfect in order to maintain the well-known FRICK Superiority.

Therefore, when you purchase FRICK Equipment you are assured of perfect service regardless of the unforeseen overload demand that might be placed on it sometime—assured of continued operation without danger of breakdowns in the midst of a busy season—assured of economical operation at all times—and a long life. Frick Equipment has been standing up under the above conditions for nearly a half-century, day after day, year after year, under the most severe conditions.

You can't go wrong when you specify "Frick Equipment." **Catalog on request.**

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

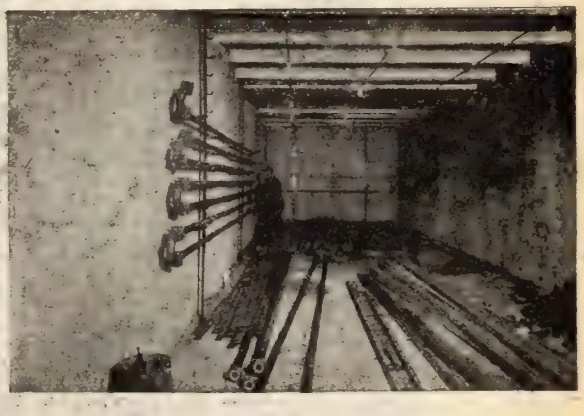
When It Pays to Re-Insulate

WHEN it becomes difficult to maintain low temperatures in your storage rooms with a reasonable amount of refrigeration, you have a good reason for believing that the material with which your plant is insulated has lost its efficiency.

Your operating cost, under such a condition, must be abnormally high. Consequently, the sooner this excessive expense is eliminated, the better for your pocketbook.

Install Nonpareil Corkboard Insulation of adequate thickness and you will have done all that can be done toward avoiding future trouble and expense due to poor insulation.

Nonpareil Corkboard is non-absorbent. That's why, as the years pass, its insulating efficiency remains practically unchanged. That's why it doesn't rot, mold or disintegrate like materials that absorb moisture. That's one reason why it pays a substantial return on the cost.



View in the plant of the Seigel-Heckinger Packing and Provision Company, Chicago, Ill. Insulated with Nonpareil Corkboard.

Send today for the 152-page book, "Nonpareil Corkboard Insulation." It contains a fund of information that every owner or manager of a refrigerating plant should keep instantly available, and there is no charge for it whatever.

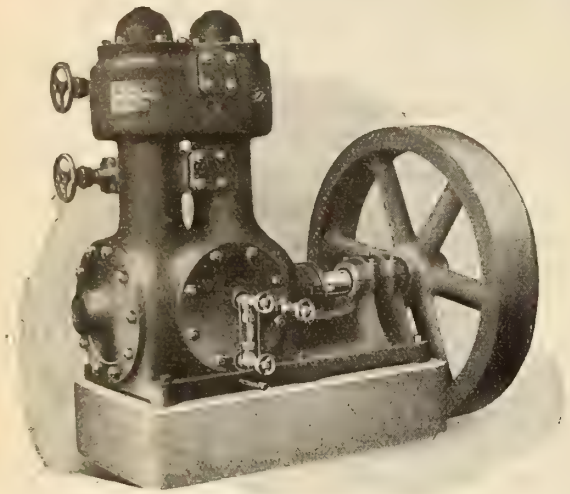
Armstrong Cork & Insulating Company, 504 McGill Building Montreal, Quebec, Canada

Also manufacturers of Nonpareil Cork Covering for cold pipes; Nonpareil High Pressure Covering for steam lines; Nonpareil insulating Brick for boiler settings, etc.; Nonpareil Cork Machinery Isolation for deadening the noise of machines; Circle A Cork Brick for cold storage room floors, and Linotile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

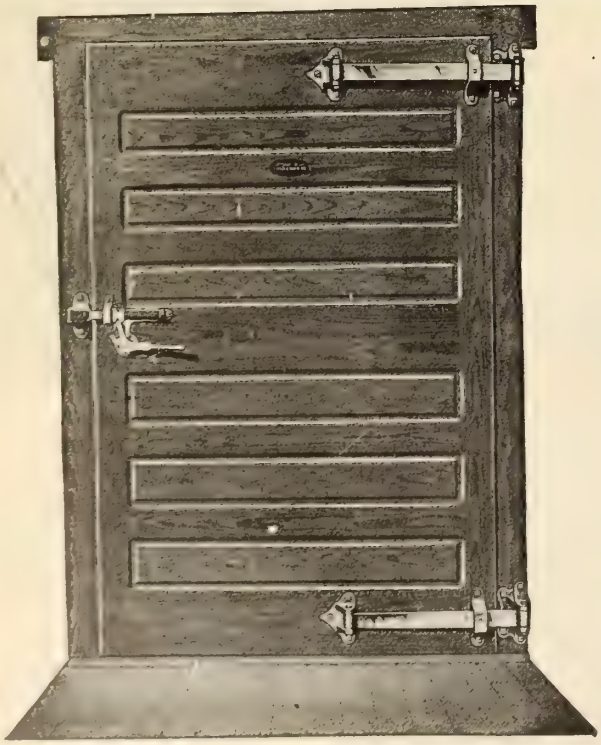
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts.; Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant**, as we find **them substantially made** and the **insulation perfect**. We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are **equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"**The doors supplied by you, in use at both plants, have been in every way satisfactory,** and we think the **Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. — HAGERSTOWN, MD., U.S.A.

Opening is Larger than Corresponding Pipe

There is nothing to interfere with the unrestricted flow of passing blow-off sediment when your boilers are equipped with the Yarway (formerly the Simplex) Seatless Blow-Off Valve. The absence of seats and discs, together with the large, smooth port, not only provides smooth passage for the blow-down, but also eliminates troubles met in other valves by the cutting and scoring of scale and grit.

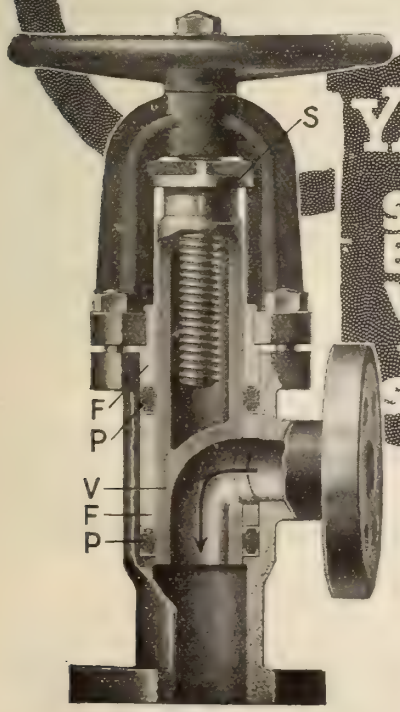
Try one for 60 days, subject to return. When writing state size of line and whether screw or flange, angle or straightway.

Learn the Good Points of Other Yarway Products

Yarway-Lea V-Notch Meter
Yarway Pipe-Joint Clamp (formerly the Simplex)
Yarway Adjustable Spray Head (C. C. Thomas Patents)
Yarway Boiler Skimmer
Yarway Hydraulic Valve (Caskey Patents)
Yarway Starting and Pressure Unloader (Richards Patents)

YARNALL-WARING CO.
7604-20 Queen Street
Chestnut Hill, Philadelphia

A. McLELLAN
103 St. Francis-Xavier St.
MONTREAL, QUE., CANADA



YARWAY
SEATLESS BLOW OFF VALVE
formerly the SIMPLEX

Operation

In closing valve, shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

In the year to come, as never before, Industry will be the controlling factor in the affairs of this Nation ..... And to Industry, now as always, The L·S·Starrett Co. acknowledges its indebtedness and reaffirms its policy of cooperation through service.

42-7

Starrett Tools

Absolute control of that out of reach valve at all times

Simply pull the chain. The sprocket rim does the rest. The

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

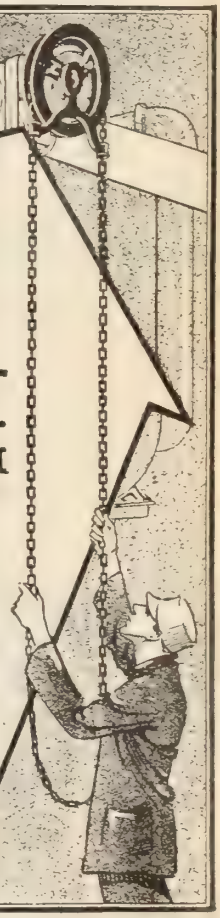
is easily attached in a few moments. Once installed it is always there waiting for the slight pull that operates the valve.

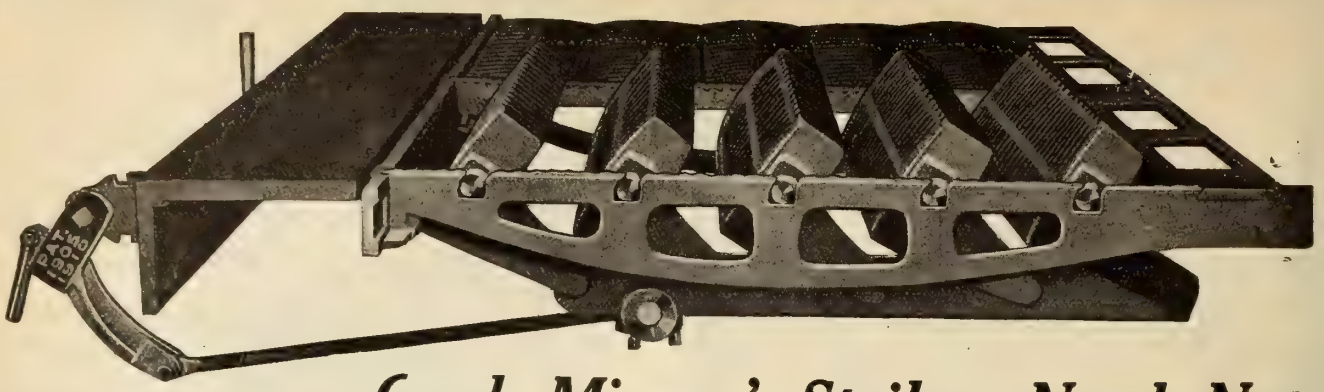
Eliminates climbing and risk of accident. Saves time and expense. Gives control of overhead valves from the floor.

Write for Illustrated Catalog.

Babbitt Steam Specialty Co.
NEW BEDFORD, MASS.

Canadian Agents:
Engineering Specialties Co., Ltd.
Toronto, Ont., Canada
Jenkins Bros., 300 W. Lake St., Chicago, Ill.
93-42





Furnaces get 60% air space and 90% underdraught by the scientific principle of Cyclone Grate construction. Burns all the fuel! No ashes, no clinkers—no waste.

Why not put Cyclone Grates to the test. Installed on a 30-day trial basis.

Coal Miners' Strikes Need Not Cause You Any Worry if You have CYCLONE GRATES

You can burn the low grades of commercial fuel (screenings, etc.), and secure maximum results with CYCLONE SHAKING AND DUMPING GRATES.

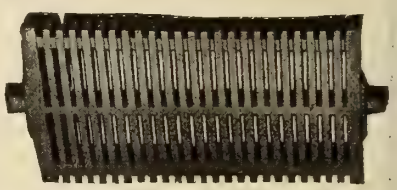
The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street **Phone G. 2660** **Toronto, Ontario**

AGENTS:

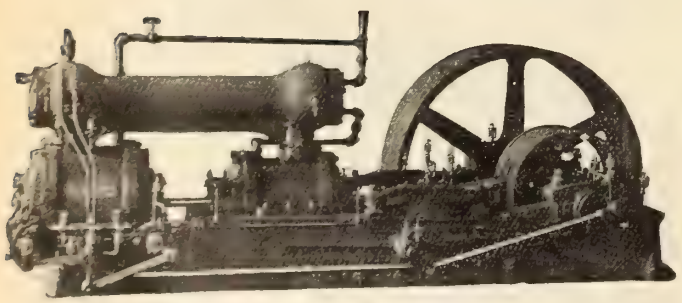
ST. JOHN, N.B.: F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator & Engineering Co., Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. CALGARY: The Western Foundry & Metal Co. WINNIPEG: Vulcan Iron Works.



NORWALK

AIR & GAS · COMPRESSORS

For Simplicity



Norwalk 100-lb. Air Compressor

IN Norwalk compressors the long and careful study given the matter of simplification has resulted in machines with a minimum number of parts—and the greatest attainable simplicity in each part.

Bulletins on Air, Oxygen, Hydrogen, Acetylene or Carbonic Acid Gas sent on request

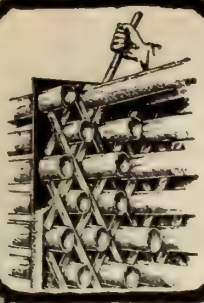
NORWALK IRON WORKS COMPANY

Pioneer Builders of Compressors

South Norwalk, Conn.

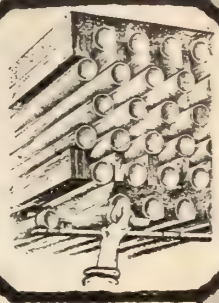
ANY·CAPACITY **ANY·PRESSURE**

BETSON BAFFLES



VERTICAL,
Any Slope for Any Make of Boiler.

The solid one-piece baffle is the ideal baffle. It makes leakage of the valuable gases impossible. Ordinary baffles of separate brick or tile blocks have joints that cannot be made and kept tight. Betson baffles do away with these troublesome joints. The Plastic Fire Brick packs solidly in the tube spaces, and conforms exactly to the shape of the tubes.



HORIZONTAL,
Any Shape for Old and New Boilers

Permanent one-piece baffles without joints, are easily made with Betson's Plastic Fire Brick. They do not crack under expansion, and are always gas-tight. Any one around the plant can do the job. No forms required. No special tools necessary. Betson baffles can be made in any size, shape or slope, for horizontal and vertical type boilers of any make.

Comes ready for use, in the yellow-top barrel.

BETSON'S
REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. 1914

Backed by a service record of 20 years.

Stock carried in all principal cities.

Write for instructive booklet.

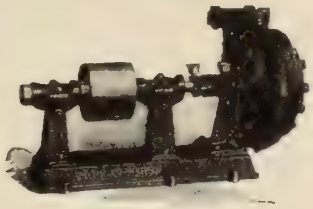
INTERNATIONAL CHEMICAL COMPANY
44 Lombard Street - - - Toronto, Ont., Canada 9-41

AMERICAN-MARSH PUMPS

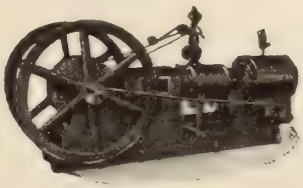
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



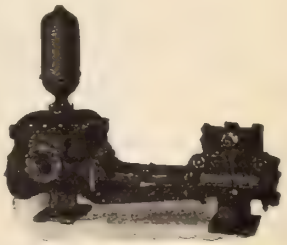
American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors

Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

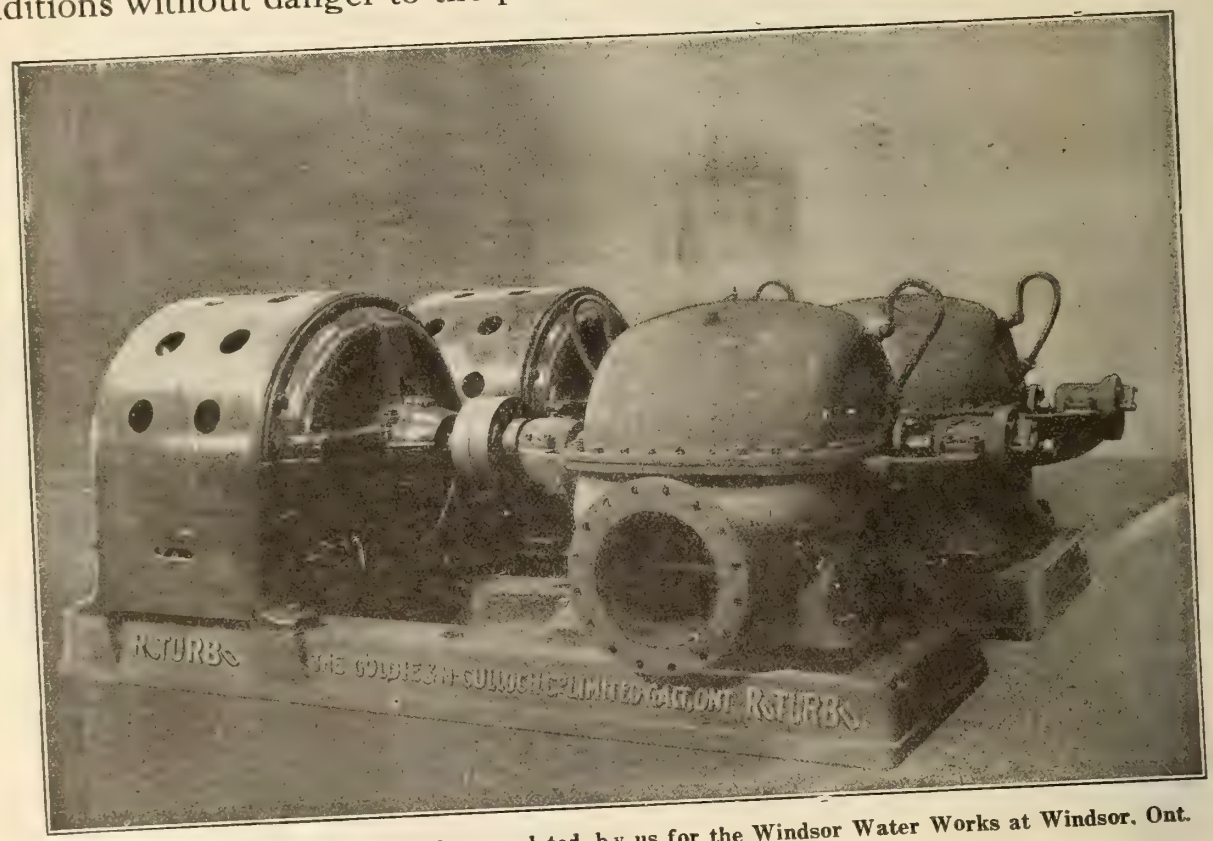
AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed by us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Bank of Hamilton Bld'g.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig 400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 | Canada, $2.00 per year; U.S. $2.50 per year. | Published Semi-monthly

The Water Powers of British Columbia, II

A Further Abstract From the Report by the Commission of Conservation, Giving Information in Regard to Actual Installations Which Are Developing Power for Municipal and Private Use

IN British Columbia there has been considerable development of water-powers, both for municipal and industrial purposes. In fact, development of this resource has contributed much to the general advancement of the Province. The more important of the existing installations are described briefly below. Such descriptions not only show what course has been pursued upon various types of streams, but also set forth the general design and character of such equipments as have been employed in the respective developments.

British Columbia Electric Railway Co., Ltd.

The history of hydro-electric development in British Columbia is intimately associated with the early activities of what is now the British Columbia Electric Railway Co., Ltd. In 1887, the Vancouver Electric Illuminating Co., Ltd., installed an electrical plant. In 1889, a second company, known as the Vancouver Electric Railway Co., Ltd., was formed. The following year, the two companies were merged and their railway lines electrically operated. In 1890, a New Westminster interurban system and a Victoria (Vancouver Island) system were commenced. These were merged into one company, known as the Consolidated Railway Co., Ltd., and their lines were operated under this control until 1897, when the British Columbia Electric Railway Co., Ltd., was formed, and, subsequently acquired the assets of all the companies above referred to.

Confidence in the development of the territory to be served, the directors of the company, at the outset, formulated their plans with respect to future development. There is, no doubt, that the remarkable development which has taken place in the districts around Vancouver, New Westminster and Victoria has been largely assisted by the liberal expenditures of the British Columbia Electric Railway Co. at a time when settlement in the province was being stimulated. The company's operations now extend over a field which contains over half the population of British Columbia.

The supply of power for the company's various undertakings is obtained from five power stations. On the mainland, the Vancouver Power Co., a subsidiary, operates a large and up-to-date hydro-electric plant on the north arm of Burrard Inlet. It also operates a steam plant in the city. For Victoria and vicinity, the company owns and operates a hydro-electric plant at Goldstream, and an auxiliary steam plant at Brentwood Bay. The Vancouver Island Power Co., a subsidiary, operates a hydro-electric plant at Jordan River.

The plant at Burrard inlet, known as the Coquitlam-Buntzen development, is the largest in the province. It consists of two power-houses at sea-level, utilizing water diverted from Coquitlam Lake, through a tunnel 2¼ miles long, to Lake Buntzen, a small lake 400 feet above sea-level, and but a short distance from Burrard inlet.

The utilization of Lakes Coquitlam and Buntzen for power purposes was decided upon sometime prior to 1898, and power was first supplied from power-house No. 1 to Vancouver in December, 1903. The original scheme comprised raising Coquitlam Lake, by means of a rock-filled crib dam, about 11 feet above its average summer level. Water so stored was delivered through a tunnel 2¼ miles long — then stated to be the longest purely hydro-electric tunnel in the world — to Buntzen Lake, at the outlet of which a concrete intake dam, 54 feet high, was built across the canon.

WESTERN CANADA POWER CO. STAVE FALLS DEVELOPMENT.

The rapid development and growth of the district around Van-

couver demonstrated that the demand would, in a short time, exceed the maximum capacity of the plant. After careful investigation, was decided to enlarge the tunnel connecting Lakes Coquitlam and Buntzen, and build a new dam to increase the storage capacity of Coquitlam Lake. Extensive additions were also provided at the power house.

SIMILKAMEEN RIVER POWER PLANT OF THE DALY REDUCTION CO. SHOWING FOREBAY, STEEL PENSTOCK AND POWER HOUSE. HEAD DEVELOPED 67 FT., HEDLEY, B.C.

By the time the enlargement of the tunnel was completed, in June, 1911, the demand on the company's system necessitated the construction of a second power-house. Work on the extension of the new dam and of No. 2 power-house completes the hydro-electric development of the Coquitlam-Buntzen schome.

Coquitlam Lake

Coquitlam Lake is about 7 miles in length, with an average width of about one-third of a mile. Its original area was about 2,190 acres. The area of the watershed is approximately 105 square miles. The surrounding mountains rise precipitously to a height of 3,000 to 6,000 feet and the greater portion of the watershed is well timbered. The annual precipitation during the last eleven years has averaged over 150 inches. The snowfall is very heavy and remains on the higher peaks until late in the summer. To provide storage to enable the entire runoff from the watershed to be utilized, it was necessary to raise the level of the lake; the spillway of the new dam is at elevation 503 feet, 60 feet above the old dam.

The New Dam

The new dam is of the hydraulic-fill type, with heavy rock toes. It is built at the outlet of the lake, upon a natural barrier. Its crest elevation is 518 feet, and the maximum height of the dam, above the lowest point of the foundation on the centre line, is 100 feet. The length along the crest, including the spillway, is 1,200 feet. The slope of the upstream face is 1 in 5, and of the downstream face 1 in 2 to 1 in 4. The spillway is cut through a solid rock spur at the east end of the dam. The concrete sill at the entrance to the spillway is at elevation 503, being 15 feet below the crest of the dam. During the construction of the dam, the outflow from the lake was carried around the dam site in a tunnel driven under the spillway, and designed to carry 12,000 c.f.s. For controlling the flow through this tunnel, permanent gates are placed in a concrete tower at its upper end.

As the city of New Westminster has drawn its water supply from Coquitlam Lake since 1892, and as the raising of the lake level rendered the original municipal intake works useless, an entirely new intake has to be provided. For the protection of the New Westminster water supply, extensive clearing operations along the shores of the lake were carried out by the company.

Hydraulic Tunnel

The total length of the tunnel which conveys water from Coquitlam Lake to Lake Buntzen is 12,650 feet. It originally had a square section, about 9 by 9 feet, with rounded corners, and was designed to carry 500 c.f.s. The area of the section was subsequently enlarged to 192 sq. feet, which is sufficient for the ultimate carrying capacity required by the scheme. The intake to the tunnel was rebuilt when the new dam was constructed. It consists of a heavy masonry retaining wall, founded on bedrock, and built against the steep hill above the tunnel entrance. This entrance is protected by a rack, and two independent sets of head-gates are provided for controlling the flow of water through the tunnel. One of these gates is of the Coffin type, 9 feet in diameter; the second set consists of two Stoney sluice gates placed side by side.

A range of mountains, which reaches an elevation of 4,000 ft., separates Coquitlam and Buntzen lakes. The watershed of Lake Buntzen is 7 square miles and the average annual precipitation during the last twelve years has been over 110 inches. The area of the lake is about 500 acres, and, by the construction of a concrete dam, 54 feet high and 361 feet long on the crest in a canon below the outlet, the lake has been made into an excellent forebay. The crest of the dam is 400 feet above sea-level. Ten outlets 24 inches in diameter and two outlets 24 inches in diameter were provided. To these are connected the pipe-lines which convey water to power house No. 1.

Power House No. 2

The water for power house No. 2 is obtained from Lake Buntzen, through a concrete-lined pressure tunnel, 14 feet 8 inches in diameter and about 1,800 feet long, driven through solid rock and controlled by three Doble needle intake valves, placed with their seats on a concrete foundation on the bottom of the lake. These needle valves are operated by oil pressure, and an outer cylinder is provided which may be lowered down to a horizontal seat, enabling them to be inspected without the use of a diver. Near the lower end of the pressure tunnel and close to the top of the hill a steel surge tank, 50 feet in diameter, is provided, and from this point three steel pipe lines conduct the water to power house No. 2. These pipe lines are each 8 feet 6 inches in diameter at the surge tank and taper to a diameter of 7 feet at the power house. About 200 feet from the power house the pipe lines pass through tunnels driven in the solid rock. A Pelton-Doble-Venturi butterfly valve is installed in each pipe-line.

No. 1 Power House

No. 1 power house is situated on the east shore of the north arm, about sixteen miles from Vancouver. The buildings were erected from the granite blasted out to form the site for the generating station. The main floor is about 5 feet above high water. The original in-

stallation has been added to from time to time. Steel penstocks convey water from the intake dam at the outlet of Lake Buntzen. Units Nos. 1 to 4 are each supplied by means of a pipe line 48 inches in diameter and 2,000 feet in length. Two pipe lines 60 inches in diameter are provided for the fifth unit. One pipe line, 84 inches in diameter at the upper end and tapering to 72 inches at the power house, is provided for the sixth unit, and a similar pipe line conveys water to unit No. 7. The present equipment consists of four 3,000 h.p. Pelton water-wheels, driving four 1,500 k.w., 3-phase, 60 cycle Weston House generators; one 10,500 h.p. Pelton water-wheel, driving one 5,000 k.w., 3-phase, 60-cycle Canadian General Electric generator; one 10,500 h.p. Doble water-wheel, driving one 5,000 k.w., 3-phase, 60-cycle Dick-Kerr generator, and one 10,500 h.p. Doble water-wheel, driving one 5,000 k.w., 3-phase, 60-cycle Canadian General Electric generator. All of the above units have a speed of 200 r.p.m. and are of the horizontal type, the water-wheel and generator being, in each case, mounted on the same shaft. In addition to the above equipment there are four exciter units, each a direct current generator with an induction motor at one end of the shaft and the water wheel on the other. The transformers and high tension switching equipment are housed in a separate building erected on the hillside behind the power house.

In 1911, as it was impracticable to build further extensions to power house No. 1 a new site was selected, about one-third of a mile south. Power house No. 2, of reinforced concrete, erected on solid rock, is a fine building of massive proportions and careful design. It contains three horizontal units, each consisting of four Pelton-Doble water-wheels, the combined capacity of which is 13,500 h.p. They are mounted on one shaft, together with the revolving field of a Dick-Kerr 8,900 k.v.a., 3-phase, 60-cycle alternator. Close to the back wall of the power house the main pipe line divides into four branches, each branch supplying water to one wheel of the unit. The speed of each unit is 200 r.p.m., and regulation is secured by a Lombard governor, auxiliary relief nozzles being provided. There are three 300 k.w. exciter units, consisting of a Dick-Kerr induction motor generator set, direct driven by one Pelton-Doble water wheel mounted on one end of the shaft. The transformer room and switching equipment are located in the same building.

Current is generated at 2,200 volts and stepped up to 34,600 volts for transmission to substations in Vancouver and adjacent territory. It is understood that the transmission voltage will soon be increased to 60,000 volts. The two outgoing circuits from plant No. 1 are carried on wood poles; the other two circuits —the outgoing lines from plant No. 2— are carried on steel towers. A tie-line connects power houses Nos. 1 and 2

The plants and equipment above described reflect great credit upon the company and its engineers.

Victoria Power Supply

Power and light are supplied to the city of Victoria by the British Columbia Electric Railway Co. and its subsidiary, the Vancouver Island Power Co.

There are two hydro-electric plants, one at Goldstream, twelve miles from Victoria, and the other at Jordan River, forty miles distant. There is also a steam electric plant at Brentwood Bay, twelve miles distant.

Prior to 1898 the city was supplied with light and power from steam plants situated within the city limits, and also owned by the British Columbia Electric Railway Co.

Goldstream

In September, 1917, an agreement was made with the Esquimalt Waterworks Co. for the supply of a maximum and minimum daily amount of water to the British Columbia Electric Railway, for a hydro-electric plant to be built at Goldstream. This agreement stipulated that all water supplied for power purposes would be returned to the waterworks company's reservoir below the power house site, and in condition suitable for domestic use. 1898 the British Columbia Electric Railway Co. constructed its Goldstream power house.

The Esquimalt Waterworks Co. has five storage reservoirs at Goldstream, situated at elevations of from 1,200 to 1,500 feet above sea level. From them the water flows first to a balancing reservoir of 3,500,000 cu. ft. storage capacity, and at an elevation 1,100, then through the Goldstream plant and thence to a lower reservoir at elevation 450, affording a head of 650 feet. The capacity of these reservoirs is sufficient to take care of considerable daily fluctuations. The penstock bringing water from the balancing reservoir to the power house consists of 4,000 feet of 33 inch, and 4,000 feet of 30 inch steel pipe.

The initial equipment, which went into operation in September, 1898, consisted of two Pelton water wheels of 600 h.p. each, direct-connected to two 350 k.w., 3-phase, 60-cycle, 700-volt generators. In 1903 a third unit of 500 k.w. was installed. In 1905 a fourth direct-connected unit of 1,000 k.w. capacity was added, and is driven by two water wheels, each of 1,000 h.p. The energy is stepped up from 700 to 17,500 volts and transmitted over a two-circuit, single-pole transmission line twelve miles long, to Rock Bay sub-station at Victoria.

Jordan River

The second hydro-electric plant supplying power to Victoria, is situated at the mouth of Jordan River, which flows into the strait of Juan de Fuca, about 40 miles west of the city. The Jordan is a mountain stream, flowing in a southeasterly direction through a deep and precipitous valley. It drains about 61 square miles—the greater portion lying at an elevation of over 1,200 feet. The entire watershed is heavily forested. The drainage area above the intake,

REVELSTOKE HYDRO-ELECTRIC DEVELOPMENT, ILLECILLEWAET RIVER. SHOWING INTAKE DAM AND WOOD STAVE PIPE LINES.

including the area above Alligator Creek diversion, is 50 square miles.

The precipitation on the western slope of Vancouver Island is heavy. At the mouth of the Jordan river it averaged, during the period 1908 to 1915, about 70 inches annually, and, in the vicinity of Bear Creek, at an elevation of 3,600 feet, an average of about 95 inches has been recorded during the last five years. Probably the average over the whole watershed exceeds 90 inches per year. At the higher altitudes, there is a heavy fall of snow during the winter months, which often remains on the ground until June or July. When this snow disappears, the flow of the Jordan falls off very rapidly. To compensate for low-water flow, storage reservoirs have been provided. Although there are no large lakes in the watershed, five sites, suitable for storage dams, have been located. Two of these dams, known as the Bear Creek dam and the Jordan dam, are now completed.

TYPE OF CONCRETE LINED DITCH.

Bear Creek flows into the Jordan 3½ miles above the main diversion dam. The storage dam on this creek lies about a mile above its junction with Jordan river. It is an earth hydraulic-fill embankment. Its greatest height is 57 feet, and the length, on the crest, is 1,020 feet. Impermeability is secured by a sheet-steel-piling curtain wall driven to a bedrock across the valley. It is proposed, ultimately, to raise this embankment to 75 feet. A spillway is excavated out of solid rocks at the north end of the dam. This dam forms a lake of 285 acres, and provides storage of 328,000,000 cubic feet. The area of Bear Creek watershed above the dam is about 8 square miles. The dam was commenced in November, 1910, and completed in April, 1912.

The Jordan dam (see Plate 4) is on the Jordan river, immediately below the junction of Wye Creek. Here the canon narrows, and is crossed by a ridge of rock which extends well up both sides of the canon. This site was early recognized as the best for a permanent dam.

The Jordan dam is a hollow, reinforced-concrete structure of the Ambursen type. Its extreme height is 126 feet above sea-level. The upstream face of the dam consists of a reinforced-concrete face, or deck, inclined at an angle of 45 degrees. This is supported on concrete buttresses, spaced 18 feet centre to centre. These buttresses are 12 inches thick at the top, and increase, by steps of 12 feet in height, to a thickness of 42 inches at the bottom of the highest buttress. The down-stream edge has a batter of 1 to 4 from the base to a point 18 feet below the crest, above which point it is vertical. A spillway, 305 feet long, with a crest 8 feet below the top of the dam, is provided near the east end. The spillway has a curved crest and rollway apron, and provides for a discharge of 23,000 cubic feet per second.

The main flume, for about 5½ miles, follows the eastern side of the Jordan valley from the dam to the forebay reservoir. The side of the valley is steep for the entire distance, and precipitous in places. The flume is 6 by 6 feet, with a grade of 1 foot in 1,000, and designed to carry 175 c.f.s. Five sand boxes, with gates in the side of the flume, are provided.

The forebay consists of a small artificial lake of 4,350,000 cubic feet storage capacity, formed in the flat between two hills by two earth-filled embankments. These were built of the material excavated from the higher ground lying between them, thus adding to the capacity of the reservoir. The maximum height of each dam is 35 feet. Suitable spillway is provided. Two steel pipes, with 54-inch diameter sluice gates, connect at the dam to the pipe-lines which convey water to the power-house. One provides water for units Nos. 1 and 2, the second serves unit No. 3. The pipe-line serving units Nos. 1 and 2 is 44 inches in diameter and 3,010 feet long. At its lower end a Y is provided for two pipes, each 6,280 feet long and 36 inches in diameter at the upper end, tapering to 30 inches diameter at the power-house. Both pipe-lines are controlled by gate valves placed just below the Y pipes. The pipe-line for No. 3 unit has a total length of 9,290 feet, and tapers from 54 inches in diameter to 48 inches at the power-house. The head at the power-house is 1,145 feet.

The original power-house, as completed in 1911, was a concrete structure with two units each of 4,000 kw. capacity. Recently, it has been enlarged; a new 8,000 kw. unit has been added, space has been provided for a fourth unit, and a new high-tension switch-room has been built. The power-house is of reinforced concrete, resting on concrete piles, 12 inches in diameter, penetrating to bed-rock at a depth of 45 to 75 feet. It contains three units. Units Nos. 1 and 2 each consist of a single Doble water-wheel of 6,000 h.p., coupled direct to a 4,000-k.v.a., Allis-Chalmers-Bullock, 3-phase, 60-cycle generator, at a speed of 400 r.p.m. Speed regulation is obtained by a Lombard oil pressure governor. No. 3 unit consists of one 8,000-k.v.a., 3-phase, 60-cycle, Canadian General Electric generator, driven by two Pelton-Doble water-wheels, one mounted on each end of the shaft. The water-wheels are together rated at 13,000 h.p. Each wheel of No. 3 unit is provided with a separate oil-pressure, relay-type Pelton-Doble governor. There are three exciter units, two of which consist each of a 100-kw., 125-volt, d.c. generator, direct-driven by a 150-h.p. water-wheel, and also by a 150-h.p. induction motor. The third is a 200-kw., 125-volt, d.c. generator, on the shaft of which are mounted a 300-h.p. induction motor and a 200-h.p. water-wheel. Water is supplied to the exciter units from a header connected to all three pipe-lines. Valves are arranged so as to permit any exciter unit to be driven by water from any pipe-line.

Current is generated at 2,200 volts, and stepped up to 6,000 volts for transmission to Victoria. The transmission line is about 37 miles long. For about 15 miles the line, which is of aluminum cable, follows the shore, and then strikes inland to Victoria, terminating in the Rock Bay sub-station. The poles are of cedar, cut along the line. Cross-arms for two circuits are provided, but only one has been installed.

City of Kamloops

Kamloops, in 1915, completed the first portion of its hydro-electric development on the Barriere River, which falls into the North Thompson from the east, about 40 miles from the city. The total drainage area of the Barriere is about 350 square miles. It divides 12 miles above its mouth, and both branches have their source in the mountainous district between Adams Lake and the North Thompson River. The watersheds are generally well wooded with fir, spruce and cedar, but, in some parts, there is a dense covering of small growth. The snowfall of the district is heavy, and severe weather is occasionally experienced. On both branches of the river, there are lakes which afford good storage sites; one of these, Barriere Lake, through which the main stream, the north branch, flows, has been utilized for storage for the present development. The area of the watershed above the outlet of the lake is about 135 square miles, and Barriere Lake has an area of some 3,600 acres. A storage and intake dam has been built at the outlet of the lake, and, from this point, water is conveyed to the forebay in a 5 by 8-foot flume, 18,000 feet in length. The forebay is fitted with sluice-gates and provided with spillway. Penstocks, 500 feet long, convey the water to the power-house, which is situated on the north bank of Barriere River. The head developed is 190 feet.

The present power-house has been built to accommodate four units, two of which are at present installed. Each unit consists of a 1,200-h.p. Francis turbine, manufactured by the Platt Iron Works, direct connected to a 750-k.v.a., 3-phase, 60-cycle alternator, supplied by Canadian Westinghouse Co., generating current at 2,300 volts. These sets run at 720 r.p.m., and are controlled by direct-acting Lombard governors.

The voltage is stepped up to 44,000 volts, for transmission to Kamloops. It is anticipated that there will be a considerable demand for power to pump water for irrigation along the North Thompson valley, which is traversed by the transmission line. The ultimate development possible on the Barriere River is between 16,000 and 20,000 h.p.

To provide against interruption to the hydro-electric service, due to winter troubles or breakdowns on the long transmission line, it was deemed expedient to provide a steam auxiliary plant in the city. As the demand for increased power was urgent, and a steam plant was more easily constructed, it was first completed. The power-house building is situated in Kamloops, near the banks of the Thompson River. It is of reinforced concrete, and contains the pumping plant for the domestic supply to the city. The boiler room contains four Babcock & Wilcox boilers, of 250 h.p. each, designed to operate at 160 lbs. pressure. The turbine-room equipment consists of two Curtis turbo-alternators, of 900 kw. capacity, built by the General Electric Co. The alternators are 3-phase, 60-cycle, 2,200-volt machines, operating at 3,600 r.p.m. Motor and steam-driven exciters are provided, also the usual condensing and auxiliary plant. The high-tension sub-station receives current from the 44,000-volt lines from the Barriere River plant, and reduces the pressure to 2,300 volts for local distribution. Complete switching equipment is provided.

The city now has at its disposal about 5,000 h.p. of electrical energy. As the demand for power increases, it is intended to increase the capacity of the plant at Barriere River and retain the steam plant as a standby.

The cost of the initial hydro-electric development is about $140 per h.p.; the installation of a further 4,000 h.p. will reduce the average cost per h.p. to $90, and it is estimated that, when the ultimate development is carried out, the cost per h.p. will be reduced to about $80.

City of Nelson Development on Kootenay River

The city of Nelson has constructed a hydro-electric power plant at Upper Bonnington Falls, on the south side of the Kootenay River. This plant supplies light and power to the city, and for mining purposes in the adjacent territory.

The site selected for this development was examined and staked at the end of 1900, the water record was granted on January 15, 1901, and the city secured title to the site for the proposed plant January 22, 1903. The plan adopted provided for a plant of four units, each capable of developing 1,250 h.p. under the minimum head of 40 feet available at high water, or 1,675 h.p. under the 60 feet head available at low water. Work was commenced April 3, 1905, but, owing to trouble, chiefly in connection with the disposal of the excavated material, the work was held up from time to time. Further delays occurred in the shipment of the plant, and it was not until December 28, 1906, that water was turned on the turbine of the first unit installed.

The power-house is of brick on a concrete foundation. The foundation is raised to the elevation of the turbine floor for four units, but the superstructure is completed for two units only. The present installation consists of two Allis - Chalmers turbines, with a maximum capacity (at highest head) of about 2,000 h.p. each. These are directly connected to Allis-Chalmers 3-phase generators, one of 750 kva., and one of 1,000 kva. The umbrella type of construction adopted enables full advantage to be taken of the total head available at any stage of water. Speed regulation is

WOODEN FLUME SKIRTING MOUNTAINSIDE

secured by oil-pressure governors. Power at 12,000 volts is transmitted 9½ miles on a right-of-way purchased by the city. The transmission line consists of two circuits of stranded aluminum cable carried on cedar poles. The city of Nelson operates its own electric street car service.

City of Prince Rupert Development at Woodworth Lake

Woodworth Lake, situated about 7 miles from Prince Rupert, has an area of 500 acres. The watershed area is about 9.5 square miles, consisting mostly of steep hillside, with very little timber on the upper slopes. The mountains rise to about 4,000 feet. There are several snowfields, but no glaciers within the drainage area. This project was investigated in 1910-12, and plans placed in operation in November, 1914.

Investigation of stream-flow revealed a high run-off, and it is anticipated a flow of from 80 to 100 sec. feet will be available for power and domestic supply. A storage dam 35 feet in height was built. The power-house is 7,500 feet below the lake, and a head of 330 feet is developed by means of a 45-inch steel pipe 7,800 feet long. The power penstock is also partly used for water supply purposes. Immediately behind the power-house is attached an 18-inch steel pipe-line, 14,000 feet long, which connects with an existing 18-inch water supply pipe near the auxiliary pumping station at Shawatlans Lake, about 5 miles from the city.

A power-house of simple design has been erected. The initial installation consists of one water-wheel of 1,650 h.p. capacity, direct connected to a 1,125 kva., 3-phase, 60-cycle, 4,400-volt, at 514 r.p.m., Canadian General Electric generator. Close regulation is secured by oil-pressure governor. A 15-kw. exciter is connected to the main units. Voltage is regulated by a Tirrell regulator. The energy is transmitted to the city over a single circuit wood-pole transmission line.

City of Revelstoke Development on the Illecillewaet River

The Illecillewaet River drains about 480 square miles of the western slope of the Selkirk Range, and discharges into the Columbia River near Revelstoke. Its valleys and the lower slopes of the mountains are heavily wooded; above the timber line, there are numerous snowfields and glaciers. The precipitation in the valley varies from 42 inches near Revelstoke to 58 inches near Glacier, and, over portions of the watershed, no doubt exceeds the latter figure. The winters, with occasional spells of very low temperature and heavy snowfall, are severe, and serious ice troubles have been encountered. The river is a typical mountain stream. (See Plate 16.) Its flow varies from about 250 sec.-feet to over 9,000 sec.-feet.

LOWER BONNINGTON FALLS, KOOTENAY RIVER, WEST KOOTENAY LIGHT AND POWER CO.'S PLANT NO. 1 IN FOREGROUND. UPPER BONNINGTON FALLS IN BACKGROUND.

The Revelstoke hydro-electric development is situated about 1½ miles from the mouth of the river. A concrete dam, 56 feet high, has been built across the canon, creating a pondage of about 10 acres. Two 6-foot diameter wood-stave pipes carry the water about 1,200 feet downstream to a power-house, where a head of 72 feet is developed.

The power-house equipment consists of a 900-h.p. Francis turbine, driving a 450-kva. Canadian Westinghouse generator, at a speed of 450 r.p.m.; also a 1,400-h.p. Escher-Wyss-Francis type turbine, direct connected to a 750-kva. Canadian Westinghouse generator running at 360 r.p.m. Exciter units, in each case, are direct connected. Speed regulation of the 1,400-h.p. unit is secured by an oil-pressure governor and of the 900-h.p. unit by a mechanical governor current, at 2,300 volts, 3-phase, 60-cycle, is supplied to Revelstoke and to the shops of the Canadian Pacific Railway. To ensure against interruption to service, due to low water, ice, or other causes, a gas engine auxiliary plant has been provided.

Western Power Company of Canada, Ltd., Development on the Stave River

The first application for a water record at Stave Falls was made in 1899, by the Stave Lake Power Co., Ltd. In 1909, the Western Canada Power Co., Ltd., was formed, for the purpose of supplying power, in ample quantity and at prices sufficiently attractive, to encourage the establishment of industries in Vancouver and its vicinity. In June, 1909, the company took over the Stave Lake development, and the first unit was placed in commission in January, 1912.

Stave Lake lies to the north of the Fraser River, and about 35 miles from Vancouver city. The watershed has only been partially explored. It has an area estimated at about 450 square miles, and lies among the granite peaks of the Coast mountains, which, rising high above the timber-line to over 8,000 feet, carry perpetual snow and numerous small glaciers. The length of the river, from its source in a glacier to its confluence with the Fraser at Ruskin is about 60 miles.

The original elevation at Stave Lake was about 230 feet above sea-level, with a fluctuation between high and low water of about 15 feet. The lake was 9 miles long by about a mile wide with precipitous shores to the east and west. From the foot of the lake to Stave Falls the river descended 80 feet. Below the falls, for a distance of 4 miles, there is a series of rapids, and the river finally debouches through a narrow granite gorge into the Fraser River.

The present Stave Lake development utilizes the head available in the immediate vicinity of the falls and also the head concentrated at that point by a dam, which drowns the rapids above and the large areas of low land at the head and the lower end of the lake. The working head varies between 100 feet at low-lake level and 120 feet with full reservoir. Very careful preliminary investigation was made of hydraulic conditions. This included extensive surveys, measurements of water supply, precipitation, flood conditions, etc.

The raising of the level of Stave Lake

materially increased its area. At a stage of 269, the lake extends for 18 miles above the dam, and its area at this stage is about 24 square miles. This reservoir will have a storage capacity of nearly 370,000 acre-feet, sufficient to maintain a mean flow of about 3,150 sec.-feet in lowest years yet recorded and somewhat more in average years. The average flow over a number of years has been about 4,000 sec.-feet, but the physical conditions at Stave Falls are such that it is not economically feasible to build a dam to an elevation of about 300 feet, which stage would be required to completely store the mean flow over the years of record. The most economical height of dam is that which would maintain a flow line at elevation of about 264 feet above sea-level.

In its natural state the main river divided into two branches about 400 feet above the falls, re-uniting about one-half mile downstream. The intake and sluice dams have been built at the head of the falls. The power house is built across the western channel, below the intake dam, and the eastern channel is utilized for the overflow and flood discharge from the sluice dam. When the lake is raised to the ultimate elevation proposed, the present sluice dam—now designed to take practically the whole flood discharge of the river—will be built up solid, with a row of gates on top for partially controlling the flood discharge and the main flood discharge will pass down an old channel about one-quarter mile to the east of the falls, known as the Blind Slough. For a flow-line at elevation of 239 (sea-level), the Blind Slough forms a natural rock spillway-dam 400 feet long, with a channel 50 feet wide and 20 feet at one side. The deep portion is at present closed by a timber crib-dam, and a temporary spillway of low elevation is built across the remainder of the channel. The permanent structure will consist of concrete piers, with log sluices, and will make ample provision for flood discharge.

The sluice dam is 150 feet wide, built of reinforced concrete. The piers are 8 feet wide, with five stop-log openings, each 22 feet wide. The intake dam is of concrete on a granite foundation. It is 160 feet long, and, when completed, will be 70 feet high. There are four main intakes, with necessary screens. The intake gates are of the radial type and weigh 23 tons each. In addition, there are two gate chambers for pipes to the exciter units.

The main penstocks are 14 ft. 6 in. diameter. The upper ends are imbedded in the concrete and belled out to 19 feet, giving a maximum velocity at the mouth of 4.6 feet per second. There are two separate 46-inch steel penstocks for the exciter units and oil pumps. The penstocks are not more than 150 feet long, thus securing excellent regulating conditions. The tailrace, 1,500 feet long, was excavated to a depth of about 30 feet.

The power house, constructed of reinforced concrete on solid rock foundation, was designed for four main units, but first completed for two, with the necessary auxiliary equipment. Each main unit consists of a 13,000 h.p., double horizontal turbine of the Francis type, built by the Escher-Wyss Co., of Zurich, Switzerland, direct coupled to a 9,000 kw., 3-phase, 60-cycle, 4,400 volt Canadian General Electric generator. There are two exciters, each 250 kw., 125 volts, driven by its own turbine, and each capable of exciting four machines. Regulation is secured by governors of the oil-pressure type, the oil pumps being driven by individual impulse wheels.

The current is stepped up to 13,000 volts and 60,000 volts, and, at the higher tension is transmitted 32 miles to Ardley, a point about midway between Vancouver and New Westminster. Another line runs south to the international boundary, where it connects with a line built by the Puget Sound Traction, Light and Power Co. into Bellingham, the total distance being 47 miles. At 13,000 volts the current is transmitted to points within 20 miles of the generating station.

From the tailrace of the existing plant to the mouth of the river, an additional fall of 130 feet is available. Two plans of developing this fall have been considered. One plan contemplates a concentration of the head at the narrow gorge near the mouth by the construction of a dam 165 feet high. The second plan provides for two dams, each 65 feet high, one at the above gorge, and one about a mile below the present plant. The latter plan involves less initial expenditure, and would enable the plant capacity to be increased by stages with the increasing demand until ultimately turbines aggregating some 120,000 h.p. had been installed. This would complete the development of the Stave River.

West Kootenay Power and Light Co.,

The West Kootenay Power and Light Co., Ltd.—a pioneer in the development of water-power on a large scale in British Columbia—owns and operates three hydro-electric generating plants. Two of these are at Bonnington Falls, on the Kootenay River (see plate 15), and the third is situated on the Kettle River, about twelve miles below Grand Forks.

These developments are the largest and most important in the interior of British Columbia, and furnish power and light to the cities of Trail, Rossland, Grand Forks, Phoenix, Greenwood, Boundary Falls, and to other users within the radius of the transmission lines.

In 1897, the gold and copper mining industries in the Kootenay country were practically undeveloped. At that time a small smelter was in operation at Trail, and mining operations were in progress at Rossland, but the total amount of energy utilized at these two points probably did not exceed 1,000 h.p. In this section of British Columbia, the mines and smelters are the largest consumers of power, and, to-day, the connected load in the vicinity of Rossland alone has increased to over 6,000 h.p. The great development of the mining and allied industries has been largely facilitated by the supply of power made available by the developments of the Kootenay Power and Light Co.

Plant No. 1, Lower Bonnington Falls

The first plant, now known as Bonnington Falls, Plant No. 1, was commenced in 1897. It is situated at Lower Bonnington Falls, and has a capacity of 4,000 h.p. under a normal working head of 34 feet. The equipment consists of three units; one turbine unit of 2,000 h.p., direct connected to one generator of 1,500 kw.; and two turbine units of 1,000 h.p., each direct connected to generators of 750 kw. The turbines are twin runners of the horizontal type. The generators are 3-phase, 60-cycle. The sets run at a speed of 180 r.p.m. Current is generated at 1,100 volts and stepped up to 22,000 volts.

Plant No. 2, Upper Bonnington Falls

Plant No. 2 is situated at Upper Bonnington Falls, a short distance above No. 1. The power house is of reinforced concrete, situated in the channel immediately below the falls, on the north side of the river. The building and intake structure form a wing dam, which diverts the water to the turbines. The head developed is 63 feet at low-water stage, but, during high water, it is reduced to 56 feet by backwater caused by the contracted area of the channel a short distance below the falls. The working head, it is estimated, may be increased to 70 feet by the removal of obstructions in the channel below, and the erection of a low dam across the river above the falls. This work is now underway.

Space in the power house provides for four main generating units, two exciter units, and the necessary transformers and switching apparatus. The main units, all of which are now installed, consist of two 8,000 h.p. Francis turbines, with vertical shaft, each direct connected to a 5,625-kva., 3-phase, 60-cycle Canadian General Electric generator of the umbrella type, and two 9,000 h.p. Francis turbines with vertical shaft, each direct connected to similar generators of 7,500 kva. The sets run at a speed of 180 r.p.m., and regulation is by oil-pressure governors.

Current is generated at 2,200 volts, and stepped up to 60,000 volts, at which it is transmitted to sub-stations at Greenwood, Rossland, Grand Forks, Phoenix and Boundary Falls—the last named being 84 miles from Bonnington.

Continued on page 17

The Increasing of Power Plant Efficiency

The Human Factor is of Vital Importance in the Problem of Increasing Power Plant Efficiency. This Element is Discussed in This Article Which Deals With Various Phases of the Subject

By ROBERT JUNE, Mechanical Engineer

IN previous articles, we have discussed various power plant instruments, and a number of types of equipment, indicating conditions under which these could or could not be used advantageously, and suggesting methods of effecting economies in operation. Since our discussions have followed the lines of accepted good practice, the points brought out and methods suggested, have the sanction of authority and constitute a valuable plan of procedure in our program of increasing power plant efficiency.

It is one think to lay out a program, however, and another to execute it, as anyone who has ever tried to stimulate the morale of an operating force and increase the efficiency of power production, knows. The problem of economical boiler and furnace operation contains a large psychological factor which must be taken into account, if satisfactory results are to be secured.

Let us assume that it is desired to increase the efficiency of a given plant. The first step is the installation of necessary recording apparatus. Very few instruments are needed for an ordinary plant, but these must be regularly used and the records reviewed and studied. It is a waste of money and effort and will defeat our purpose to go into greater instrumental refinements than the operator can intelligently understand and handle in every particular.

This we can say unreservedly; every boiler setting should have a draft gauge and draft gauge system capable of instant and constant indication of boiler outlet and furnace draft. Accurate water measuring and coal weighing devices are desirable. The chief engineer of a plant of say 600 horsepower or larger should also possess a standard orsat or gas-handling set, and temperature records and observations should be preserved.

Supposing, now, our plant to be equipped as described. The business of effecting conservation in a steam generating plant goes far beyond a mere experiment by trial of the sources of preventable loss and the making of suggestions for improvement. If improvements are to be made they must be under the direction of a competent individual. This may be the chief engineer or boiler room superintendent, or it may be that an outside efficiency engineer is called in. In any event the individual who is to be responsible for the improvement has a job on his hands requiring, above everything else, tact and good judgment.

Let us take, first, the case of the outside so-called efficiency engineer, who is called in to investigate plant conditions with the object of effecting power improvements. The personality of this man is, by all odds, the first and most important consideration. His work will be a bitter disappointment to his client if he does not possess the ability to advance his technical findings in a way that will call into play the loyalty, skill, and energy of the men over whom he is to have more or less supervision. It is infinitely preferable to engage a man of mediocre technical education and experience, who is possessed of tact and personal likableness, than to employ a more learned but tactless scientist, so far as permanent benefits are concerned. Let us see why this is so.

Outside supervision is decided upon. The engineer assigned to effect the improvements visits the plant and goes over its layout; he questions the operating forces, conducts certain preliminary tests, and perhaps places in the boiler room an assistant more or less equipped with knowledge and instruments. The results of this preliminary investigation is usually a report between 20 and 40 pages long, containing statements of fact as to adaptability of fuel, draft, gas analyses, plant routine, and operating methods; it is apt to contain criticisms with respect to all of these; it may attempt to show the effect of one deficiency upon all the rest. In hardly any instance is the plant fully equipped for first-grade performance. Therefore suggestions are offered to the management, with respect to certain changes or additions to be provided in the equipment, and the reasons are given to support such recommendations. This is all very well. After the management has

INSTRUCTIONS TO FIREMEN

Details

1. On hand fired furnaces. After shaking grates, take scraper and push fires to the rear, leaving bed of hot coals 2" to 3" thick. Throw green coal in front to required thickness, spread lightly in the rear.
2. Maintain level fuel bed at all times.
3. Fires must be cleaned every twelve hours on load less than 2000 KW.
4. Fires must be cleaned every eight hours on loads in excess of 2000 KW.
5. On hand fired furnaces only one fire door may be opened at a time.
6. Weigh and record all coal placed in stoker hoppers.
7. Do not let supply of coal in stoker hoppers fall below level of top of hopper.
8. Keep continuous flow of feed water into boilers.
9. When shifts are changed have feed water at normal level.
10. Blow down boiler every twenty-four hours, starting with boiler #1 at 10 o'clock P. M. Open and close blow-off valve slowly, allowing 2 minutes by watch for complete operation.
11. Operate soot blowers on all boilers three times in twenty-four hours, starting with boiler #1 at 9 A.M. 5 P.M. and 1 A.M.
12. Blow soot blower units from front to rear of boiler, starting with Unit A in first pass, allow three revolutions of the blower element then shut off steam on this unit and operate unit B in a similar manner, etc.

gone over the report it gives the chief engineer a chance to mull it over, and from him it receives back a guarded criticism of the findings. He praises the report faintly, and, because the operating forces have proven themselves loyal and capable in the past, in so far as the management has been able to determine, the effect is to delay constructive action on the programme outlined in the report.

Now, why does the operating engineer look upon the efficiency man with a cold eye? Well, in the first place, when it comes to intimate knowledge of the details of operation, such as likelihood of sudden extreme demands for steam, or the reverse, the operating man knows from experience the situation in his plant, while the outsider cannot possibly get it all. The efficiency engineer, therefore, is at a disadvantage. Very likely the operating engineer will, in his own mind, lay great stress upon some minor matter, while overlooking important phases of operation, and the mere fact that something known to him has not found its way into the report prominently causes him to discount all the rest.

Operating forces are only human, and the spirit of resistance is set up against any suggestions offered by the outsider. Now the technique of operation has a more important bearing on the attainments of high efficiency in boiler practice than any other factor, consequently, unless the efficiency engineer can win the confidence and backing of the operating forces, his work will be valueless. Modern production practice calls for rapid changes in methods, as new and better ways of doing things are discovered. If the boiler room in question supplies a large factory, the chances are that the management and all of the factory department heads are thoroughly alive to the frequent necessity of change. They live in an atmosphere of progress and do not hesitate to make radical changes in the location of machines and methods of handling operations, if these seem desirable. The boiler room is a different proposition. Here the tendency is to refer everything to custom and precedent. The operating men have performed their duties in certain individual ways, and no complaint has heretofore been registered against their methods Why, then, should a change be proposed.

The very first requisite of an improvement is, therefore, ample time in which to effect it. The services of the efficiency engineer are of value to the plant management in increasing proportion to the length of service; that is to say, if the efficiency engineer is to give sixty days time to the plant, his services will be six times as valuable to the management if the time is spread over a period of a year than if it is confined to two months, and three times as valuable over six months as over two. It takes about so long to work out resistance to change, and the operating forces must be given opportunity to accommodate themselves to the presence of one who stands, for the time being, closer to the management than they do themselves.

Granted tact and technical skill on the part of the efficiency engineer, it will still be very surprising if the operating forces are not more or less antagonistic to his presence in the plant for a period of two months or more. When the operating men finally realize that the efficiency engineer does not intend to recommend wholesale discharge, and that he is not in the plant for the purpopse of showing them up, but rather for the purpose of co-operation with them, to the end that they themselves may increase their own efficiency, they will begin to be stimulated by his efforts. If the efficiency engineer has real technical ability, as well as tact, they will begin to respect him for what he knows and for his character.

The process works two ways. The efficiency engineer discovers that his original impressions regarding the plant and the men were incorrect in many details. Real results are finally in a fair way to be attained when the operating man comes to look upon the efficiency engineer as a regular employee. It is then much easier to work together, and the efficiency engineer can set himself to the real test of his capability. This consists in so managing to suggest his thoughts and methods to the operating men that they will beat him to their expression and execution; in other words, they will adopt the thought or suggestion as their own.

At this point, if the efficiency engineer has managed to get the operating men to advance as their own the ideals he is seeking to inculcate, he, to some extent, negatives or deprecates them, the result may be beneficial, in that it may cause the operating men to make every effort to prove the correctness of their views, and since the idea is, as they believe, the creature of their own making, unquestioned support will be given to its successful accomplishment.

There is no question that the mental attitude of the operating force has an extremely important bearing upon the successful operation of the plant equipment. Thus it often happens that, in a plant containing one kind of mechanical stoker in successful operation, that when a new engineer comes on the job, differences will begin to be apparent in stoker operation which can be attributed more to the prejudice of the engineer than to lack of knowledge or ability on his part to operate the equipment properly. It is therefore of the greatest importance that any man, who is set up as an instructor over men who consider themselves already thoroughly trained and competent, should possess infinite tact and good judgment. When such a man overcomes the inertia of bad habits these will inevitably be replaced by the inertia of good habits.

The important thing to remember is that it takes time and much patience to accomplish the desired results. Some managers, it is true, do not have any great confidence in methods such as we have outlined, and, being impatient of results, believe that the quick and sure way to accomplish reform is to perform, at once, a surgical operation by discharging the old crews, or at least their chiefs.

It is the writer's opinion, backed up by the experience of men who have tried both methods, that the best results are not secured by wholesale firing. A new chief and new assistants are at a loss when it comes to detailed knowledge of plant conditions, and the time which it takes to familiarize themselves with

INSTRUCTIONS TO FIREMEN

General

1. Even load in the neighborhood of 10,000 pounds of steam flow per hour must be maintained on each boiler. Bank one or more boilers if necessary to secure the proper load on each boiler in operation.

2. Maintain even flow of feed water. Permit rise of 8 inches in gauge when load drops rapidly, and fall of 8 inches below normal in gauge in case of sudden demands on boilers.

3. For hand fired boilers. Use the spreading method, firing 8 to 10 shovelfulls at a charge, starting from rear and completely covering fuel bed.

4. For stoker-fired furnaces maintain even fuel bed thickness of 6 inches.

5. Go to instrument board after each firing. If necessary adjust damper draft and ash pit draft in accordance with actual load of steam flow obtaining. (See table in paragraph 6).

6. Regulate conditions as follows;

		Pound Hour.				
WHEN;	Flow per boiler is	8000	9000	10000	11000	12000
THEN	(Ash pit must be	1.2	1.4	1.5	1.6	1.8
	(Damper must be	0.03	0.04	0.05	0.08	0.10
	(Fuel bed must be	4"	4-1/2"	5"	5-1/2"	6"

7. Instrument readings must be recorded every 30 minutes on log charts.

8. Steam pressure must be maintained at 150 pounds per square inch at all times.

these details is largely lost. True, they are less inclined to criticize and withhold co-operation, but they are less capable of making helpful suggestions and of adopting the ideas put forth to the actual plant conditions. Unless there is actual insubordination and continuous attempts to hamper the work of the efficiency engineer, it is far better to retain the old men, who will have at the start of their education a close knowledge of the systems, materials, and equipment with which they have to work.

Instruction From Within

In the preceding sections of this discussion, we have considered the case of the outside efficiency engineer who is called in to improve the efficiency of the plant. All that has been said regarding the necessity for tact and good judgment and the use of a little practical psychology on the part of the efficiency instructor applies equally well if there is to be a permanent instructor inside the plant. That there is ample need for constant training and instruction of power plant employees, is a fact generally recognized by experienced engineers.

It is clearly the duty of the management to provide proper training for its employees, and any management which fails to do this is clearly negligent of its duties. Necessarily the means provided will depend entirely upon the size of the plant and the operating conditions. Thus, in a large central station there may be delegated permanent instructors with each shift in the boiler, pump, turbine, and high-tension rooms, on the switchboard, and with the repair gang, whereas in the smaller plant a single individual may act both as instructor and supervisor. Between these two extremes a number of variations are possible. The point should be clearly borne in mind that the expense of such training is small indeed in comparison with the savings which can be effected through the work of well-trained crews. As a matter of fact the savings can usually be made so large that they will cover many times over the expense of one or more high-priced specialists.

The truth must be realized that only by prolonged training can an adult, who has been given his own gait for many years, be brought to form new habits. He may recognize the value and importance of doing things by newer methods. Yet, if all his life he has been accustomed to doing them in a certain way it will take time, effort, and patience for him to change, yet because this change is absolutely essential it should be consciously and patiently striven for, by both instructor and operator.

The value of correct methods is apparent. Thus, boilers, during periods when tests are conducted by experts, give efficiency results which are almost never attained in average daily practice. Granted that the conditions of load and service during tests conformed to normal requirements, the only explanation of the failure on the part of the operating crews to maintain equally good efficiencies is that they do not carry on the work the way experimentors did. Lack of knowledge, and perhaps lack of incentive, are the real reasons for this failure. In very few plants do the firemen receive any training other than a few words of instruction, after which they are left to shift for themselves. As for helpers and coal passers, they are expected to learn by personal observation of the routine work done by others. Such a process of education, if such it may be called, is of entirely too long a duration at its best, and it is extremely wasteful in both fuel and labor.

After training and instruction have been given verbally and by example, until the men have reached a certain degree of proficiency, the time is at hand to standardize operations and to put them in writing. Typewritten instruction cards should be placed in the boiler room. These cards should detail all operations, and the men should be checked up on their knowledge and compliance with the typewritten instructions. Typical cards are shown in the accompanying illustrations. These cards can be worked out for each individual plant, and they are certainly desirable tools for effecting efficient operation.

WATER POWERS OF CANADA

At the regular meeting of the Toronto section of the American Institute of Electrical Engineers, held in the Engineers' Club on Friday, December 19th, a very interesting paper on the "Water Powers of Canada" was read by Mr. H. Harvey, of the Hydraulic Department, Hydro-Electric Power Commission of Ontario. The paper, which was illustrated by lantern slides, presented a summary of the extent of one of the great assets of the Dominion, and outlined some of the extensive developments under way or in contemplation at the present time.

The Maritime Provinces are not so abundantly blessed with water powers as is the remainder of Canada, but while large developments are not possible, there are many smaller powers available for use in the pulp and paper industry and for use in the exploitation of mineral resources. Quebec is very fortunately situated as regards potential water powers, and while large developments have already taken place, the greater portion of the water powers of the province still remain unutilized. There is, at least, 240,000 horse power still available and capable of easy development near Montreal, while the Saguenay River system and Lake St. John are capable of furnishing over 1,000,000 horse power. This, together with other potential water powers near Quebec City, will undoubtedly benefit industry in this vicinity. The water powers of Quebec will be of immense value in the exploitation of the mineral wealth of the province, and particularly so in electro-chemical and metallurgical industries.

The same applies to the water powers of Manitoba and within a radius of 100 miles of Winnipeg; it is altogether probable that large communities, dependent upon electro-chemical and metallurgical industries, will spring up. The fixation of atmospheric nitrogen for the making of fertilizer will undoubtedly be one of the most promising fields for manufacture, since Manitoba is so conveniently situated, as regards the grain-growing section of the country.

The Prairie Provinces have available considerable water power, the Bow River and the Saskatchewan being capable of considerable development, while the farther-north, the Churchill River emptying into Hudson Bay, has over 1,000 feet head throughout its course.

The Athabasca and Peace Rivers, too, are capable of development, but their location in the north country, emptying as they do into the Mackenzie River, which flows into the Arctic Ocean, renders them of value for the future only.

The Yukon and Klondyke regions have many water powers, and some of these are developed at the present time, the power generated being used in the operation of gold dredges.

The Province of Ontario is the largest industrial centre of the Dominion and at the same time is possessed of the greatest natural wealth in water powers. This is particularly fortunate, in that her coal resources are non-existent. The water powers of the province are divisible into four main divisions, the Ottawa River basin, the Great Lakes, the James Bay basin, and the basin tributary to the Winnipeg River area. The characteristics of these four basins vary greatly, and in some of them the results of deforestation, etc., are noticeable. This is particularly true of such rivers as the Grand and Thames, where the character of the river has been changed from one of comparatively uniform flow to one of excessive run-off, of little use for power or navigation. In all, Ontario possesses 5,000,000 horse power capable of development. This figure includes international boundary waters up to the treaty limit only.

In the paper, and in the discussion which followed, the importance of water power development was emphasized, and the necessity of eliminating the importation of the 25,000,000 tons of coal now brought into the country was brought out.

P. W. Ellis, chairman of the Niagara Falls Park Commission, took part in the discussion, and gave some interesting facts relative to the developments in the Niagara district. He also mentioned the extensive plans of the Commission for the making of this district into a national playground. The necessity for the fullest development of the Falls was also emphasized, and in the further discussion which followed that of Mr. Ellis, it was brought out that the probable limitation of the developments at the Falls would not be affected so much by the necessity for the preservation of scenic beauty as by ice removal. A sufficient amount of water during the winter months must flow over the crest to remove this source of trouble.

THE LARGEST WESTERN ICE PLANT

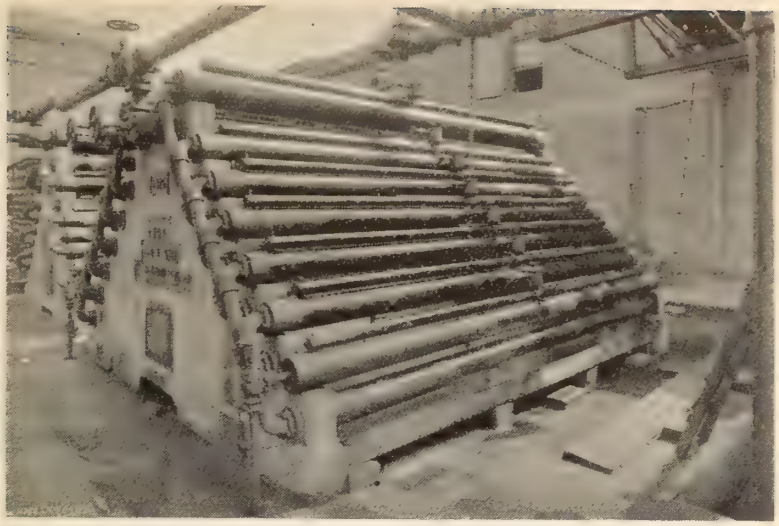
By FRANK C. PERKINS

THE accompanying illustrations, Figs. 1, 2 and 3, show the compressors, ammonia condenser of 8-inch pipe and ice tank of 800 lb. cans, with six control electric crane for lifting 3 cans at a time, as utilized in Denver, Colorado, at the 250-ton ice plant of the Colorado Ice and Cold Storage Co. The writer is indebted to George L. Vail, chief engineer, and Victor J. Azbe, consulting engineer, St. Louis, Missouri, for the photographs and data of this largest ice plant of the West.

It is pointed out that while the full capacity of the plant is 350 tons of ice per day, at which rate it is operated six months in the year, still during the cooler six months about 210 tons of ice is manufactured per day, of which 110 tons is put in storage for summer peak loads.

The boiler equipment includes six boilers, the steam pressure maintained being 130 lb. gauge, two of which are of the B. & W. water-tube type, each rated at 350 boiler-horsepower, connected to an economizer.

There are also two of the boilers of the Parker type and of 411 h.p. capacity each, with a short stack, making it necessary to use induced draft. Running the boilers at rating, a flue-gas temperature of 450 deg. F. was obtained. The last two boilers in the plant are of the Kewanee type, rated at 250 h.p. each and the boilers are hand-fired, the grates being of the Vail nozzle type. The air openings are round, one-half-inch diameter on the lower side of the grate and one-quarter inch at the top and the free air opening is 12.8 per cent. of the grate area. Colorado lignite is used, having a heat value of about 10,000 B.t.u. per lb. It is of the black variety and of higher grade than the brown Texas lignite. The boiler-feed water comes from an artesian well, and this water is excellent for boiler purposes, as it practically contains no scale-forming matter. The condenser circulating water is obtained from a surface well by means of two 6 in. centrifugal pumps directly connected to turbines, each having a capacity of about 2,000 gal. per min. This water is at a temperature of about 54 deg. F., summer and winter. It first passes over the ammonia condensers, leaves at about 75 deg. F., and at that temperature goes to the steam condensers. The characteristic of this water is that it begins to deposit heavy scale at a temperature of about 110 deg. F., so that the steam condensers become heavily coated in a short time.



CONDENSERS.

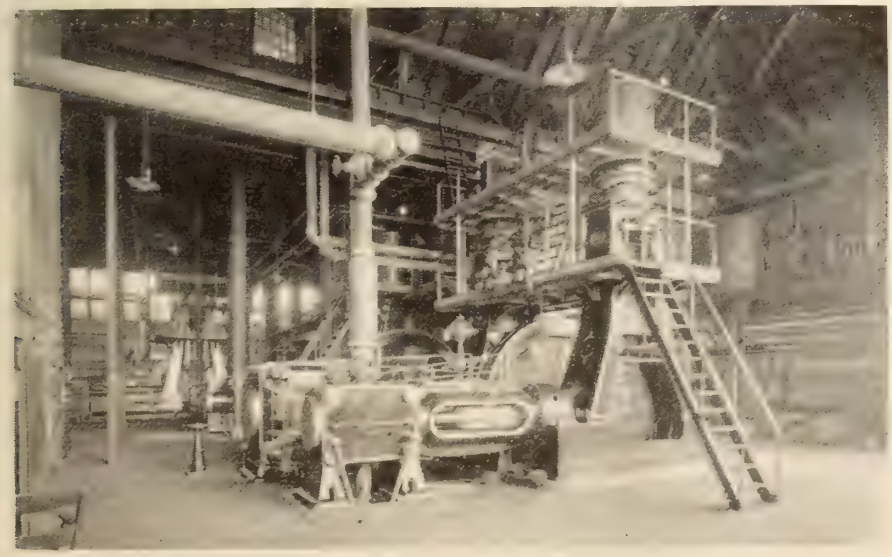
There are four refrigerating machines in use besides the usual auxiliaries. The engine room contains three 250-ton and one 75-ton refrigerating machines, one a cross-compound, one a simple Corliss with single-acting compressor cylinders, and two simple Corliss-driven compressors. The Corliss engine cylinders discharge at atmospheric pressure into steam condensers. These condensers are drums 10 ft. long and 37 in. diameter made of thin gauge copper. When the plant is operated under full capacity, there are 14 of these condensers in use, and since the full plant capacity is 350 tons of ice per 24 hours, then each unit condenses steam for 25 tons of ice each 24 hours.

There are several interesting features in the freezing system for 800-lb. ice blocks, the dimensions of the cans being 23½x12½ in. at the top; 22½x12 in. at the bottom and 7 ft. 11 in. long. As far as effort of pulling is concerned, there is less of it here than is usually encountered with the usual system employing cans of half the size. This is primarily due to the electric crane that is employed. This crane has six controls, one for raising, one for lowering, and the others for moving lengthwise of the tank or sidewise in either direction and no pushing or guiding is required, but while thawing there is no other effort required but controlling the crane.

It may be stated that the electric crane is designed to raise three blocks, or 2,400 lbs. at a time. The pulling is rapid and one workman in one hour will pull from 40 to 48 blocks. The cost of pulling per ton of ice is between two and three cents, and as the plant produces about 100,000 tons of ice per year, the saving by the improved system of pulling 800-lb. crane amounts to $12,000 per annum.

It is pointed out that in the ice tanks there are no ammonia coils, the tank having a double bottom and is fitted with compartments. When a can is inserted into its compartment, there is an inch space between the can and the compartment wall and the brine passes from a brine cooler into the double bottom through a ⅜-in. hole into each can compartment and up through the 1-in. space around the can. The brine level in the tank is maintained exactly at the level of the ice block when frozen and the brine overflows into a compartment, then to a tank, pump and brine cooler finally.

It is of interest to note that for a 50-ton system the tank occupies only a



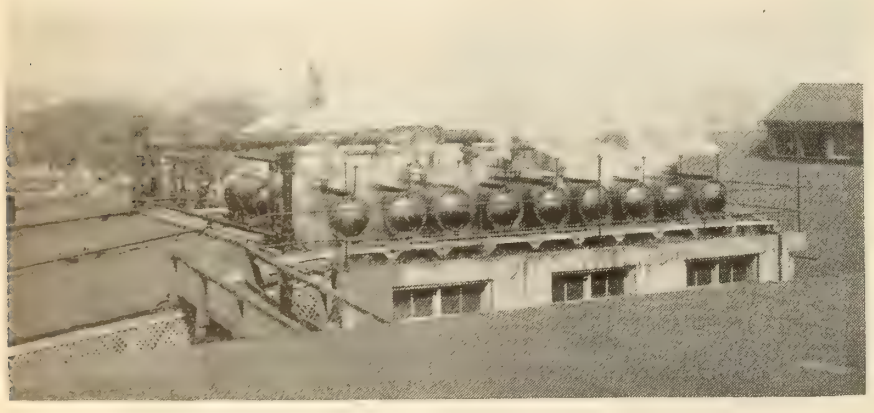
VIEW OF COMPRESSORS.

space measuring in plan 27½x33 ft., while brine is cooled in flooded coolers having 22.6 sq. ft. of surface for each ton of ice, as compared to the usual 100 to 200 sq. ft. employed. The brine cooler for the 50-ton ice tank has 160 tubes 2½ in. in diameter and 12 ft. long. The brine makes eight passages through the cooler, which occupies a horizontal position, and is at all times two-thirds filled with liquid. This liquid does not go over to the machines, as the discharge pressure is always at about 220 deg. F. with a condenser pressure of 150 pounds per square inch.

There is provided for the ice tank circulation of brine several turbine-driven centrifugal pumps operating against a head of about six pounds and the amount of brine circulated per minute per ton of ice is about fifteen gallons, and the temperature difference of brine entering and leaving the brine cooler is from 1½ to 2 deg. On the evaporating side of the refrigerating system the suction pressure maintained is 18 lb., but greater pressure can be obtained easily with more cooling surface. In the ammonia-condensing system there are 29 stands of drip condensers, all being 24 pipes high and 20 ft. long. The plant is provided with condensers made up of 8-in. standard pipes and the ammonia vapor flows successively through 14 lengths of 8-in. pipe, each having 18 ft. of effective length. These 8-in. pipes are interconnected by 2-in. pipes and while the velocity in this condenser is relatively low, good results are obtained in its operation.

There is great interest in the ice storage, which includes two ice-storage houses, one of 4,000 tons capacity and the other, 15,000 tons, the latter being the largest ice-storage house in the country. Its dimensions are 175 ft. long, 60 ft. wide and 60 ft. high, which would mean that there were 30 layers and 500 tons of ice to the layer. The ice is stacked regularly and all the blocks pitched toward the centre of the storage, due to pitching of the floor six inches so as to prevent any danger of the ice sliding toward the walls. The ice blocks lie directly on the floor and at the walls come close to the brine coils, but do not quite touch them. The coils themselves are six inches from the wall and provide for ample air circulation.

It is claimed that in the large storage house there is ten miles of 1¼-in. brine piping to maintain a temperature of 16 deg., this temperature being lower than is usually considered necessary, but the result is that the ice taken out in summer is first-class and the loss is next to nothing.



ANOTHER PORTION OF THE EQUIPMENT.

CLASSES FOR THE INSTRUCTION OF STATIONARY ENGINEERS

THE grading of certificates in Ontario has necessarily aroused considerable interest in educational matters among the engineers of the province. To meet the need for instruction along this line and to give the stationary engineer the opportunities enjoyed by others, the Department of Education has extended the scope of the technical education covered in the night classes, to embrace stationary engineering.

Classes have been established in various centres of the province, and instructors appointed. The subjects covered are those particularly of interest to the engineer in view of the approaching examinations. Thirteen cities have taken up this work and approximately 333 students enrolled. The following list gives the names of the different centres in which the classes have been started, together with the names of instructors and number in attendance:

Brantford, 24 students—Instructor, C. Carriss, engineering staff of the Waterous Engine Works.

Galt, 26 students—Instructor, W. F. Stubbs, engineering department of the Goldie and McCulloch Co.

Hamilton, 37 students—Instructor, J. M. Brown, superintendent the steam plant of the Dominion Power and Transmission Co.

Kitchener, 9 students—Instructor, Mr. Pflug.

London, 22 students—Instructor, D. H. Weir, instructor in science and engineering London Technical School. Mr. D. H. Weir is assisted by various local stationary engineers.

Niagara Falls—This class is in process of organization.—Instructor, Mr. Gisbourne, of the Hydro-Electric Power Commission of Ontario. It is expected that classes will start early in January and forty men have signified their intention of joining.

Ottawa, 40 students—Instructor, John Blezard, of the engineering staff, Department of Mines.

Peterborough.—In progress of organization.

Sarnia, 26 students in two sections—Instructors, W. Wainright in stationary engineering, and M. T. McCordick in arithmetic.

St. Catharines, 54 students — Instructor, Mr. Shields.

Toronto, 37 students, divided as follows: Power plant engineering, junior, 26; instructor, D. Ross, Central Technical School. Power plant engineering, senior, 11; instructor, M. B. Watson, director of engineering Central Technical School.

Windsor.—Instructor, Robert Meade.

Walkerville, 13 students—Instructor, Geo. Bergess.

An analysis of the above figures would tend to show that the stationary engineer was not taking full advantage of his opportunities, whether from lack of knowledge of the classes themselves or otherwise.

In addition to the arranging for these various classes, the Department of Education, through Mr. K. S. MacLachlan, has been instrumental in preparing a syllabus for the guidance of the instructors. The purpose of this syllabus is to aid the instructor in determining the details of the subject matter and to aid in its presentation to the class. The syllabus embracing, as it does, the wide field of steam engineering, covers too broad a field for the complete subjects outlined in it to be taken up in any one class during one winter in night schools. The requirements of stationary engineers vary greatly, and the instructor is given considerable latitude in his selection of subject matter of the greatest benefit to his students.

In case the instructor in any city is definitely preparing men for examination for certificates, he is governing his course according to the Act and its regulations as issued by the Trades and Labor Branch of the Department of Public Works for Ontario.

The Engineering Institute of Canada has made full arrangements for a Dominion-wide convention to be held in the city of Montreal on January 27-29. During the meeting several important papers will be read and discussed; a number of federal and provincial officials will likewise be present, some of whom will give addresses on the activities, past, present and future, of their respective departments, principally in relation to engineering work. The convention will be held in either the Ritz Carlton or the Windsor Hotels.

The Transmutation of Energy

A Paper Read Before the C.A.S.E. at the Brantford Convention Which Deals, in a Clear Manner, With the Various Forms in Which Energy is Made Evident to Us

By C. C. CARRIS

OF all branches of human endeavor none is more urgent in its demands for the accurate recording of facts than of engineering.

The politician may deal with the inconsistencies of human nature, and obtain the assistance of others by his skilful tongue; the merchant can study the peculiarities of his customers, tickle their vanity, and attract them by his display of goods in windows and advertisements; the artist may paint that which is not and yet succeed, if his results are pleasing to the eye, and in many other things appearances are of great importance.

But for the engineer there is no safety in anything but facts. Even though he attains social success through a knowledge of his fellowmen, his actual work, the creation of his skill, must meet the inexorable test of the forces of nature which it is meant to control. He cannot say, "I thought," he must know.

The overloaded bridge will not stand, even though its designer be an eloquent orator. The undersized bolt will not hold no matter how highly polished; the ship will sink if its weight exceeds its displacement. There is no charm that will overcome the forces of nature; their magnitude and direction must be accurately estimated and met by the superior strength of the materials employed.

It is related of one prominent engineer that he was requested to give evidence as to the cause of a disastrous boiler explosion. After much contradictory evidence had been heard, he was asked if he could give the reason for the accident. In reply he stated that the matter was quite simple, the cause of the wreck being merely that the material of the boiler had been subjected to a greater stress than it was able to withstand.

In that simple remark lies the explanation of many superficially mysterious accidents, and the reason that material is subjected to greater stress than it is able to withstand, is usually a lack of accurate knowledge of the facts concerning the stresses to which the structure is to be subjected.

The branch of engineering that comprises the calling of the stationary engineering and his brothers, the marine and locomotive engineers, calls most insistently for facts, and nothing but facts. The reason of this is the very large amount of energy controlled even in the smallest power plant. A very small error in the observation of essential facts may result in the release of this energy with the probability of the death or injury of the engineer and his assistants, and possibly the sacrifice of the lives of many in the adjacent buildings.

Therefore, in addressing a gathering of stationary engineers, who, by the very nature of their calling are trained to deal with facts, it is not advisable to dwell much on fancies or suppositions, but to speak of observed and recorded facts, which constitute the basis of true theory. These facts will be of interest to the stationary engineer, if they deal more especially with the subject of energy, as his whole occupation is concerned with the direction of this peculiar commodity.

One of the fundamental facts of the universe is that energy may be transmitted into many different forms, but that its total cannot be increased or decreased in any way. It may be that further research into the wonders of the universe may reveal some great central source of energy, but present we do not know of such.

The present source of energy for this globe is the sun, which has stored in it a great amount of power, on which our very existence depends.

It is intended in the present remarks to trace some small portion of the sun's energy and to see how much of it is utilized and how much wasted in the various forms into which it is transmitted. The two great sources of motive power that are most widely utilized are the heat contained in various forms of fuel, and the energy stored in water at high levels. Both of these forms are derived from the sun: in some cases many years ago; in other cases from day to day.

The unit by which energy is measured is the foot pound, or a weight of one pound elevated to the height of one foot. The same amount of energy is contained in one pound weight one thousand feet high, as there is in a thousand pound weight one foot high. As every stationary engineer knows, the present practical unit is the horsepower which represents thirty-three thousand foot pounds of work per minute. These two units will be used in the measurement of the various forms of energy considered in the following remarks:

The energy produced by the combustion of fuel was in the first place derived from the heat of the sun, which assisted the growth of plants and gave them the energy to incorporate the various elements available in the soil and atmosphere into the complicated hydrocarbon structures composing wood, peat, etc. Some of this material formed comparatively recently is utilized now as fuel in its original bulky form. The trees and plants that grew many millions of years ago have been compressed and heated, reducing at the same time their bulk and their hydrogen content and forming the fuel we know as coal in all its many forms, from lignite to the hardest anthracite, reaching in some cases the almost pure form of crystallized carbon in black or white diamonds.

The exact process of manufacture of the liquid and gaseous fuels and asphalt to coal oil, gasoline and natural gas, with the hundreds of intermediate grades used for various purposes, is as yet not fully known, but they appear to be derived from vegetable or animal growths that have been subjected to pressure and heat.

The energy contained in fuels is measured in the first place in B.t.u., which is an abbreviation for British thermal units. The B.t.u. represents the heat necessary to raise the temperature of one pound of water from 62 deg. F. to 63 deg. F. The equivalent of the B.t.u. when converted into water work is 778 foot pounds.

The following table gives the approximate B.t.u. and foot pounds available in one pound of various fuels. Taking the height of Niagara Falls as 160 feet, the third column gives the number of pounds of water which would have to pass over the Falls to produce the same amount of energy:

Energy Equivalents

	Foot Pounds	B.T.U.	K.W. Hours	H.P. Hours
Foot pound	1	0.0012861	0.00000037662	0.00000050505
B. T. U.	777.5	1	0.0002928	0.0003927
K.W. Hour	2,655,200	3415	1	1,3410
H.P. Hour	1,980,000	2547	0.7457	1

Fuel—	B.T.U. per lb. Low	High	Average	Foot lbs. per lb.	Lbs. of Waterover Niagara
Wood	8,300	9,100	8,700	6,770,000	42,280
Peat	5,000	9,000	7,000	5,450,000	34,020
Lignite	6,356	7,603	7,000	5,450,000	34,020
Coal, bituminous	13,000	15,000	14,000	10,890,000	68,000
Coal, anthracite	12,000	13,500	12,750	9,920,000	61,370
Carbon, pure	.....	.....	14,544	11,304,232	70,651
Coke	.....	.....	12,600	9,800,000	61,200
Gasoline	19,000	21,000	20,000	15,560,000	97,200
Alcohol, denatured	10,000	12,000	11,000	8,558,000	53,460
Fuel oil	18,000	20,000	19,000	14,780,000	92,340
Acetylene	.....	.....	21,430	16,660,000	104,150
Hydrogen	.....	.....	62,032	48,261,000	301,476

Unfortunately our present methods are so inefficient that only a very small percentage of the energy available is delivered in the form and at the point required.

In an average boiler plant the losses are approximately as follows:

Heat wasted in ashes and coal falling through grates, 5 per cent.

Heat wasted by radiation from walls of furnace and boiler setting, 5 per cent.

Heat wasted directly through stack, including portion necessary to maintain draft, and including steam from the coal and heat wasted by incomplete comb., 22 per cent.

Heat utilized in forming steam, 68 per cent.

Of this steam some portion is used for operating injector or pump for feed-water, and more heat is lost by the radiation from the steam pipes. So that in the case of a steam heating plant using coal of, say, 14,000 B.t.u. per pound, only about 9,000 B.t.u. is delivered to the customer. Assuming the feed-water to be received at 65 deg. F. and raised to 125 pounds steam, it would then contain 1,192 B.t.u. per pound. Deducting the B.t.u. in the water, 33 B.t.u. per pound. We have to supply 1,159 B.t.u. per pound.

Our one lb. of coal of 14,000 B.t.u. should supply about 12 lbs. of steam. We will consider ourselves lucky to get 8 lbs. out of it.

If the water returned from the radiators at 212 deg. the customer will actually receive:

$$\begin{array}{r} 1159 \\ 180 \\ \hline \end{array}$$

979 B.t.u. from each pound of steam supplied, or × by 8 = 7832 B.t.u. from each lb. of coal, an efficiency of about $\frac{7832}{14000}$ = 56 per cent.

Now, let us compare this with electric heating, assuming that we are using Niagara power. The first loss we encounter is due to the turbine efficiency which we can assume is about 85 per cent. The next is in the generator, say, 95 per cent. efficiency; step up the transformer, 98 per cent.; transmission line, 95 per cent.

First step down transformer, 98 per cent., second step down transformer 98 per cent. Multiplying up those efficiencies we get a total efficiency of 72 per cent. The heater itself, if of the non-luminous or low temperature type, has an efficiency of practically 100 per cent. In other words, all the electrical energy delivered to the heater is converted into heat within the building heated. The only source of loss of heat is the infinitesimal amount conducted to the outer air by the entrance wires. In the case of the luminous heater there is also a small portion of the energy wasted, as far as heat is concerned, by being converted into light. How small [illegible] later.

Following up our comparison with steam we find that of every 100 foot pounds contained in the coal only 56 ft. lbs. are delivered as useful heat, whereas of every 100 ft. lbs. of energy contained in the falling water at Niagara, 72 ft. pounds can be delivered as useful heat an efficiency 29 per cent. higher.

A further interesting comparison between steam heat and electric heat is as follows:

1—K.W.H. = 2,655,200 ft. pounds.
= 3,415 B.t.u.

The average price of 1 K.W.H. delivered is about 1¼c. The number of B.t.u. delivered by steam heat from 1 lb. of coal is about 56 per cent. of 14,000/—7,832 B.t.u. To obtain 3,415 B.t.u. as before, we would require about $\frac{3415}{7832}$ — .436 lbs. of coal $\frac{2000}{.436}$ × 1¼c — $57.00 per ton of coal so that soft coal would have to raise to seven or eight times its present price before electric heat could compete with steam heat.

In the matter of cooking the comparison is very different, the monthly cost of cooking for an average family running about $2.00, which would not buy very much hard coal.

Passing on from heating to power, and dealing first with the average single cylinder non-condensing steam plant, under summer conditions we find an average steam consumption of about 34 lbs. per indicated h.p.h. With a mechanical efficiency of 85 per cent., the consumption per B. h.p.h. is about 40 lbs.

In our boiler calculations we have assumed an efficiency of 65 per cent. from coal to steam. The engine under consideration uses $\frac{40 \times 1159}{60}$ × 778 — 600,000 ft. lbs. per minute and produces 33,000 foot pounds of power per minute, an efficiency of 5.5 per cent.

The efficiency from coal to engine shaft is 3.58 per cent.

The work of various engineers in designing, constructing and operating steam plants to produce power from coal is no doubt worthy of praise, but as an economic performance it is very poor. At the present time there is no justification for the operation of any steam plant in Western Ontario for power purposes only, except in the case of those factories such as sawmills, which produce their own fuel as a by-product of their regular processes.

Even in this case careful investigation should be made as to whether some portion of the waste cannot be prevented by change of process and also as to whether the waste cannot be better utilized as the raw material for some other process.

The power plant which is designed primarily as a steam heating plant, including those plants in connection with factories using large amounts of steam for cooking, is in a much stronger economic position.

In fact, steam heating is the most satisfactory and efficient method of heating buildings at present in use. The point to watch in designing a combined heat and power plant is to see that the power plant is small enough so that all the exhaust steam is used for heating. Any excess of heat required during extreme weather should be supplied by live steam. If the power demands exceed the heat demands, the balance of the winter power should be supplied by electricity.

It is not uncommon in factories requiring large amounts of power to see great quantities of exhaust steam escaping unused even in extreme winter weather. Under present conditions this should not be permitted, but the load on the engine should be reduced by the use of motors until no exhaust steam is wasted during zero weather.

Owing to the plan of charging on peak load or connected load, it is cheaper to err on the side of using a small amount of live steam, rather than having too much exhaust steam available.

We have seen that the efficiency of transmission from water to electricity delivered is about 72 per cent. Taking the efficiency of the motors at 87 per cent., there proves to be 62 per cent. of our water power delivered at the motor shaft.

Man's attempts at utilizing electrical energy have, up to the present time, been much more satisfactory than his attempts at utilizing the chemical energy contained in fuel.

A side of the power question that is often overlooked is that coal, besides being a source of heat, is also the raw for the production of useful drugs and dyes and other products. Its ultimate value to humanity for these purposes will be far greater than its power value. We also require it for heating as distinct from power. Now we have a great store of coal in this earth, but it is not unlimited and we know of nothing to replace it. It is essentially a thing to be hoarded and used carefully. We can leave it in the ground like money in the bank, and can draw on it when we wish, either now or thousands of years from now. It will keep, it won't spoil.

But water power is opposite in its properties. Every cubic foot of water passing down the falls expends its energy in wearing away the rocks of the river bed. That energy is gone forever, as far as we are concerned. More water follows it, but the energy contained in that particular weight of water is lost.

It must be used to save it, whereas coal must be left unused to save it.

Not many years from now people will be complaining of the folly of this generation in wishing to retain a water falls as something to look at, while wasting millions of tons of valuable coal to do work that could have been done by the wasted water power.

The third item to be considered is

lighting. Before going into this subject, it is well to inquire, what is light?

Light, as we see it every day, consists of vibrations of the luminiferous ether of such length that they affect the mechanism of the eyes. The longest rays that affect the eyes are those given off a dull red heat. The shortest rays that we can see are the violet. A mixture of these rays give the sensation known as white light. There are also ultra red rays and ultra violet rays, none of these are visible, but they both produce chemical effects and therefore photographs can be made by their use, which proves their existence. The light that is most useful to the eyes lies between yellow and green, but unfortunately in our attempts to produce light of this color we also produce rays of many other colors and also produce a large amount of heat. ,

The most efficient light in common use, the gas-filled tungsten lamps, requires about ½ watt per candlepower. This lamp gives off a quantity of rays up around the violet end of the spectrum; so much in fact that the effect on the eyes is unpleasant unless the lamp is shaded. It also gives off a very large amount of heat. The balance of the power consumed in producing useful light is very small, being about 15 per cent.; an ordinary carbon filament lamp using about 4 watts per candle power only delivers about .2% of the power consumed as light, a plain tungsten lamp about 7 per cent. This can readily be proved by putting a lamp into a fish globe full of water and leaving it there one hour. Measure the temperature of the water before and after.

So if we deliver 42 per cent. of our water power at the lamp, we only get 10.8 per cent. of it as light from a gas filled lamp, 1.42 per cent. from a carbon lamp, and 5 per cent. from an ordinary tungsten lamp. Just think of that for a moment, 1,000 kw. at Niagara Falls equals 50 kw. of actual light in Brantford, or put it another way; a man turning a crank can do about 44 lbs. of work per second or 2,640 ft. pounds per minute—60 watts, or 50 candlepower from ordinary tungsten lamps. With 100 per cent. efficient lamps the same man can produce 715 candlepower. There is room for considerable study and the possibility of making a fortune by the production of a more efficient lamp. There are two general methods in use of producing light, first the highly heated filament; second the luminous vapor, such as used in the mercury arc, and the Moore vacuum tube. It is unwise to prophesy, but the heated filament seems at present to have reached the end of its possibilities. All substances at present known will fuse at any increase in temperature over the 27,000 centigrade now used in the gas-filled lamp.

The luminous vapor system seems to offer the greatest possibilities of improvement, based on the use of high tension current passed through tubes filled with gas at low pressure. In the meantime it is our duty to press for the gas filled-lamp in all suitable locations. The units available are still rather large for house use except in special fixtures, but for general factory, store and street illumination it is the only light to consider.

These remarks have in general dealt with the steam plant only from the point of efficiency. Nothing in them should be construed as reflecting on their reliability, which is over 99 per cent. There are many factories that are glad in cases of emergency to fall back on their steam engine. But this consideration does not justify us in wasting good coal, so long as cheap water power is available.

One thought in closing. It is always repugnant to the mind of the intelligent man to think that after this life comes death in both mind and body. On the other hand, his mind rejects the idea of absolute idleness for all eternity, except during the flash of time called life.

May we not hope that even as we transmute energy into various useful, but different forms, so will the Chief Engineer of the universe transmute our vital spark of energy into forms of usefulness, of which at present we have no conception.

The Transmission of Power by Means of Gas

The Following Article Published Through the Courtesy of the "Times Engineering" Supplement Gives a Correspondent's Plea for the Use of Gas in the Transmission of Power

A COMPARISON WITH ELECTRICITY

ONE of the objects aimed at by the proposal to provide a general supply of electricity distributed from 16 huge generating stations is to get rid of the cost of conveying coal to each individual factory. But why is it taken for granted that electricity is the only agency whereby the carriage of coal can be eliminated? Why has not the possibility of using gas for the purpose been at least considered.

The idea of conveying energy to great distances by means of electricity is familiar. It looks a simple matter to string a wire to any distance and send power along it in any desired quantity. But where the distance is great and a large amount of power is required, the "wire" is apt to assume formidable proportions, and the loss by the way is by no means negligible. Let us take as a definite example the transmission to London of, say, 240,000 kw. generated in the Yorkshire coalfield, some 173 miles away.

Electrical Transmission

The size of the conductors and the efficiency realized will obviously depend on the mode of transmission adopted and the voltage at which the current is delivered to the line. As regards method, there is little doubt that the transmission would be on the three-phase system. In America and elsewhere, long distance transmissions at potentials of 100,000 volts and more have been in operation for years, but in this country (England) the distances are short, and the voltages employed (so far as the writer is aware) do not exceed 30,000. For a 173-mile transmission, it is practically certain that the voltage would be higher than 30,000, and not more than 100,000, and it will be instructive to see how the transmission works out in these two extreme cases.

If the current density is 1,000 amps per square inch, the drop will be 7,330 volts per line, or, say, 12,700 volts between phases. With an initial potential of 30,000 volts, the terminal pressure will be only 17,300 volts, and the loss in transmission 42.3 per cent., which is out of the question. With a current density of 500 amps., the drop between phases will be reduced to 6,350 volts, or 21.2 per cent., giving a terminal pressure of 23,650 volts. The loss is still very high, but, at the voltage stated, it could be reduced only at the cost of an enormous expenditure in copper. To deliver 240,000 kw. in London at 23,650 volts, the current would be 6,518 amps., requiring (at 500 amps. per square inch) 13 square inches of copper per line, or 39.1 square inches in all. If the conductors were solid, each would be 4 1-16 inches in diameter—a very respectable "wire." At nine tons per square inch per mile, the three lines would weigh 352 tons per mile, or about 61,000 tons in all. Working, however, at 100,000 volts, the current would be reduced to 1,766 amps., the united area of the conductors (at 1,000 amps. per square inch) to 5.3 square inches, and their weight to 47.7 tons per mile, or 8,250 tons in all. The drop would then be 12,700 volts, or 12.7 per cent., and the current would be delivered at 87,300 volts.

Cost of Gas Pipe Line

Now, let us glance at the other alternative, and, instead of transmitting the energy in the form of electricity, carbonize the coal at the pit's mouth, pipe the gas to London, and generate current there by means of gas engines. The amount of gas required to yield 240,000

kw. will be about 5,000,000 cubic feet an hour, or 84,000 cubic feet a minute. A 24-inch steel pipe will convey this gas, with an initial pressure of 300 lbs. per square inch. The wall of the pipe will be 5-16 inch thick at the compressor end, reduced to ¼ inch as the pressure drops. It will weigh from 160 to 200 tons per mile, or about 32,000 tons for the whole line—just one-half of the weight of the copper required to transmit the same amount of energy at 30,000 volts, or four times that for a 100,000 volt transmission.

But the price of electrolytic copper to-day is about £125 per ton, while steel tubes can be bought for, say, £30. The metal required for transmission by gas will, therefore, cost less than that for electric transmission, even at 100,000 volts, and only about one-eighth of that required at the highest pressure which has yet been employed in this country. Aluminium might be used instead of copper, but this metal, also, is more expensive than steel.

Now, as to the loss of energy in a scheme of gas transmission. To compress 84,000 cubic feet a minute to 300 lbs. per square inch will require some 21,726 i.h.p. If the mechanical equivalent of the 240,000 kw., viz., 321,674 h.p., is added to this, the total becomes 343,400 h.p. Of this total, only 21,726 h.p., or 6.3 per cent. is expended in the transmission, as against 21.2 and 12.7 per cent. respectively with electricity.

Storage and Load Factor

But there is yet another factor to be taken into account. Until there is a practicable means of storing electricity on a large scale, the whole of the generating and transmission plant—boilers, engines, dynamos, transformers and line—must be capable of supplying the maximum demand at any moment. Gas, on the other hand, can be easily and cheaply stored, and so may be generated and transmitted at a uniform rate throughout the 24 hours, the fluctuations in consumption being taken care of by storage at the delivery end. If, for instance, the load factor is 50 per cent., the generating and transmitting plant need be capable of furnishing and conveying only 42,000 cubic feet of gas per minute. The cost of this plant may, therefore, be reduced by one-half, and its advantage in point of cost over electricity will be doubled.

Coal Economy

There remains to be considered the question of coal economy. If it were merely a case of generating electricity for use in the neighbourhood of the power station, the actual consumption of coal to drive the dynamos might be less with steam-engines than with gas power; but where the electricity has to be conveyed a long distance, the losses in the conductors and in the transformers must be set against those in the manufacture of gas, and the weight of coal required to furnish a given amount of power at the far end of the line will be practically the same in both cases.

But while the consumption of coal is approximately the same for both modes of transmission, there is a vast difference in what is obtained from that coal. For, whereas in the one case we get power, and power only, in the other we receive, in addition, from every ton of our coal well over half a ton of coke, several gallons of tar, and from 16 lbs. to 20 lbs. of ammonium sulphate. So valuable are these "by-products," that the question of carbonizing the coal used to generate electricity in large stations has been seriously discussed. A satisfactory gas-engine of over 5000 h.p. has, however, yet to be built, and at present, for large power stations, the steam turbine holds the field. A new factor, however, is introduced by the generation of gas from coal of all grades at the pit's mouth, and the substitution of the conveyance of gas under pressure for the transportation of coal. The economies thus effected would go a long way towards making the gas-driven generator a commercial possibility.

Supply of Heat

So far, the transmission of power has been considered. But in many factories, and every home, large quantities of heat are also required, and although heat can be conveyed in the form of electricity, the process of converting heat into electrical energy and the latter back into heat is wasteful in the extreme. If the 240,000 kw. were required for use as heat, that heat could be obtained from 30,500 cubic feet per minute of gas of 450 B.Th.U. net, as against the 84,000 cubic feet required to generate the equivalent in power. So far, then, as the supply of heat is concerned, the superiority of gas is overwhelming.

No doubt great economies might be effected in the manufacture of gas by generating it in the coalfields in large works on the most modern lines, instead of in a multiplicity of works of all sizes and types, most of them occupying expensive and highly-rated sites, scattered throughout the length and breadth of the country, and having to transport every ton of their coal. The cost of bringing to London the coal used by the Gas Light and Coke Company was given last July by the Governor to the President of the Board of Trade as 12s. 9d. a ton. For last year's consumption, this would work out at £1,187,000, equivalent to 10¾d. per 1,000 cubic feet of gas sold. The money spent on the carriage of one year's coal would have paid for a main large enough to bring from Yorkshire the whole of the gas made by the company during the year.

The potentialities of gas transmission being so enormous, it is strange that gas has not been considered as an alternative to electricity in connection with the vast schemes of power supply which have recently been brought forword. This omission is the more surprising when it is remembered that compressed air has long been used as a medium for the conveyance of power, and that something like 150 times as much energy can be transmitted by a gas main as by the same pipe conveying air. The possibility of piping gas to long distances is hardly realized in this country, although in the United States it has for many years past been carried upwards of 200 miles, in the case of natural gas, and 35 miles or more in that of coal gas.

Leakage and Condensation

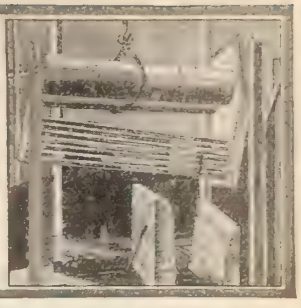
When the question of the long-distance transmission of gas was first mooted here, grave doubts were entertained on the score of leakage and condensation. When the first long-distance mains were laid in the United States gas was cheap, the jointing of pipes to resist high pressures was not understood, and the losses by leakage were enormous. But the art of pipe-jointing has made great strides since then, and the leakage from the later American pipe-lines is said to be inconsiderable.

The fears expressed as regards condensation were based on the assumption that the gas employed would be of the pre-war illuminating type, and that its heavier constituents would be thrown down in such quantities as seriously to reduce its calorific value. Recent experiments, however, in the compression of ordinary coal gas for motor vehicles show that at a pressure of 300 lb. the loss of calorific value is only from 3 to 4 per cent. Any such loss might be prevented by the use of one of the so-called "fuel gases," but for economical transmission over long distances it is essential that the gas should be of low denity and high calorific value. It is probable, therefore, that the long-distance gas would be of the ordinary coal-gas type, made, however, without reference to those standards of illuminating power for the attainment of which the consumer has been so heavily taxed in the past.

It does not follow that there would be no field for "fuel gas." There is a large demand for power, light and heat within a comparatively short radius of the coalfields; and the conveyance of the poorer gases over short distances is distinctly a commercial possibility. It should be remembered, moreover, that any general displacement of coal by gas would involve the production of coke in quantities far exceeding the demand for metallurgical purposes, and for this coke the manufacture of fuel gas would supply a profitable outlet.

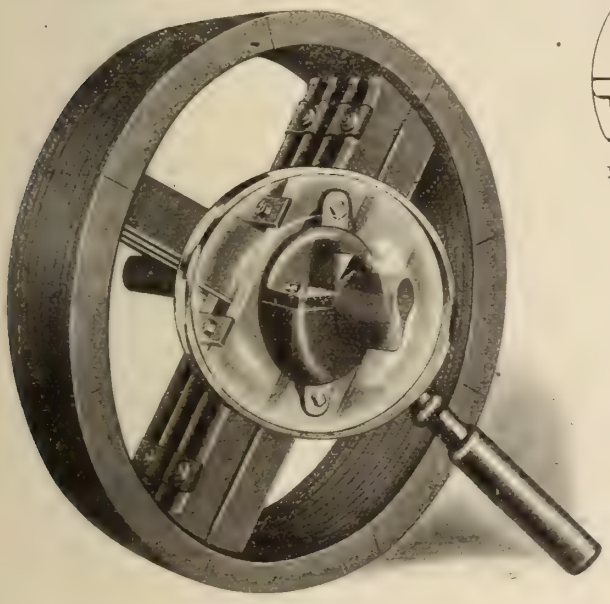
The Link-Belt Company are extending their Belmont Foundry at Indianapolis. The extension virtually consists in the completion of their new furnace buildings Nos. 7 and 8, which will be of 15-ton capacity instead of 10-ton, like the present furnaces. They are also purchasing the necessary machinery, such as rolling mills, sand blast and other foundry equipment needed to take care of the additional capacity. The building will be about 70 feet wide by 400 feet long.

NEW POWER PLANT EQUIPMENT



ANTI-SLIP DEVICE FOR WOOD PULLEYS

Slippage of pulleys on live shafting is one of the many troubles that the engineer has to contend with. The loss of efficiency in this way is often considerable. Where heavy loads are placed on a certain pulley it is very difficult to prevent slip. The illustrations herewith show a simple device that the A. Bernard Industrial Company, Montreal, have designed and placed on the market.

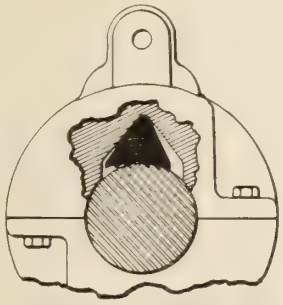


The device may be attached to any make of wood-split pulley, and consists of three distinct pieces held together with two standard machine screws. The recess in the collar and the dog are so designed that the slightest tendency to slip causes the dog to take a firmer grip on the shaft, thus preventing slipping.

PRIMING REMEDIES

A general indication leading one to think boiler priming is taking place is the violent agitation of the water in the gauge glass, together with its muddy and discolored appearance. Sometimes this level will record as much as two inches of difference within the space of a few seconds; sometimes disappearing below or above the glass altogether. If it is thought that fluctuation of steam demands is giving rise to the trouble close down the boiler stop valve a little.

The anti-priming pipe, usually found in Lancashire or Galloway type boilers, is a slotted pipe fixed inside the boiler towards the top, cast in sections and bolted together. This pipe should be at least three-quarters the length of the boiler, and the area of the slots at least equal to the bore of the steam valve.



METHOD OF OPERATION.

Whenever the boiler is opened up for cleaning or repairs, these slots should be examined for corrosion and reduction of orifice area, as priming trouble may be due to this cause. One peculiar feature of priming is that the trouble may be apparent in a more or less greater degree with the type of labor employed in firing, thus proving that the manner in which the boiler is fired is an important factor in this respect. The thinnest film of grease clinging to the water within the boiler will sometimes give rise to priming, hence care should be taken to eliminate this from the feed-water. Boiler compositions introduced for the purpose of reducing scale must be used sparingly and in small quantities at a time. A day's supply should not be injected within a few minutes by means of the boiler pump or injector; instead, it should be spread over a whole day's supply of feed-water. Priming due to a high-water value can be remedied by lowering the water line, but in this expert advice should be taken in order that the danger limit is not reached.

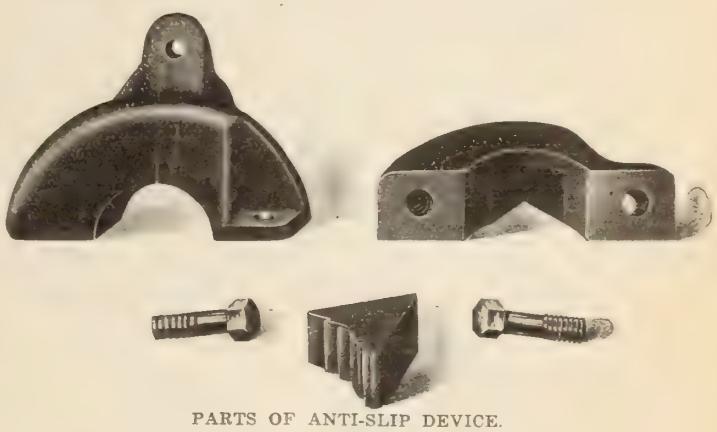
WATER POWERS OF B. C.

Continued from page 7

At No. 2 station there are also step-up transformers, from 2,200 volts to 22,000 volts. This enables plants Nos. 1 and 2 to be run in parallel for transmitting power to Rossland, Trail, Nelson and Silver King mine. The longest distance over which current at this voltage is transmitted is 32 miles.

Plant No. 3. Kettle River

The Kettle River plant, known as Plant No. 3, or the Cascade Forks. At this point the river flows through a gorge, with a series of rapids and falls, providing a natural head of 120 feet in a distance of about one-half mile. A dam at the head of the gorge raises the water level some 36 feet. From the dam the water is conveyed by 700 feet of open-rock cut and 400 feet of tunnel to the pipe-line intake; thence to the power house in a steel pipe 7 feet in diameter. The head developed is 156



PARTS OF ANTI-SLIP DEVICE.

The generating equipment comprises three units, each of a 1,300 h.p. turbine, consisting of two 39-inch horizontally mounted runners, direct connected to a 750-kva., 3-phase, 60-cycle, Canadian Westinghouse generator. Speed of the units is 400 r.p.m., and control is by Escher-Wyss mechanical governors. Two 45-kw. exciters are provided. Current is generated at 2,200 volts and stepped up to 22,000 volts for transmission to sub-stations at Grand Forks, Phoenix, Greenwood and Boundary Falls, the last named being 28 miles from No. 3 Plant.

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - President
H. V. TYRRELL - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII. TORONTO, Jan. 5, 1920 No. 1

PRINCIPAL CONTENTS

The Waterpowers of British Columbia—II. 1
The Increasing of Power Plant Efficiency 8
The Largest Western Ice Plant 11
The Transmutation of Energy 13
The Transmission of Power by Means of Gas 15
New Equipment 17
Editorial 18
Operator's Point of View 20
Selected Market Quotations 23

The Transmission of Power

IN this day of electricity we are somewhat prone to consider it the only available means of transmitting power to any great distance, and we neglect at times consideration of other means which might prove both feasible from an engineering standpoint and profitable in a commercial sense. The utilization of our Western lignites has provided us with a number of very interesting problems, and among these is the finding of an outlet for the gas resulting from carbonization, now on a commercial basis. The burning of the excess gas under boilers, the generation of electricity and its transmission to distant points might prove possible but the resultant efficiency would be limited.

Great Britain has a somewhat analogous problem on her hands at the present time, and the erection of huge central stations at the mine mouth is seriously being considered. It is proposed to burn the coal under boilers and to transmit electrical energy to the surrounding industrial centres. This scheme, or solution of the problem, does not suit a correspondent of the London *Times*, who suggests an alternative scheme for the transmission of energy which has a lot to commend it. In brief, he proposes that the coal be coked and the resultant gas be transmitted to the various centres which would otherwise utilize electrical energy. The gas, according to his figures, could be transmitted for less power loss than electrical energy, and for less capital expense. Instead of the electric motor internal combustion engines would be used, and the overall efficiency should be materially greater than the combined steam prime-mover and electrical system.

Another advantage would be found in the use of gas for metallurgical and other heating purposes, and the heat units made available from a given amount of coal would be greater than if electrical transmission were used.

The coking of coal, or the carbonizing of lignite, in itself tends to conservation since valuable by-products, ammonia and coal tar compounds, are recovered. In the case of England, a further step could be contemplated and any excess coke over and above that required for metallurgical and other industries near at hand could be completely gasified and the gas resulting transmitted in the same manner.

The suggestion is a good one and well worthy of careful consideration. It would seem to be feasible in certain cases in our Western Provinces and in its entirety might be an alternative to the briquetting of lignites as well as an outlet for the gas formed if the lignite were carbonized and briquetted.

A Much-Misunderstood Term

TERMS of a semi-technical and semi-commercial nature are in current use, which are very imperfectly understood, even by those who should be absolutely clear on the matter. A typical example of this is much in evidence of late in connection with the Ontario Government's Stationary Engineers' Act. For the purpose of grading certificates of competence, and also of grading the relative importance of different plants, a basic unit of power must be adopted. The natural factor to use is the capacity of the boiler, and this is expressed in terms of boiler horsepower. It is this latter expression which leads to so much confusion.

To the general public, horse-power is a familiar term. They know it as a measurement of their car's capacity. They have heard it spoken of in connection with the locomotive that draws them from town to town, the ship that carries them across the lakes and oceans, the aeroplane, etc. The stationary engineer knows it as a measurement of his engine's capacity. The technical engineer, when he thinks of horse-power, recognizes it as a measurement of the rate of doing work. That is 33,000 foot lbs. of work **per minute.** When the term is applied to a boiler nobody seems to be very clear as to what it means, and long misuse has clouded the meaning more than necessary.

Both engine and boiler makers found it necessary, when marketing their wares, to have a simple way of explaining their rating to prospective buyers. Engine builders for some time used a rating based on the circular inches in the engine cylinder, and called this nominal horse-power. This was so far from being a measure of the engine's capacity for doing work that it was soon discontinued, and the indicated horse-power rating was adopted. The boiler-maker needing a rating for his wares, designated his boiler as being of so many horse-power. To determine this, a certain number of square feet of heating surface were allotted to produce one horse-power, this number of feet divided into the total heating surface being the boiler rating. This was a step towards a standard, but unfortunately every maker used a different divisor, usually taking one that would give the highest rating to the boiler. Apart from this,

the rating did not, and does not convey much meaning to the average commercial user. For instance, two users may have each a 100 H.P. engine. One is compound condensing, and uses 18 lbs. steam per horse-power per hour. The second is an automatic slide-valve and uses 30 to 35 lbs. steam per horse-power per hour. Now, if they go out and ask for a 100 H.P. boiler in the open market one will get a boiler inadequate to his needs. Recognizing this, experiments were made by the American Society of Mechanical Engineers, who determined that a boiler horse-power should be the capacity to evaporate 34½ pounds of water at 212° F. to steam at 212° F. per hour. This is a definite performance, involving the expenditure of a definite amount of heat, which gives a definite amount of energy available, and horse-power is energy expended at a certain rate. Now, obviously as fuel is the medium to supply the heat, the evaporation depends on the amount of fuel burnt per hour. Therefore, if a prospective buyer knows the grate surface he can form a fair idea of the evaporative capacity of the boiler. A very closely approximate rule is to take the area of the grate and multiply it by three. For instance, a 60-inch boiler will have a fire grate 5 x 5, and multiply ing by 3, gives 75 H.P. The Ontario Government standard is 34 pounds of water from and at 212° F. per hour. They also give 15 square feet of heating surface per horse-power for a horizontal boiler, and variations from this for other types. However, horse-power, based on heating surface, is only useful as a commercial term. It is the evaporative capacity of the boiler that counts, and, while the heating surface has something to do with this, the amount of fuel that can be burnt per square foot grate per hour is the real governing condition.

A Real Mechanic For a Day

OH, I like a-hangin' round the house the week past Christmas time; the feelin' that camps in my chest is powerful nigh divine. I love that season of the year, by gum, I surely do—it makes me be a kid once more and makes old things come new.

In that there season of the year I get my saw and file, I get my hammer and the glue, I hatch also a smile, and then I gather spikes and tacks, a daub of paint what's red, and tell the kids to come along, I'm fit to go ahead.

And that procesh then starts to come in anguish and in woe; I have to put a spine in new and straighten out a toe—and put a neck beneath a head, and sprout a brand new leg, and make a hen look like as though she'd squat and mold an egg.

And what are all these wondrous things I operate on now—to chase the wrinkle and the scowl from out the childish brow? Why, just the Christmas stream of junk that's built for hours of play—the elephants that thrive an hour, the dolls that live a day.

I put new ears upon the horse, new wheels upon the carts, the Noah's Ark calls forth in grief for sixteen brand new parts.

Oh, in them hours I do rare tricks that sawbones wouldn't try—I carve a leg from out a slab, of beads I mold an eye. Ah, yes, I am a man of parts, smart lookin' to the child; he glories in my stone age craft and in my art so wild. I am a genius for a day, real wheat without the chaff, as I plan new noses for the pigs, new legs for the giraffe.—ARK.

The street railway company in Spokane, Washington, uses a tower for its repairmen that is operated by air pressure. An air cylinder, ten inches in diameter and seven feet long, is connected with the air-brake system of a steam car through control valves located in both ends of the vehicle. The air pressure secured is used to raise and lower the mechanism. Two men can be supported for twenty minutes. For jobs which take a longer time, chains are used to take the weight off the cylinder.

Smile

SMILE—Every time you get the chance—it is the chance smile that wins.
SMILE—If you are thin—laugh if you are fat—and if you're neither—just grin.
SMILE—At hard luck—the fates may think you like it and quit.
SMILE—And never let the sun set on your troubles—set on them yourself.
SMILE—At the past and you can grin at the future.
SMILE—While you are awake and you will laugh in your sleep.
SMILE—When you fail and you will die laughing at your success.
SMILE—When you are mad—and try to frown when you are happy.
SMILE—At a fifteen and it will look like a dollar.
SMILE—If it kills you and you will die with a grin on your face.
SMILE—Every time you think of it and you will soon get the habit.—*"Under Cover."*

Australia Considering Alcohol as Fuel

THE question of growing crops for the production of alcohol to be used as liquid fuel has been under discussion at an agricultural conference in Australia recently. It was stated that in a few years liquid fuel, as at present used, would be exceedingly scarce, and the world would have to turn to alcohol for motive power. The ordinary crops were too expensive to raise for their use in the manufacture of alcohol for industrial purposes and the only one at the present time which seemed to offer much promise of success was sorghum. While this is true of crops in commercial cultivation, another source of supply might well be available in Australia. The Commonwealth of Australia Institute of Science and Industry has been carrying out experiments with the object of producing commercial alcohol from the prickly pear. If this can be done, there is a vast field to be exploited, and in addition to it benefiting from the manufacture of the spirit, Australia will have found a means of checking the spread of the greatest of all vegetable pests. At present there are nearly 23,000,000 acres covered by the prickly pear, an area greater than that under crops. It is estimated that the pest is spreading at the rate of 1,000,000 acres a year.

Copyrighted by the International Feature Service.
—Coffman for the International Feature Service.

ABOUT TIME.

The Operators' Point of View

RE GRADED CERTIFICATES

The Editor,—"Justice," in answering my letter which appeared in your issue of November 20, puts an entirely different meaning into his reply, which appears in your December 5 issue. No doubt there are dubs in the engineering profession as well as in other walks of life, but it is very seldom that a man is raised to the position of chief engineer in a plant of any importance unless he has proven to the management that he has qualifications which entitle him to consideration. Although there are to my knowledge lots of men who have charge of two boilers and possibly an engine, who have not much engineering ability yet are holding down jobs that would come under the definition given by "Justice." Now I really do not think that "Justice" would care to be the man to succeed one of these men if they were compelled to go up for examination and were found not to be educated sufficiently to pass. If I am correct in this surmise I have no hesitation in withdrawing the name that I wished on him. In conclusion to "Justice" No. 1 I would say: Do not become discouraged. There is plenty of room at the top—be prepared.

CHIEF.

To Justice No. 2

The Editor:—We are getting results. My impression was that the Engineers were just holding their breath, waiting to hear what the other fellow had to say. In this surmise I have been correct, for we are having lots of correspondence. New blood has appeared. Now as to our new correspondent, Justice No. 2. my learned friend has waded in pretty deep, and I am a little afraid that he may find the going pretty hard if he is not more careful in his statements, to wit. Have not the men who are in charge of plants of unlimited capacity proved that they are qualified to hold down their positions. The fact that they are holding their positions is more conclusive evidence to my mind than if they had set down and passed the highest examination that the British Board of Trade could have designated, or the naval authorities would have asked for in an examination for chief engineer on the latest type of Dreadnought. And again, the managers of commercial industries in these days of strong competition are not altogether pin heads. They are not allowing a non-producing department like the power plant to be long under the supervision of a chief engineer, who, to [illegible] correspondent, are bluffs. Bluff would have been a good name for our friend to have assumed.

Now, just to correct any doubts as to where I stand, Justice No. 2 need not be at all alarmed. When the times comes, I hope to be up with the rest of the boys, ready for my examination and with a just hope based on my experience, and also to Providence that I was fortunate enough in my young days to secure an education that will be of sufficiently high enough grade to give me an excellent chance of securing a first-class certificate. My plea was and is for the man who, by perseverance and determination based on an ambition that any man should be proud of, have overcome all obstacles and attained a position in charge of a large plant. I have one such man in mind at the present time in charge of one of our largest plants, a man who can talk very intelligently on engineering subjects, who I know could not pass the examination for a second-class certificate. Yet in every way he is an exceptionally good man, can handle men and knows when he is getting good results from his plant. The writer of this has in his employ a staff of about 20 men. One of these men could sit down and pass any examination that the examiners could put before him. Yet he would not be a first-class engineer then. He is a wizard for engineers' examination questions, but lacks all other qualifications that are necessary in the making of a man to handle large plants economically and efficiently. No, my friend's ability to figure out the problems that the examiners will place before you not alone suffice you, even if you are fortunate enough to secure the coveted certificate. For the paper will not make the man, and some of those poor unintelligent employees who are so easily deceived by those chiefs, who you say are at the present time being bluffed, will soon call your hand if you are fortunate enough in putting one over on them and securing a position in their plants. Yes, it is justice we want and it is justice I expect we will get. 70 per cent. or less if a man's experience calls for anything, and I have confidence enough in the integrity of our examiners to know that they will not turn any man down, who, like the man I referred to above, has all the earmarks of a first-class man, but lacks the education to work out problems in higher mathematics.

CHIEF.

GRADED CERTIFICATES

The Editor,—I have been much interested in the correspondence appearing over the name of "Justice." I am afraid he does not know the meaning of the word, at least so far as the grading of the stationary engineer is concerned. To my way of thinking, if he has had the experience, he should be granted a first-class certificate, that is, a man with wide experience, one who can clear the ground, put in the foundations and set up his power plant in accordance with the Government regulations, is deserving of a certificate, although he may not have had the school training that the young engineer has to-day. Why make him take a back seat because of his not having all the formulae in his head.

I know I for one could not sit down and figure out the horsepower of a boiler without a handbook, and yet this year I figured out and set up a boiler plant of 800 boiler horsepower which is giving the best results.

I have worked my way from a fireman to the position of engineer, machinist, and machine shop foreman, and now I have to lay down my engineering tools because I cannot compete with the young engineer of to-day. I doubt if this man "Justice" could tell you which end of his engine is running the fastest.

Now, I am not one of those bluffers, but, according to the law of this country I will not be able to obtain a first-class certificate, and there may be a good many more like me. Let "Justice" consider the old engineer who has had twenty-five or thirty years of the trials of the boiler house and engine room without ever having to pull his fire.

The Central Technical School, Toronto is holding night classes, free of charge, for the sationary engineer. The classes are divided into two grades, junior and senior, and while both classes have covered half their allotted work for the year, registration is still open to those who care to take the balance of the courses, and as the last half hour of every lecture is usually spent in the general discussion of practical problems and in question and answer discussion, in which students and instructor take equal part, the classes become a valuable clearing house for information, whether or not those taking the course are preparing for examination. Next year it it the intention of those in charge of this work to organize the night classes into a systematic three years' course, fitting in with the new regulations of the Board of Stationary Engineers. The first year course will cover all technical and theoretical work required for 4th and 3rd class men. The other years will cover one class each. The scope of the instruction carried on will be considerably greater than that required by the regulations.

SOME ELECTRICAL DATA

By J. E. McCormack

TABLES of equivalents in electricity generally consist of statements as to the amount of energy or capacity represented by the terms given, but here is something a little different.

It is hoped that this will be an aid in comprehending some of the various electrical terms used in practice. Here goes!

A cell is a chemical generator of electrical energy.

A battery is a combination of two or more cells.

A primary cell or battery is one in which the electrical energy is developed by direct chemical action.

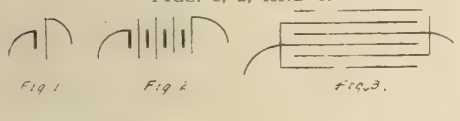
A secondary cell or battery, more often spoken of as a storage or acumulator cell or battery, is one in which the passing of an electric current through it causes chemical charges which render it capable of receiving, retaining and re-developing, a certain amount of electrical energy.

An element (electrically speaking) is the active electrode of a cell.

An electrode is a conductor by which a current enters or leaves an apparatus.

The electrodes of a primary battery are the plates of metal or other substance

FIGS. 1, 2, AND 3.



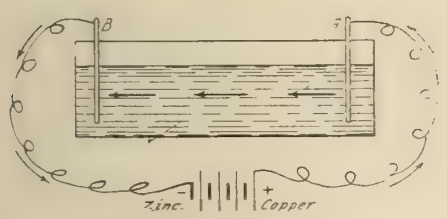


FIGURE 4.

immersed in the liquid. The zinc plate is called the generating electrode and the other plate the conducting electrode. The latter is usually made of carbon, copper being the next most commonly used.

The poles of a battery are the parts of the electrodes which project out of the liquid.

The fluid in a battery is called the electrolyte and in primary batteries is referred to as the exciting fluid or electrolyte.

The terms pole or terminal apply to the ends of a break in any electric circuit.

The negative pole, terminal or plate, is the one by which the current returns to a generator or leaves an instrument.

The positive pole, terminal or plate is that by which the current leaves a generator or enters an instrument. It is the opposite or converse of negative.

The anode is the electrode by which the current enters an instrument (or a battery).

The cathode is the electrode by which the current leaves an instrument (or a battery).

Fig. 1 represents the symbol for a single cell.

Fig. 2 represents the symbol for a number of cells joined in series to form a battery. The short thick line represents the zinc or negative (—) pole. The longer thin line represents the copper or carbon forming the positive (+) pole. Similar symbols are sometimes used to represent condensers but owing to the essential difference in their use there need be little confusion in this double use, but Fig. 3 represents a symbol often used for indicating condensers and which is free from the above objectionable feature.

Electrolysis is the decomposition of a chemical compound by the electric current. Fig. 4 represents a vat containing a solution, the solute of which is undergoing electrolysis by the current from a four-cell battery.

The internal circuit is that part of the circuit within the battery. The external circuit is that part of the circuit outside the battery and extends from the copper at one extremity of the battery and through the wire (conductor) to A, thence through the solution to B, thence through the other conductor to the zinc plate at that end of the battery.

In Fig. 4, the arrow heads indicate the flow of the electrical current. By referring to the definitions for Anode and Cathode given above, it will be seen that with regard to the internal circuit the zinc element of the battery is the anode of the internal circuit; the copper element being the cathode. As regards the external circuit, however, it will be seen that the electrode A being the one by which the current enters the solution is the anode of the external circuit, B being the cathode. As electrolysis calls for a considerable amount of electricity, and as this is more cheaply produced by mechanical than by chemical means, batteries are not used nowadays for effecting electrolysis on a commercial scale and therefore the terms anode and cathode are in practice seldom used now with reference to the internal circuit of a battery, yet is used in that connection just often enough to occasionally confuse or puzzle the novice to whom this point has not been explained. These terms (anode and cathode) are now most commonly applied to plates or rods attached at the ends of a break in an electric circuit such as A and B in Fig. 4, the corresponding terminals in an electro platers' vat, or the carbon rods used in cutting metals by electricity. The terms are also used in X-ray work, etc., and

FIG. 5.

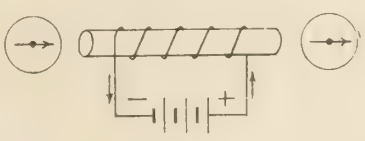


FIG. 6.

always, when applied to external circuits, in this way the anode is the one conected with the positive terminal of the source of current and is the one by which the current enters the vat or other object.

The zinc plate of a primary cell is spoken of as the negative, minus (—), or south, pole or terminal. It will be seen by Fig. 4 that it forms the anode of the cell but that an attached electrode B is the cathode of the external circuit.

The carbon or copper plate or rod of a cell or battery is spoken of as the positive, plus (+), or north, pole or terminal, and it will be seen by Fig. 4 that, while it forms the cathode of the cell, an attached electrode A is the anode of the external circuit.

In the ordinary dry cell the binding

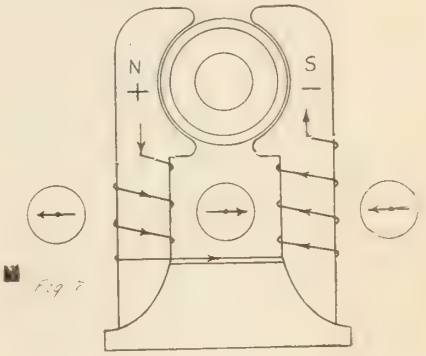


FIG. 7.

post in the centre of the top of the cell is the positive or plus terminal, the element being carbon.

In cells the carbon or copper = plus = + or positive and an electrode plate or rod attached to it by a conductor becomes an anode.

With regard to the lead plate type of accumulators (storage batteries), the + and — poles are easily distinguishable. Charged positive plates (peroxide of lead) (PbO_2) are a velvety chocolate brown color and hard like soapstone. It is usual to paint their lugs red.

Charged negative plates (sponge lead) (Pb) are of a pale slate or light grey color and can be cut into by the thumb nail. Their lugs are painted black.

It is well known that with magets unlike poles attract and like poles repel. The needle of a mariner's serviceable compass is a magnet and is acted upon by the magnetism of the earth. One end of the needle points to the earth's magnetic pole near the geographical north pole of the earth and is called the north pole or north end. Since like poles repel this would seem to be a misnomer and "north-seking" pole would seem more appropriate but owing to common usage the former term is accepted and is applied to all magnets. If we suspend a magnet by its center, its north pole will tend to swing so as to point northwards and the steel magnets on the market generaly have this pole marked by means of a prick punch or by a cold chizel, the other pole remaining unmarked.

Alfred W. Marshall, A.M.I.E.E., M.P., Mech. E., in his book, "Magnets and Magnetism Simply Explained," says (when referring to the name given the end of the magnet which will point north if free to do so): "Owing to this con-

fusion of meaning, various scientists have adopted or given other names to the poles of a magnet. The N pole as defined above is called Austral by the French, by mathematicians Positive (+), Lord Kelvin called it the True South, Faraday called it the Marked Pole, Sir G. Airey the Red (colored accordingly). The S pole is called Boreal by the French by mathematicians Negative (—). Lord Kelvin called it True North, Faraday called it the Unmarked Pole, Sir G. Airey the Blue (colored accordingly).

Now supposing we want to use a cell or a battery to produce an electro-magnet and want to make one certain end the North, N, +, Marked, or Positive pole of the magnet (the other end being of course the South, S, —, Unmarked, or Negative pole), we can easily manage that. Fig. 5 illustrates the direction in which the electric current must flow to produce a given polarity. This is right-hand winding but left-hand winding gives the same result, providing the current flows AROUND the bar in the same direction. The polarity is determined by the direction in which the current flows around the bar and is independent of the current travel from either end towards the other. Let one

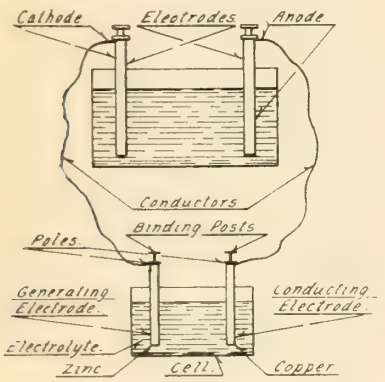


FIG. 8.

grasp the bar in his right hand and with the finger tips pointing in the direction of the travel of the current, the thumb, when extended along the bar, will point toward the magnet's north pole end. When looking at the end of the magnet, if the direction of the flow of the current is opposite to the travel of the hands of a clock or watch, then the end next the eye is the north pole end. Fig. 6 shows the north (+) and south ((—) ends of the magnet, the arrow heads indicating the direction of flow of current around them. Fig. 7 indicates the current flow and resultant polarity as applied to the field magnets of an overtype dynamo. From this fig. one can see how the principle applies to ordinary horse-shoe electro-magnets. The circles with arrows inside indicate the positions the needle of a mariner's compass would assume with the compass placed as indicated by the circles. When making small electro-magnets, if one finds that the polarity is wrong, all he has to do is reverse its connections to the cell or battery. Opposite connections gives opposite polarity. In the ordinary dry cell the central binding post belongs to the + pole of the cell and corresponds to the long thin mark given in the symbols.

Occasionally one is working away from where his source of (electric) current is and cannot see which pole or terminal either wire (conductor) is coming from or attached to, but if he has the right two conductors the polarity can be easily ascertained by the use of "pole-finding" paper, or, if this is not available, then by one of the following methods.

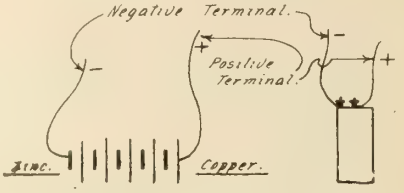


FIG. 9. FIG. 10

1. Use a few crystals of iodide of potassium dissolved in water. Insert the terminals. The liquid will take a stain, generally brown, at the positive terminal (the anode). Adding a paste of starch is supposed to cause a blue or violet color to the spot that occurs but I find the brown tinge quite persistent. As this preparation is liquid, or if thickened enough with starch, a paste, a dish is required for it while in use.

2. Blotting paper moistened in a solution of iodide of potassium in water will give a brown spot at the positive terminal. In this method the starch paste may be mixed in the above solution before dipping the paper but I do not think it any advantage to add the starch.

3. Place the wire ends into a solution of a tablespoonful of common salt in a pint of hard water. The one that sends up bubbles (or that sends up the most bubbles if both send them) is the negative pole.

4. Wet a piece of blue print paper and touch the two terminals to it. The negative terminal will bleach the paper white.

I have used each of the above successfully and with as low as four vols. I consider them sensitive in the order in which I have placed them here, the more sensitive ones mentioned first. The stronger the solutions of iodide or of salt the more sensitive I find them. The distance apart at which the terminals are held in the solution or on the paper also affects the length of time required to produce results. The blue print paper method may also be used on 110 volt circuits but on these and higher voltages the operator should guard against receiving a shock himself as the result of touching a bare terminal or handling the terminals without a proper amount of insulation to protect him.

The following methods are less sensitive than those already given unless in the case of a strong acid being used in this next one. They are arranged in the order in which I have found them sensitive.

5. To determine which is the positive and which the negative wire polish the wire terminals and insert them in an acid fluid. The positive end will tarnish quickly; the negative will remain bright.

6. Split or slice a potato and push both terminals into the fresh cut surface, the terminal around which the potato changes color (usually to a greenish shade) is the negative.

7. Place the wires a short distance apart in water, the wire from which the most bubbles rise is the negative.

I have referred to the fluid in a battery as being called the electrolyte. In chemistry, any substance whose solution will conduct an electric current is called an eletroclyte. Prominent among these are solutions of nitri acid, of hydrochloric acid, and of sulphuric acid. Solutions of the bases, potassium hydroxide, sodium hydroxide, barium hydroxide, and solutions of the following salts—potassium chloride, sodium chloride (common salt), ammonium chloride (sal ammoniæ), potassium nitrate (saltpetre) and potassium acetate. Some of these are seldom or never used in the sense in which an electrician employs what he commonly understands as "the electrolyte," and like the anode and cathode problem there is a chance for possible confusion if speaker's viewpoint is ignored or is obscure.

I have frequently seen in query columns in periodicals, questions identical with this. "If I cut a steel magnet in two, will I have two magnets, the one a north pole magnet and the other a south pole magnet?" The enquirer's idea seems to have been that the original magnet is all north pole from one end to the centre and all south pole from the other end to the centre, and that by cutting it in two he might isolate each pole and have single pole magnets. For use in some classes of "invention," this would come in very handy if it could be accomplished. In reality, when the magnet was cut in two, one would find that he had two magnets, each shorter than the original and each with north and south poles. One might as well expect to cut a string in two and each piece have only one end, as to expect to cut a magnet in two and each piece have only one pole. With equal magnetic density a short magnet (within certain limits) will support as much weight on an armature in contact with its pole as a longer magnet will support, but if used for drawing the armature to itself through a given air gap the long magnet will pull the same armature across a wider air gap than a short magnet will. If it is required that alternate poles of permanent bar magnets be presented, the method is to use two magnets placed with their north pole ends pointing in opposite directions. With electro-magnets reversing the flow of current reverses the polarity. As for the practicality of cutting steel magnets in two it must be remembered that hammering, jarring or other rough usage of steel magnets tends to weaken them and so should be avoided. Neither should poles be forced against one another.

The Canadian SKF Company, Ltd., have recently issued No. 5 of their Engineering Date Sheets. This particular sheet covers the application of ball bearing to fans of various types.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	26 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 67	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..		7 50
Premier, 10¾ oz.....		7 80

PROOF COIL CHAIN

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ i.n	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	60
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.....	....
Royalite, per gal., bulk.....	22½
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.....	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$2	20
Leather in sides 1	75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	16 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	43
Emery Cloth .....list plus	37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.....	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon...	2 00
Whiting, plain, per 100 lbs..	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 6c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$0	34
Sheets, 24 oz. and heavier base 0	42
Brass tubing, seamless 0	46
Tubing, I.P.S., 1" base..... 0	48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

METALS

Lake copper $24	25	$25 00
Electro copper	24 00	25 00
Castings, copper....	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12	00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.

Boiler pressure minus cylinder pressure—What's the answer?

160 lbs. on the boiler gauge—145 lbs. on the indicator card—or 100° Super-heat at the boiler and only 20° at the prime mover? Conditions like this usually mean insulation that has gone bad from age or abuse.

But there's one sure way of constantly maintaining pressure and heat all through your plant—and that is with Johns-Manville Asbesto-Sponge Felted Insulation.

This insulation will retain its original thermal efficiency because, unlike others of felt, it is constructed of many resilient layers made of fibrous asbestos and sponge. It is not easily damaged by handling in shipping or after installation; it is adaptable to all steam conditions and this is in addition to the fact that thermally it is the most efficient commercial steam-pipe insulation known.

Ask any of our branches for detailed information about the way Asbesto-Sponge will keep your steam the closest to boiler pressure.

Canadian Johns-Manville Company
Limited

Montreal Toronto Vancouver
Winnipeg Hamilton London Ottawa

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE
POWER PLANT MATERIALS

LOOK FOR THIS BRAND

Highest Grade

Mechanical Rubber Goods

For Every Purpose

BELTING

Power Transmission
Conveyor and
Elevator

PACKING

"Redstone" Pure Red Sheet
Cloth Insertion Sheet
"Sun" Spiral

THE UNIQUE

GUTTA PERCHA & RUBBER LIMITED

TRADE P.M.S MARK

PAPER MILL SPECIAL

TORONTO — CANADA

TRANSMISSION BELT

HOSE

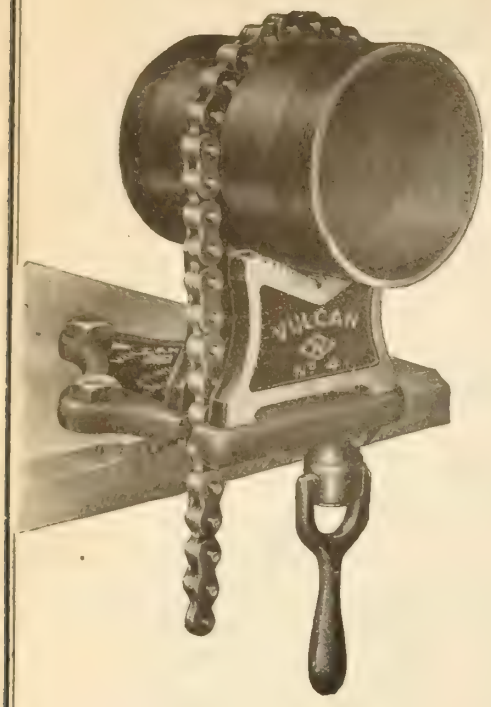
Water, Steam, Air Drill, Pneumatic Tool,
Oil, Gasoline, Suction and Fire Hose,
Underwriter Mill Protection Hose

GUTTA PERCHA & RUBBER, LIMITED

HEAD OFFICE AND FACTORY: TORONTO, CANADA

BRANCHES:

Halifax, Montreal, Ottawa, Calgary, Fort William, Lethbridge, Winnipeg, Vancouver, Regina, Victoria, Saskatoon, Edmonton,



Williams' "Vulcan" Drop-Forged Chain Pipe Vises

ARE attachable anywhere—to bench, post, or other convenient support. They are compact in design — being smaller and lighter than clumsy, heavy cast tools. They are unbreakable—being made entirely of wrought steel. They are positive in their grip, readily adjusted, rapid and powerful in action.

When looking for a superior Pipe Vise, remember that Williams' Chain Pipe Tools have been *Standard* for nearly half a century and have behind them Williams' unconditional guarantee of service. Vises in 3 sizes—for ⅛ to 8-inch pipe.

May we send you a copy of our new catalog?

J. H. Williams & Co.

"The Drop-Forging People"

78 S. Clinton Street CHICAGO, ILL. | **78 Vulcan Street BUFFALO, N.Y.** | **78 Richards Street BROOKLYN, N.Y.**

The A. G. LOW CO., LTD., 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, Alberta and British Columbia.

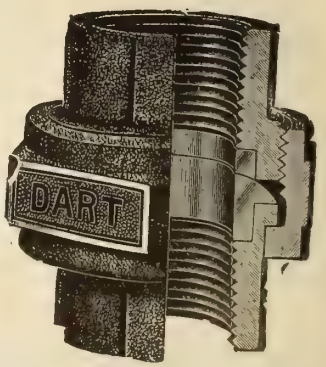
You Will

give pipe coupling troubles and up-keep expense a decisive knock out by using

DART
UNION PIPE COUPLINGS

The Bronze Face and Seat last indefinitely—there is no rusting or corroding at the joint, no deterioration.

The Heavy Iron Parts will not stretch or pull apart. Never scrap Dart Unions. Use again.



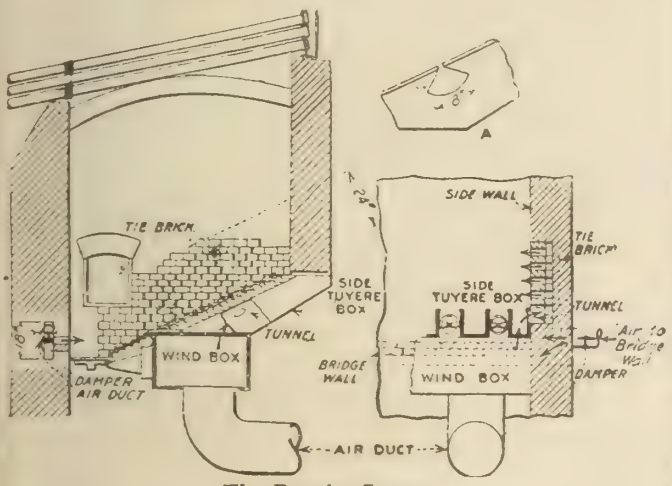
Your Jobber Will Supply You.

Manufactured by DART UNION CO., Limited, Toronto

Add Power to Your Furnace—

by eliminating the fuel-waste resulting from the "freezing" of clinkers to the side walls. The Bernitz Method of constructing side walls with interior air passages through which cooling air currents are passed to keep the bricks below the fusing point will

Positively Prevent the Accumulation of Clinker Mass.



The Bernitz System as applied in a Taylor Stoker Installation

The Bernitz Method

1. Saves coal by insuring more perfect combustion of the fuel used.
2. Increases boiler efficiency by shortening time spent in cleaning walls.
3. Increases efficiency by burning coal which formerly clinkered.
4. By shortening time spent in cleaning walls reduces influx of air through doors.
5. Saves B.t.u.'s usually lost by radiation through side walls.
6. Permits increased forcing of fires by eliminating danger of clinker "freezing."
7. Makes it possible to remove such clinkers as are formed without dumping fire.
8. By reducing manual labor in boiler room keeps laborers more contented.
9. By keeping fires clean insures greater uniformity in heat applied.
10. Is equally applicable to old or new constructions.

The Bernitz Method is licensed, not sold. It has received full patent protection in Canada and in foreign countries and licenses under these patents are being granted on the basis of the H.P. rating of the boilers under which the Method is to be installed.

Several Installations in Canada

Write for fu particulars to

ERNEST BERNITZ, Inc.

506-508 Tremont Building, Boston, Mass.

Exclusive Agents in Eastern Canada: **Fraser & Chalmers of Canada, Limited Beaver Hall Hill, Montreal, Canada**

Water Problems

Submit your water problems to

E. J. PHILIP & SONS

Ontario representatives of

Roberts Filter Mfg. Co.

Manufacturers of Water Filters for

Municipal, Industrial or Residential Uses

Any Capacity

E. J. PHILIP & SONS

57 Queen Street West

TORONTO - CANADA

ENGINEERING EQUIPMENT

DEPARTMENT OF LABOUR

Ontario Government

Minister:
Hon. W. R. Rollo.

Deputy Minister:
W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a STATIONARY steam plant of 50 B.H.P. or over, in the Province of Ontario, must hold a Stationary Engineer's certificate from the Board of Stationary & Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers.

After January 1st, 1920, the Certificate issued by the Board will be of four grades viz First Second, Third and Fourth. Application forms for graded certificates will be mailed upon request after the above-mentioned date. The certificates now issued by the Board will be graded into Third and Second-Class upon renewal, same being classified from the information contained in the renewal application which will be sent to each certificate holder.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse-power, and used for hoisting or conveying persons or for operating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1st, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request. The B.H.P. and other information contained in these forms is to be used for statistical purposes. A Registration Certificate will be issued to each applicant. All applications, or requests for same, should be mailed to the Chairman.

W. C. MCGHIE, CHAIRMAN OF BOARD

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., c. 61.

Before any work of repair or alteration is commenced in any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, Parliament Buildings, Toronto.

D. M. MEDCALF, CHIEF INSPECTOR OF STEAM BOILERS

WANTED

First-class machinery draftsman, by large Canadian in city near Toronto. In making application give details of experience, age and salary desired, etc. Apply Box 205, Power House.

WANTED.—Second-hand crude oil stationary engine, about 50 H.P., or two engines that will give that power.

The Miramichi Quarry Co., Ltd.
Quarryville, N.B.

WANTED

Representatives to handle special line of British made "Elastic Steam Jointing Cement" (for all joints) and Iron Cement for casting, etc. Exclusive territory offered parties conversant with trade. Replies treated confidential. Apply Box 151, Power House.

BOOKS

on all branches of Engineering and every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT
Books Bought Best Prices Given
W. & G. FOYLE, Ltd.
121-125, Charing Cross Road, London, England

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 TO 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

MONCRIEFF'S "UNIFIC"
WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

NEW PUBLICATION

The Franklin Manufacturing Company, Franklin, Pa., have recently issued a publication on heat insulation. This publication is entirely unlike the ordinary commercial catalogue and has been brought out with the idea of assisting the designing and operating engineer in the choosing of heat insulation of various types. To this end, in addition to the descriptive matter pertaining to the various types of insulation manufactured by the Franklin Manufacturing Company, a major portion of the book is devoted to heat transmission and loss problems and formulae, together with tables and charts.

A YARD OF INSTALLATIONS

The average buyer of power plant equipment, especially if the purchase cost runs into three or four figures likes to visit some neighboring installation to see the equipment in use.

The next best thing to a visit is a pictorial reproduction of the installations.

"A Yard of Installations" aptly describes the latest folder put out by the American Steam Conveyor Corporation, Chicago, with this thought in mind.

This folder shows in an attractive panel, views of installations of the American steam ash conveyor. The folder itself is about a yard in length, as the title indicates, and some nineteen or twenty installations are pictured.

This folder is being extensively distributed among power plant executives and is one of a series of pieces being issued.

The Canadian Ice Machine Co. have recently changed their Toronto address from 82 Chestnut Street to Villiers and Munitions Streets.

WANTED

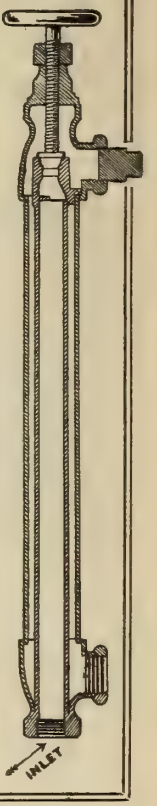
Power House Engineer, holding second-class Provincial certificate as assistant to chief engineer, for large industrial plant near Montreal, must be experienced in the operation of D.C. generating sets, transformers, air compressors and hydraulic pumps. Permanent position for the right man. Applicants speaking English and French given preference. State experience, qualifications, age and salary expected. Box 206, Power House.

THE LONG Patent Steam Trap

Has Only One Moveable Part

The Long Patent Steam Trap is advanced in construction. Has positive advantages over all other traps, and is protected by patent rights.
The valve is actuated by the expanding and contracting of a tube, a motion that is positive and of sufficient force to close the valve against a pressure of 200 pounds. The movement is due to the expansion and contraction of different metals.
Works against 1 and 200 pounds of pressure—no possibility of freezing. Has two outlets so it can be installed in any position. Applied to drain steam lines, mains, Jacket kettles and separators and can be adopted in drying room systems.

FULL DETAILS UPON REQUEST. YOU'LL SAVE MONEY.



J. T. LONG
84 Adam St.
MONTREAL CANADA
If your dealer does not sell it, Write direct

WHEN WRITING TO ADVERTISERS KINDLY MENTION THIS PAPER

Boiler Room Foreman Wanted
For Plant of 1800 B.H.P.

To capable man, competent to take charge both for upkeep and operation, we offer steady employment and good wages.

Apply giving full particulars of past experience and grade of certificate held to Box 203.

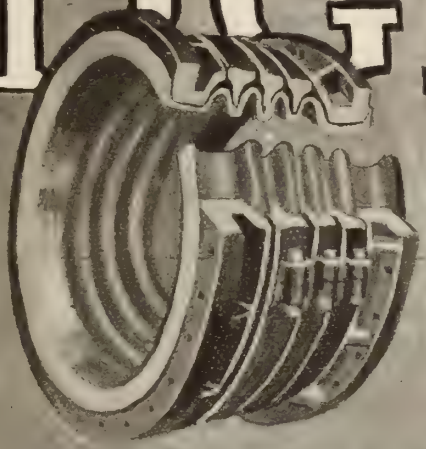
"POWER HOUSE"
143 University Ave., Toronto

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

BADGER



SELF-EQUALIZING EXPANSION JOINTS

CANADIAN AGENTS
Fraser & Chalmers of Canada, Ltd.
Beaver Hall Hill
Montreal, Canada

E.B.BADGER & SONS CO.
75 PITTS ST. BOSTON

CANADIAN AGENTS
Fraser & Chalmers of Canada Ltd.
Beaver Hall Hill,
Montreal, Canada

Valve Engineering Company

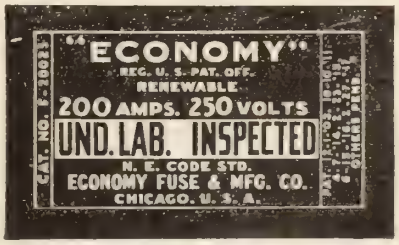
160 King Street West, Toronto

Power House Equipment

"Sold on a Service Basis"

M. J. Keane, for 19 years associated with the Leading Lines in Power Plant Equipment, is now located in Toronto, representing

Penberthy Valves and Injectors,
Steam Traps and Separators,
Vanstoned Pipe and Bends,
Asbestos and Rubber Sheet Packing,
Flexible Metal Hose,
"Witwyte" Packing, "Spando" Packing
Etc., Etc.



ECONOMY FUSES—

All Capacities

Approved by Underwriters' Laboratories

Economy Renewable Fuses in ALL CAPACITIES, from 0 to 600 Amperes in both 250 and 600 Volts were approved by the UNDERWRITERS' LABORATORIES, established and maintained by the NATIONAL BOARD of FIRE UNDERWRITERS and now bear the label "Und. Lab. Inspected." Economy "Drop Out" Renewal Links also bear the inspection symbol.

In your future purchases of enclosed fuses be sure to insist that both the fuses and the renewal links bear the inspection symbol.

IN ALL CAPACITIES

Economy "Drop Out" Renewal Links made approval possible for renewable fuses. Millions in use for many years. Ask for and insist upon ECONOMY Renewable Fuses and the famous Economy "Drop Out" Renewal Links.

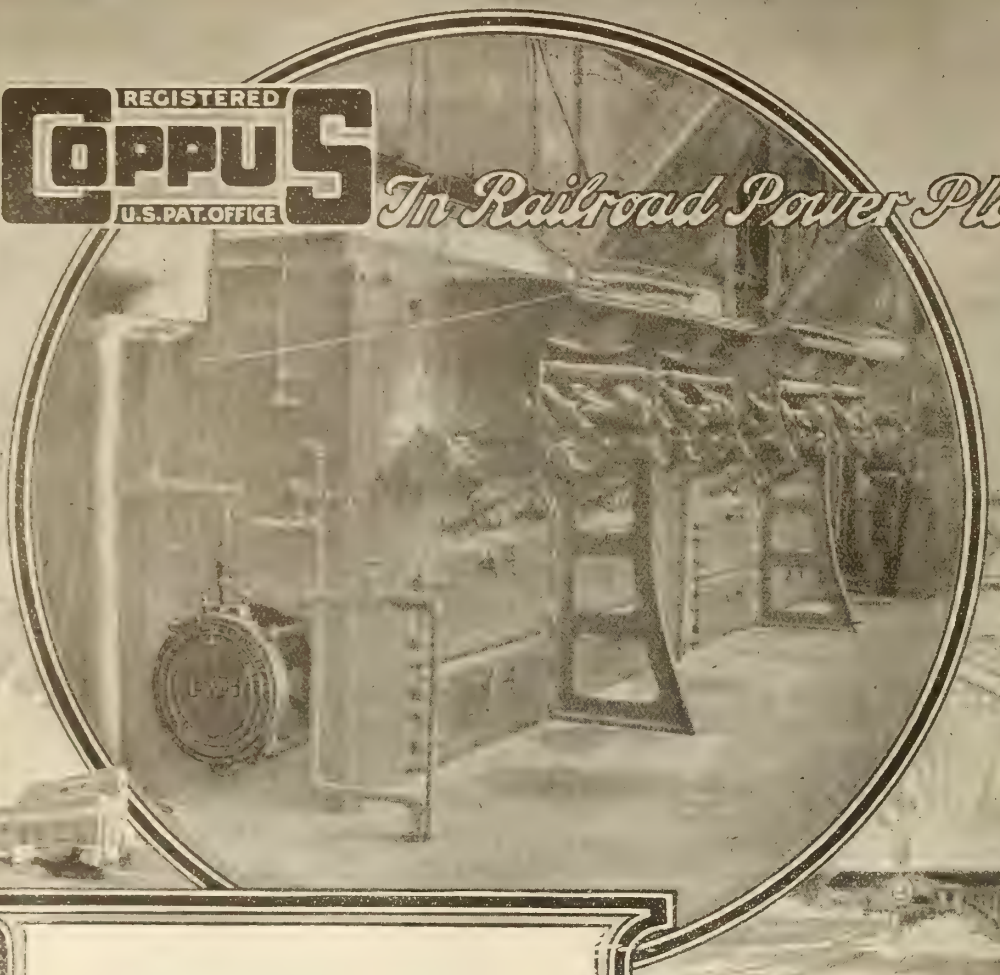
ECONOMY FUSE & MFG. CO.

Kinzie and Orleans Sts., Chicago, U.S.A.

Economy Fuses are also made in Canada at Montreal

REGISTERED COPPUS U.S. PAT. OFFICE

In Railroad Power Plants



Railroads are sticklers for efficiency. Equipment approved by them must produce results — save money — earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers **pay.**

Every one of this big battery of blowers—one of which is shown above—has cut coal costs—reduced labor charges—and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peek loads quickly—and burn cheap fuel. COPPUS Blowers **pay a profit** to the Central Railroad of New Jersey. **They can do as much for you.** Why not put them on the job? Catalog H-22 will show you how

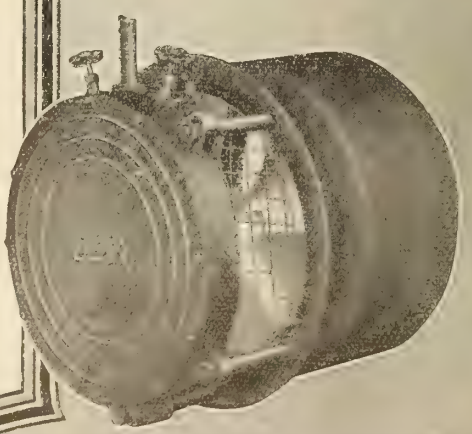
"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

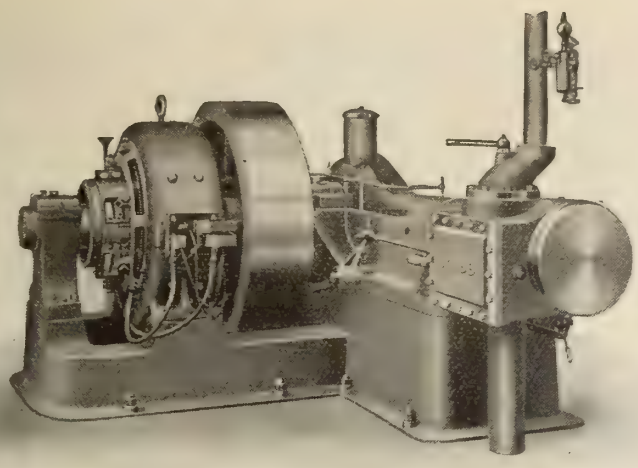
341 Park Ave., Worcester, Mass.

Agents for Montreal: Mason Regulator and Engineering Co. Agents for Winnipeg: Penhall & Hanson. Agents for Chicago: Monadnock B'dg. Agents for [illegible]: Arthur S. Leitch Co., 1001 Kent Bldg.



COPPUS TURBO BLOWER

ROBB POWER PLANTS



Engines

Corliss, slide valve, vertical, horizontal simple and compound.

Boilers

Water tube, return tubular, improved Scotch marine and portable.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office:
Phone Westmount 6800

Toronto Office:
20 Victoria Street

SAFETY FIRST

The NONPAREIL Shaking and Dumping Grates

Established 1900

Save 10% In Fuel Expense

OUR GUARANTEE SHOULD DECIDE YOU TO GIVE THEM A TRIAL. Nonpareil Shaking and Dumping Grates are put under any kind of a boiler for a test period of 30 days. If they fail to save 10% in fuel bills and do not prove entirely satisfactory they may be removed and shipped back to us—we will pay the freight.

There's no better way to meet fuel scarcity and high prices than by installing the Nonpareil Shaking and Dumping Grates. They will save 10% of your present fuel expense by giving complete combustion for every pound of coal used. You can use low-grade fuel, too, and secure maximum results. These are statements born of facts which we are prepared to prove.

Simple enough for a Girl to operate

Grate bars and repairs to all shaking grates and boilers of all sizes. Fire brick work, building in boilers, and general repairs.

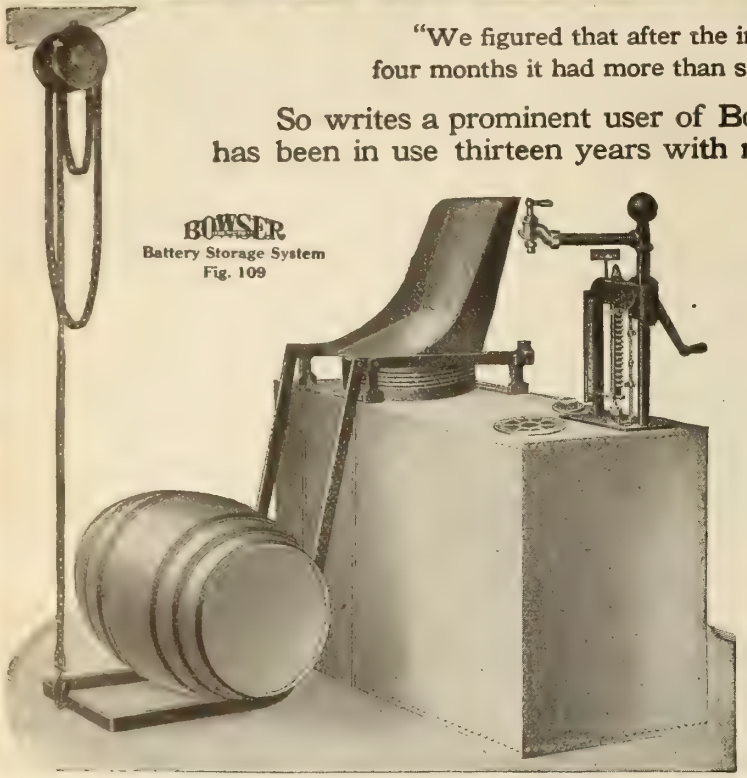
The W. R. Sexton Boiler Setting Company

127 D'Arcy Street, TORONTO, Phone College 682

Why Don't You Save Too!

"We figured that after the installation had been in three or four months it had more than saved its entire cost."

So writes a prominent user of Bowser Oil Storage. Their equipment has been in use thirteen years with no operating troubles or upkeep cost.



BOWSER
Battery Storage System
Fig. 109

If you are not using Bowser Storage Systems for your oils you are losing money every day.

BOWSER ESTABLISHED 1885

Systems Do Save

You can save the Bowser Way. Our literature shows how. Write for it at once.

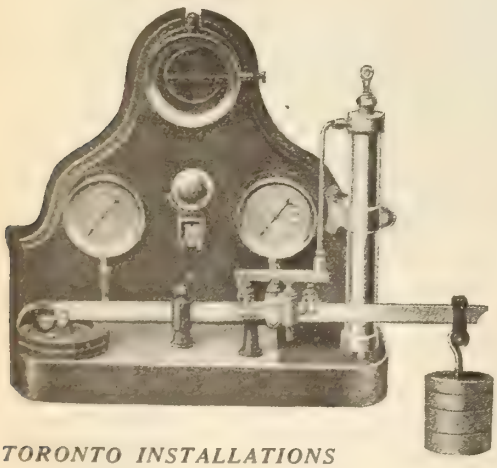
BOWSER COMPANY, LIMITED
68-68 Fraser Avenue
TORONTO, ONT.

LONDON
32 Victoria St. S.W. 1
HAVANA
Lonja del Comercio 427

PARIS
5 Rue Denis-Poissor
SYDNEY
6 Castlereagh Street

"McDONOUGH" SYSTEM

For the Automatic Regulation and Control of Air, Fuel and Water



TORONTO INSTALLATIONS

Sheet Metal Products of Canada,
T. Eaton Co.
Davies Packing Co.
Harris Abattoir.
Canadian Kodak Company.
Hinde & Dauch Paper Co., Limited.
Consumers' Gas Co. (3 plants).

ASSURES EFFICIENCY--SAVES MONEY

THE McDONOUGH DAMPER REGULATOR

This Damper Regulator saves $300 per boiler annually in many plants. It will on ½-lb. variation regulate Dampers, Stoker Engines, Stoker Motors, Forced Draft Engines, Gas Supply to Boilers. We put in the Quality before we put on the name.

We install this Damper Regulator in your plant for 30 days' trial, free of cost to you.

THE FEED WATER REGULATOR

We know positively that this Feed Water Regulator does what other Regulators try to do—maintains a flow of water to your boilers at the exact rate it is being evaporated into steam, that means boilers give drier and more steam for less money than is possible with other Regulators.

Two Good Reasons WHY:

Pittsburgh, Pa., Sept. 19, 1918.

We have your letter of August 9th and wish to advise you that we have your Automatic Regulator installed in our power plant, in this city.

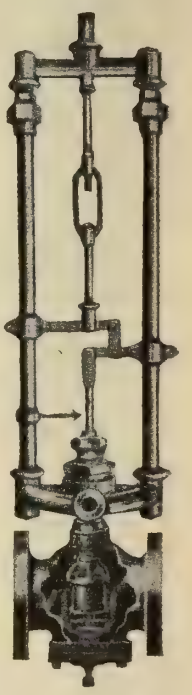
We have been keeping record of the coal used in anticipation of this installation, and find that we have an actual saving in coal alone of twenty-five (25) per cent. for the past three months, with considerable of an increase in our factory production.

JAS. H. MATHEWS & CO., INC.,
(Sgd.) Jas. H Mathews, Pres.

Toronto, November 17th, 1918.

We have had the McDonough Automatic Damper Regulator System and Feed Water Regulators System in use for more than six years in our Old and New Plants and we are pleased to state that these two controlling systems have been satisfactory and we find same a great saving equipment giving us steady water level in our boilers and a steady head of steam as well. We will be glad to recommend these controlling systems to prospective purchasers of steam plants.

THE WM. DAVIES CO., LTD.,
(Sgd.) J. C. Gillies, Mech. Supt.



Write us to-day for full particulars

McDONOUGH AUTOMATIC REGULATOR CO.

JAS. McDONOUGH
323 MARKHAM STREET
TORONTO
Phone Coll. 3986

"We Install a Jenkins Bros'. Valve With a Feeling of Confidence"

THIS is the actual statement of a prominent engineer, just after he had installed a genuine Jenkins Bros.' Valve in a troublesome line.

"That extra metal that Jenkins puts in his valves is just where it's most needed and I've never known a 'Jenkins' to break down even on a line where the pressure and strain is greatest."

Over fifty years of valve making is behind genuine Jenkins Bros.' Valves. They are the result of a thorough understanding of valve requirements and valve uses.

Jenkins Bros.' Valves are of all types and sizes for all uses, made of brass, iron and cast steel. They are distinguished from their imitations by the "Diamond Mark" cast on the body.
Look for it—demand it.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works:
103 St. Remi Street
Montreal, Canada

Agencies in all the
Principal Countries
of the World

European Branch:
6 Great Queen St., Kingsway
London, W.C. 2, England

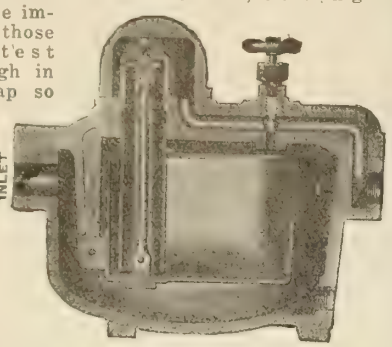
KIELEY

IMPROVED HIGH AND LOW PRESSURE

STEAM TRAP

For General Service

No power plant should be without a dependable steam trap. It is the great economizer of fuel and promoter of power plant efficiency. The KIELEY Improved Trap is the latest development in the art of steam trap construction, and is suitable for all service, either high or low pressure. The important parts and those subjected to greatest wear are placed high in the top of the trap so that by removing two nuts and the small cap all parts are easily accessible and removed for repairs — no breaking of connections necessary, neither do you have to remove the cover. Seats and discs are of best metal, absolutely non-corrosive; for exceptionally severe service seats and discs are constructed of nickel or monel metal, and the bodies of cast iron. Kieley traps never leak when in service—our water seal assures you this.



Leaky, unreliable steam traps are expensive. Adopt the KIELEY and be certain of efficient, economical service.

THE ARTHUR S. LEITCH CO.

Kent Building, TORONTO

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

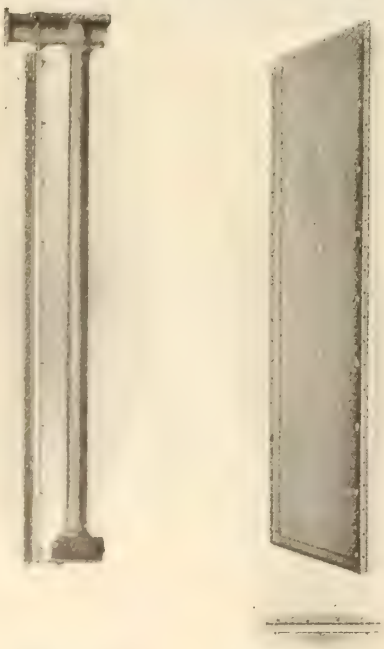
Mason Regulator Company

BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

Sectional Covers

Article No. 7



Sectional covers consisting of two steel plates with about 2 inches of magnesia or asbestos insulating material between them are now used in the majority of cases for enclosing one or both sides of the Economizer in preference to the older method of bricking it in.

The edges of the outside plates are fitted with stiffening angles so punched or drilled that when the sections of covering are in place, bolts can be slipped through and the edges drawn snugly together, making the covering practically air-tight, as well as heat-proof.

This covering has a big advantage in that it may be easily taken down and replaced if it should be desirable to gain access to the Economizer for inspection or cleaning.

GREEN'S ECONOMISER, LIMITED.

TORONTO

ECONOMIC Carling BLOWERS SUPERIOR

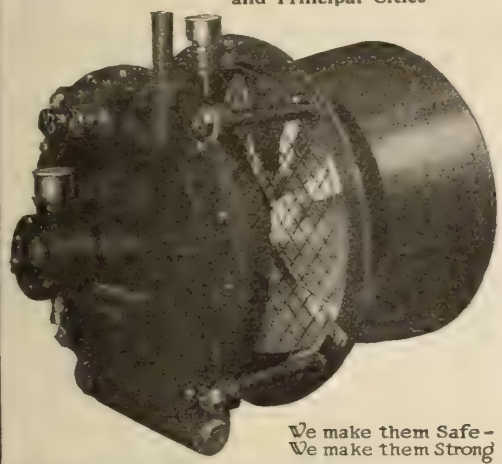
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

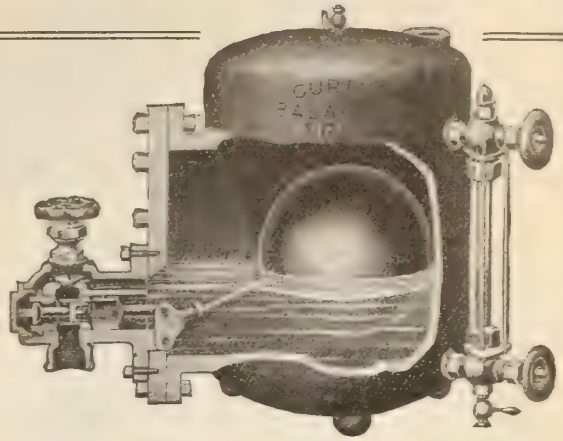
CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

Mason Steam Specialties

Mason Reducing Valve

ASSURE YOU RELIABILITY OF SERVICE

The practical knowledge of experts who are continuously coming into contact with difficult engineering problems should be of considerable assistance to you. Let us demonstrate the "Mason Service" on your next problem.

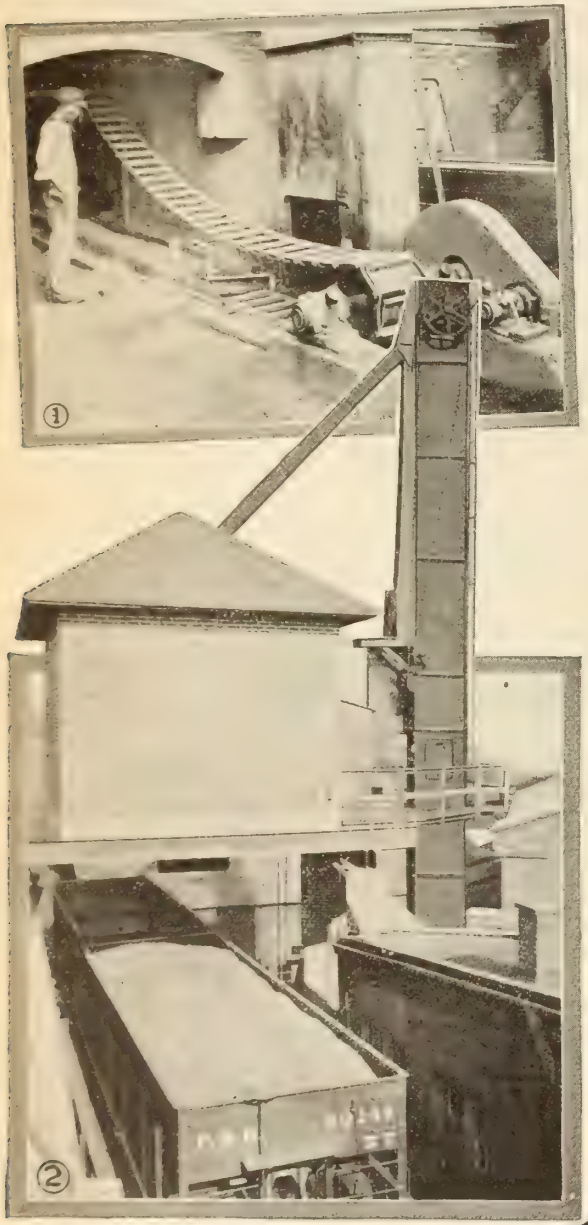
THE MASON LINE

Mason Reducing Valves (Genuine)
Mason Pump Governors
Mason Pressure Controllers
Bundy Steam Traps for every service
Coppus Turbine-driven Blowers
Sims Hot Water Generators
Sims Storage Heaters
Sims Open Feed Water Heaters
Bundy Oil Separators
Ashton Gauges and Safety Valves
Everlasting Blow-off Valves
Babbitt Sprocket Rims
Stratton Steam Separators
Reilly Multi-coil Feed Water Heaters
Reilly Evaporators and Distillers
Reilly Multi-screen Feed Water Filters

Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.

The Mason Regulator & Engineering Co., Limited
Successors to H. L. Peiler & Co.
Montreal Office and Factory
135-153 Dagenais St.
Toronto Representative:
The Arthur S. Leitch Co., 1002 Kent Building

LINK-BELT
CONVEYORS FOR ASHES



LET us show you how easily Link-Belt Machinery can solve that bothersome problem of disposing of your ashes.

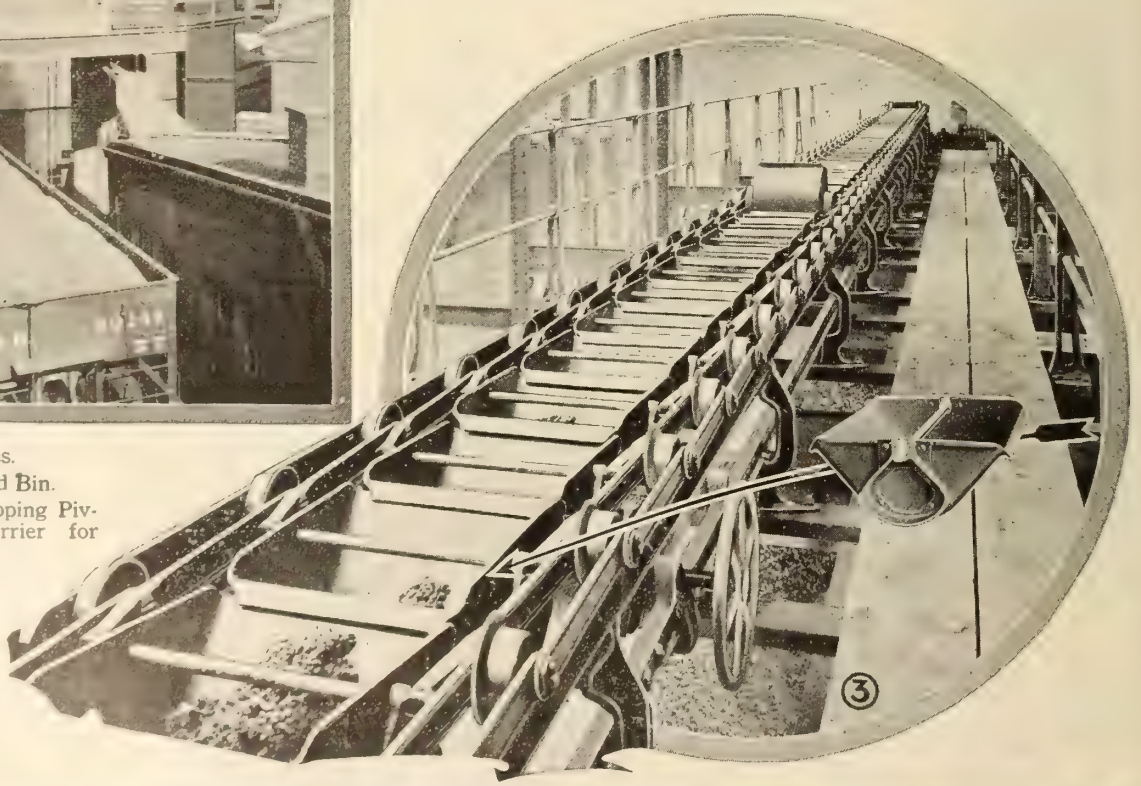
Link-Belt machinery starts with handling and preparing coal right at the coal mine, and the same efficient methods employed by us for the handling and preparation of coal at the mine is also employed for handling coal at the power house and removing the ashes.

Ask us to send one of our experienced engineers to look over your present handling methods and let us develop a standard Link-Belt plan to do this work for you in the most effective and economical manner. We also design and build labor-saving conveyors for handling miscellaneous materials of all kinds; coal handling machinery, locomotive cranes, portable wagon loaders, electric hoists. Catalogs on request.

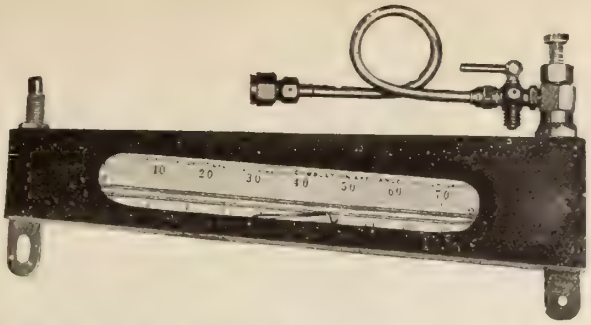
CANADIAN LINK-BELT COMPANY LIMITED

WELLINGTON AND PETER STREETS, TORONTO

1. Conveyor for Ashes.
2. Ashes Elevator and Bin.
3. The Peck Overlapping Pivoted Bucket Carrier for coal and ashes.



The Peck Carrier is the recognized standard machine for handling both coal and ashes in the modern Boiler House.



The Hays Differential Draft Gauge indicates the draft over the fire or the drop in draft through the boiler.

GUESSING IS A LUXURY—

Hays Improved Gas Analyzer

For testing boiler furnace gases, producer gases, casing head gas, exhaust from internal combustion engines, gases from sulphur burners, nitric acid gases, chlorine gas, etc., etc.

the greatest extravagance an engineer can indulge in.

Without exaggeration, 25% of all the fuel used under steam boilers on the North American continent is wasted by preventable heat losses in the boiler furnaces alone.

Look over the list of the possible and common causes of heat losses in boiler furnaces. In how many cases have you no check on losses from these causes in your boiler plant—in particular, no knowledge of the amount which is actually preventable? **In how many cases are you guessing that everything is all right?**

You can't even locate losses by guesswork. You can't eliminate them when you don't know where they exist. There is only one sure way—locate and measure the losses with

HAYS COMBUSTION APPARATUS

Sources of serious fuel losses which are largely preventable:

Excess or insufficient supply of air.

Leaky boiler setting.

Leaky baffles.

Holes in fire.

Unburned coal in ash.

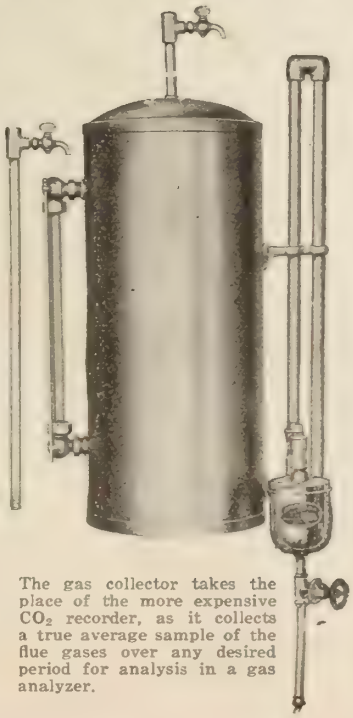
Fire too thin or too thick.

Firing periods improperly timed.

Fire cleaning periods improperly timed.

Draft too weak or too strong.

With measuring instrument you can isolate and measure the losses due to these causes in your furnace—you can only guess at them without. Can you afford to be without the instruments?



The gas collector takes the place of the more expensive CO_2 recorder, as it collects a true average sample of the flue gases over any desired period for analysis in a gas analyzer.

Then you have a basis to work from and a standard to work towards.

Ask for our book, **"How to Build Up Furnace Efficiency."** It is a treatise on boiler losses and their prevention—shows where fuel is wasted, how to stop the waste and keep it stopped.

We manufacture:

Draft Gauges—Indicating and Recording.

Automatic CO_2 Recorders.

Automatic Flue Gas Collectors.

Engineers' Gas Analyzer—a modified "Orsat."

Practical, sturdy instruments meant for continuous use in the boiler room.

The Jos. W. Hays Corporation

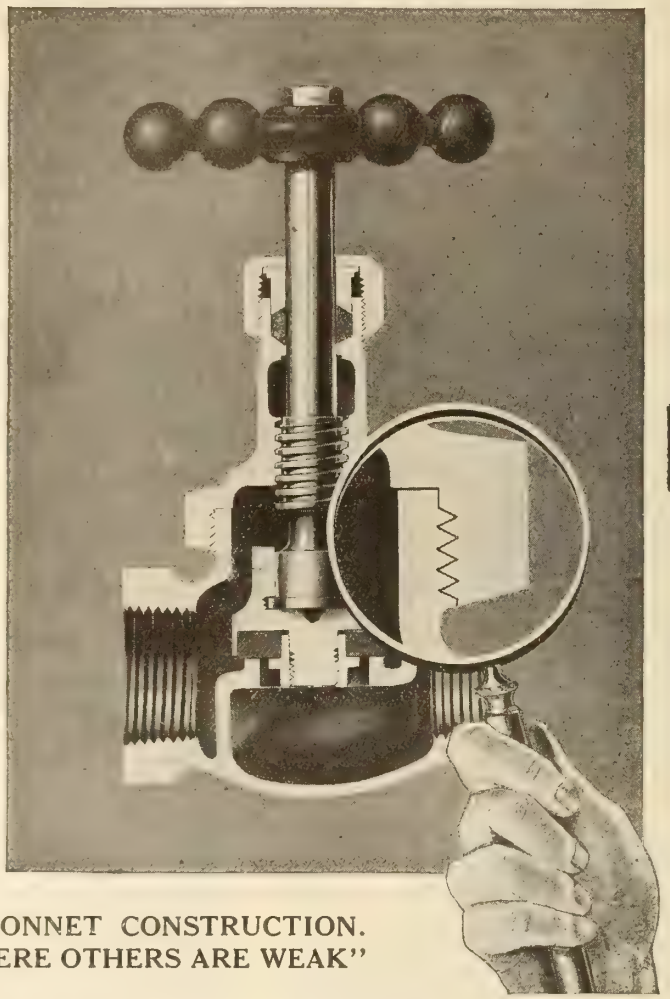
Michigan City, Indiana, U.S.A.

General Representatives for Canada:
Stephen H. Payne, 30 Church St., New York

REPRESENTATIVES IN CANADA:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto
Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal
Wm. Goold, 701 Merchants Bank Bldg., Winnipeg

COMPODISK

PENBERTHY



PENBERTHY

"OUTSIDE BONNET CONSTRUCTION.
STRONG WHERE OTHERS ARE WEAK"

VALVES OF QUALITY

A STEP FORWARD!

DO YOU KNOW?

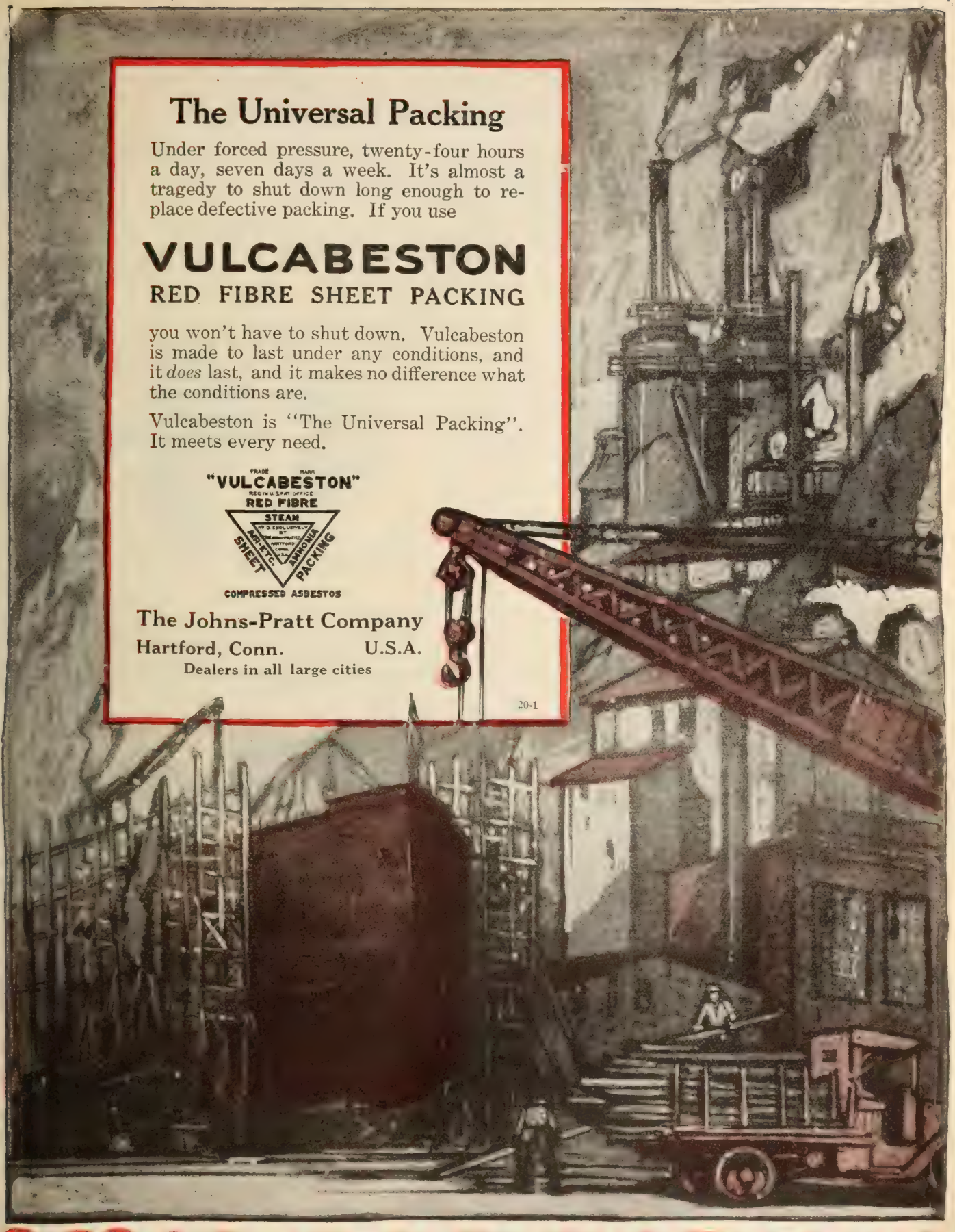
That the Penberthy VALVE was the FIRST VALVE made in Canada "with the outside bonnet construction."

***It is the first* radical and important improvement made in valve construction for generations.**

ALL Penberthy Valves are designed with outside threads on the bonnet end of the valves. When tightening down bonnet to place, this construction prevents spreading or enlarging bonnet end of body, causing a loose fitting and unsafe valve. The threads, being on the outside of the body, are immune from the corrosive action of the steam and water, preventing the body and bonnet from freezing together, eliminating all strains and making an extraordinary strong valve at the vital point where others are weak.

Manufactured by

PENBERTHY INJECTOR CO., LIMITED WINDSOR, ONT.



The Universal Packing

Under forced pressure, twenty-four hours a day, seven days a week. It's almost a tragedy to shut down long enough to replace defective packing. If you use

VULCABESTON
RED FIBRE SHEET PACKING

you won't have to shut down. Vulcabeston is made to last under any conditions, and it *does* last, and it makes no difference what the conditions are.

Vulcabeston is "The Universal Packing". It meets every need.

TRADE "VULCABESTON" MARK
REG IN U.S.PAT. OFFICE
RED FIBRE
STEAM
SHEET
ANTI-ETC.
AMMONIA
PACKING
COMPRESSED ASBESTOS

The Johns-Pratt Company
Hartford, Conn. U.S.A.
Dealers in all large cities

20-1

VULCABESTON

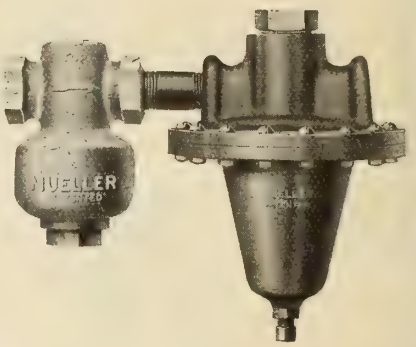
MADE IN CANADA

MUELLER

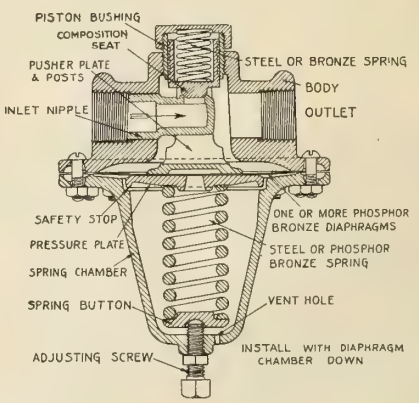
Reducing and Regulating Valve

FOR WATER; SINGLE SEAT

This valve is constructed with reduced seat opening. Specially adapted for house service in sizes not larger than 1″. Standard stock valves have iron bodies, iron diaphragm chambers, phosphor bronze diaphragms and all interior working parts of bronze. Seat disks are furnished of suitable material for the desired service.



A-5010



WE MAKE MUELLER

Basin and Bath Trimmings, Bibbs, Sill Cocks, Ferrules, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps; Regulators and Reducing Valves for Water, Air, Steam and Oil; Bubbling Fountains, Gas Cocks, Globe, Angle and Check Valves, Etc. Forgings in Brass; Castings in Brass, Bronze and Aluminum; Specialties for Automobile Companies, including Bronze Bushings, Gasoline Cocks, Etc.

Upon request, circulars completely describing the MUELLER line of Reducing and Regulating Valves for Steam, Water, Air and Oil will be forwarded.

H. MUELLER MFG. CO.,
LIMITED
SARNIA, CANADA

Write for our Canadian Catalogue "A."

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS

FOR BAND SAW MACHINES

WESTERN PINE MFG. CO.
—Manufacturers—
Lumber, Sash and Doors
Spokane, Wash.

Magnolia Metal Co., May 28, 1919.

Gentlemen:—

As nearly as I can recall, I began using MAGNOLIA METAL twenty-seven years ago. I have, from time to time, used other babbitts, but have always come back to using MAGNOLIA.

The most important machines around this plant are babbitted with MAGNOLIA METAL. The MAGNOLIA lined bearings on one American Band Resaw, doing extra heavy work, show no particular wear after seven years of continuous service.

I have always given particular attention to the melting and pouring of babbitt metal, preparing the boxes to be babbitted, cleaning well and heating the box. I never mix the scrap babbitt from the old box with the new metal. Always heat the metal only enough that it browns a white pine stick easily and pour while hot.

Yours very truly,
WESTERN PINE MFG. CO.
John Pfeffer, Supt.

SOLD BY LEADING DEALERS EVERYWHERE OR

MAGNOLIA METAL CO.

Office and Factory

MONTREAL, 226 St. Ambroise St.

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

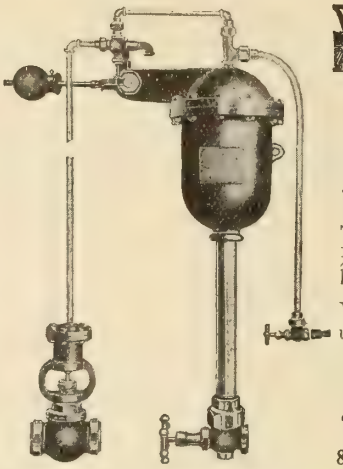
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



VIGILANT

Automatic Feed Water Regulator

The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.

Years of service test has proved it th utmost in reliabillty and efficiency.

Catalogue presents many points of interest. May we send you a copy?

The CHAPLIN-FULTON Mfg. Co.

8 Penn Avenue - Pittsburgh, Pae

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

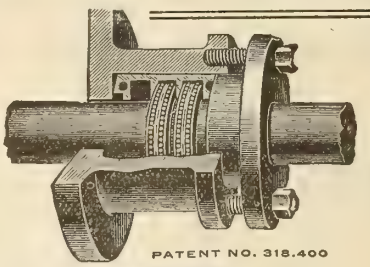
For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,086
" "	775 193	" "	905,103
" "	776,194	" "	934,629
" "	791,300	" "	979,206
" "	805,6[illegible]	" "	1000,75

Why not Buy the Best, when in market for Packing?

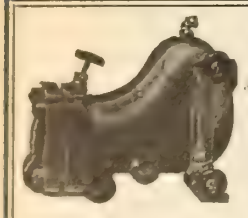
HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897



McDANIEL IMPROVED STEAM TRAP

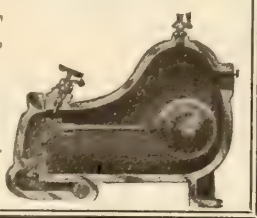
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY

26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.

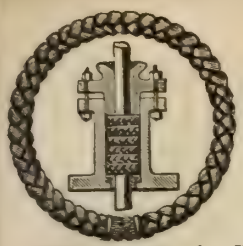
No. 146 N. 7th Street. PHILADELPHIA, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

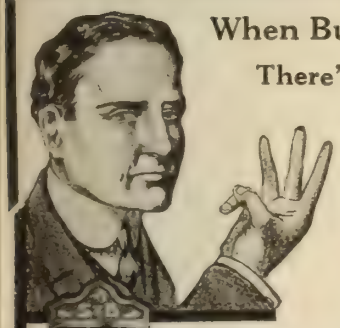
The J. C. Wilson Mfg., Co., Limited

BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us



When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:

Milton and Prentiss,

Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

"SAFETY FIRST"

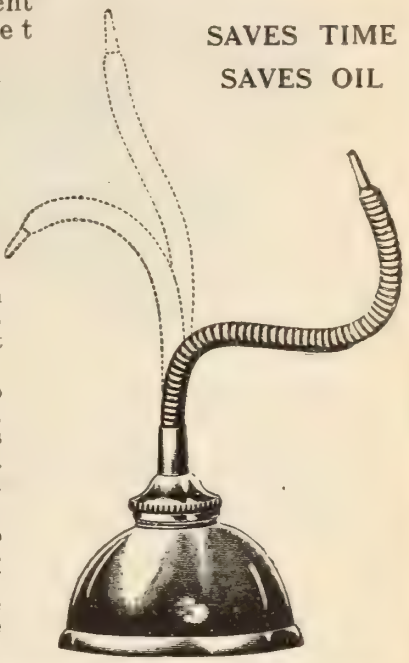
Bend the Spout

to suit the position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL



Note the flexible spout. It enables you to oil all places—many places that previously could only be reached with force pump cans with specially bent spouts.

Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY

196 KING STREET WEST - TORONTO, ONTARIO

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300

CRANE FITTINGS

CRANE

LIMITED

HEAD OFFICE & WORKS
1280 ST PATRICK ST
MONTREAL

BRANCHES: Vancouver, Calgary, Winnipeg, Toronto.

LUNKENHEIMER "RENEWO" VALVES

The "seat guard" with which the "Renewo" is provided aids in preserving the seating surfaces and keeping them clean. The seating surfaces are regrindable and all the parts, including the **seat ring** and **disc** are renewable. To further enhance their durability, both the **seat ring** and **disc** are made of Lunkenheimer "Valve-nickel"—a material having exceptional wear-resisting qualities.

The body, bonnet, stem, etc., are made of high-grade bronze composition formulated especially for the duty each part performs, making the **"Renewo"** the most practical, durable and economical valve to be had.

Globe, Angle, Cross, Straightway and Horizontal and Angle Check types for pressures up to 200 and 300 pounds.

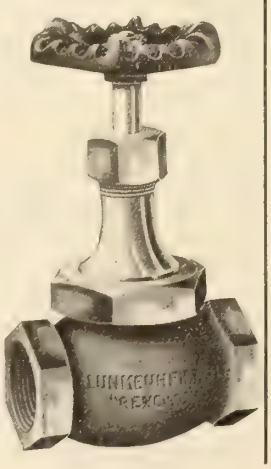
Specify **Lunkenheimer "Renewo"** and insist on getting the genuine. Your local dealer can furnish them, if not, write us.

Write for Booklet No. 535---D.C.

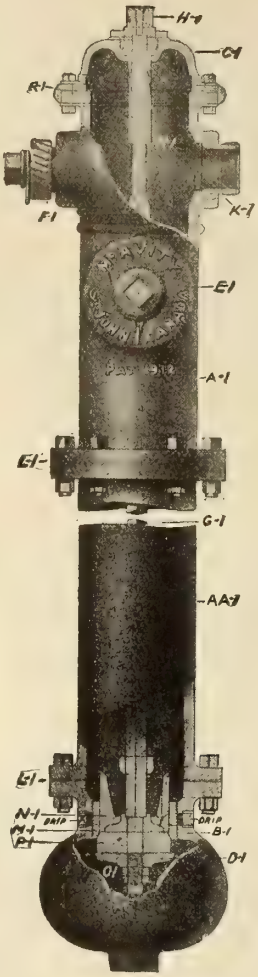
THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World
CINCINNATI
New York Boston
Chicago London

1-17-43



"McAVITY"



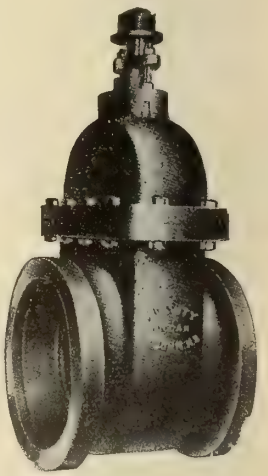
New Improved Fire Hydrant

(Patd. 1912)

The latest improved Compression or Matthews type Hydrant which is used without Frost Case, owing to Removable Seat, Valve and Fittings.

"McAVITY" GATE VALVES

with Iron Body, Bronze Fittings, with either BRONZE or HARD WHITE METAL SEATS RENEWABLE.



T. McAVITY & SONS

LIMITED

St. John, N.B., Canada

TORONTO

Harvard Turnbull & Co., 207 Excelsior Life Bldg.

MONTREAL WINNIPEG EDMONTON CALGARY

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Bond Engineering Works, Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
W. S. Sexton Boiler Setting Co., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metiskin Mfg. Co., Rochester, N.Y.
Shell-Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Yarnal-Waring Co., Philadelphia, Pa.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
W. R. Sexton Boiler Setting Co., Toronto.

BOILER HOUSE ACCESSORIES
W. R. Sexton Boiler Setting Co., Toronto.

BOILER SETTINGS
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metiskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
W. S. Sexton Boiler Setting Co., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS
Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton. Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.

ELEVATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Sturtevant Co., B. F., Toronto. Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS
MacLean Publishing Co., Toronto.

EXHAUSTERS
Green's Economiser, Ltd., Toronto.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED
Beveridge Paper Co., Montreal, Que.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

The Jeffrey Carrier

Requires Little Lubrication

THIS desirable feature of the JEFFREY Pivoted Bucket Carrier is obtained by the use of large rollers and glass-hard bushings. The extra-sized rollers give increased leverage to the oiled bore with a corresponding decrease in both the speed of the rubbing surfaces and the horsepower pull.

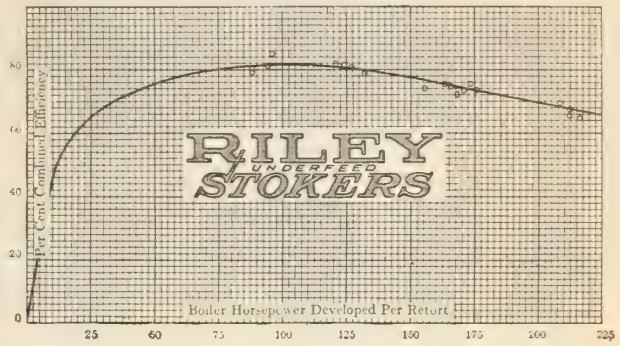
The new **JEFFREY Roller** is a marked improvement over all others. It is so hard that it resists the action of high-grade machine tools. The bore is, of necessity, ground on a special grinding machine.

There are many other unique features embodied in the JEFFREY Carrier. Catalog No. 210 gives full details. Write TO-DAY for your copy.

THE
Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL
CANADA

Handle it Mechanically

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

The first year after installing Riley Stokers, the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

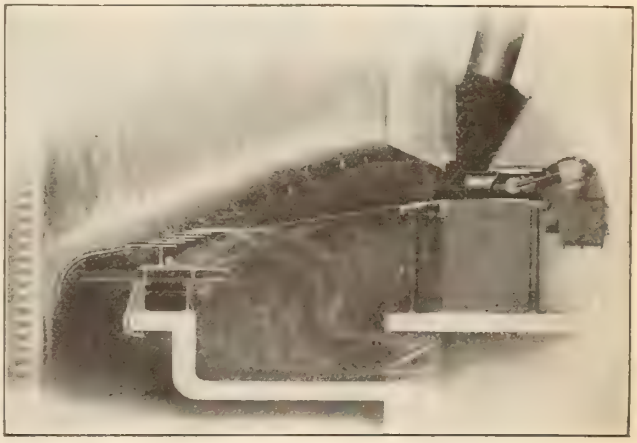
Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

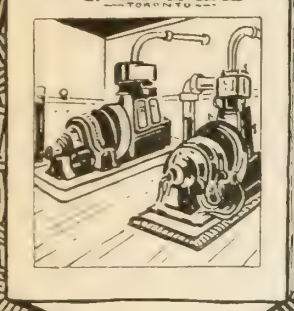
Catalog HR 2 sent on request.

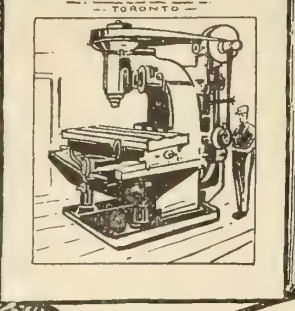
For information on Murphy Automatic Furnaces for small boilers, see Jan. 20 advertisement or send for Murphy Furnace Catalog HM 2.

Sanford Riley Stoker Co.
WORCESTER, MASS.

British Licensee: Erith's Engineering Co., Ltd., London. French Licensee: Erith, Leroy & Cie., Paris, France.







For Self-Promotion And Sales Promotion Use These Publications

POWER HOUSE

Twice a month—$2.00 per year.

Serves the power plant engineer—Steam, Electric Refrigeration, Hydraulic.

CANADIAN MACHINERY

Weekly—$3.00 per year.

Covers the metal working field—serving shop executives, purchasing agents and owners. First-class mechanical paper and market paper combined.

CANADIAN FOUNDRYMAN

Monthly—$1.00 per year.

A paper for the foundry owner, superintendent and foreman. Claimed by its readers to be unexcelled.

MARINE ENGINEERING

Monthly—$2.00 per year.

Interprets marine engineering in its broad sense, serving the shipbuilders, navigation companies and their officers. (The editor holds an extra first-class B.O.T. certificate).

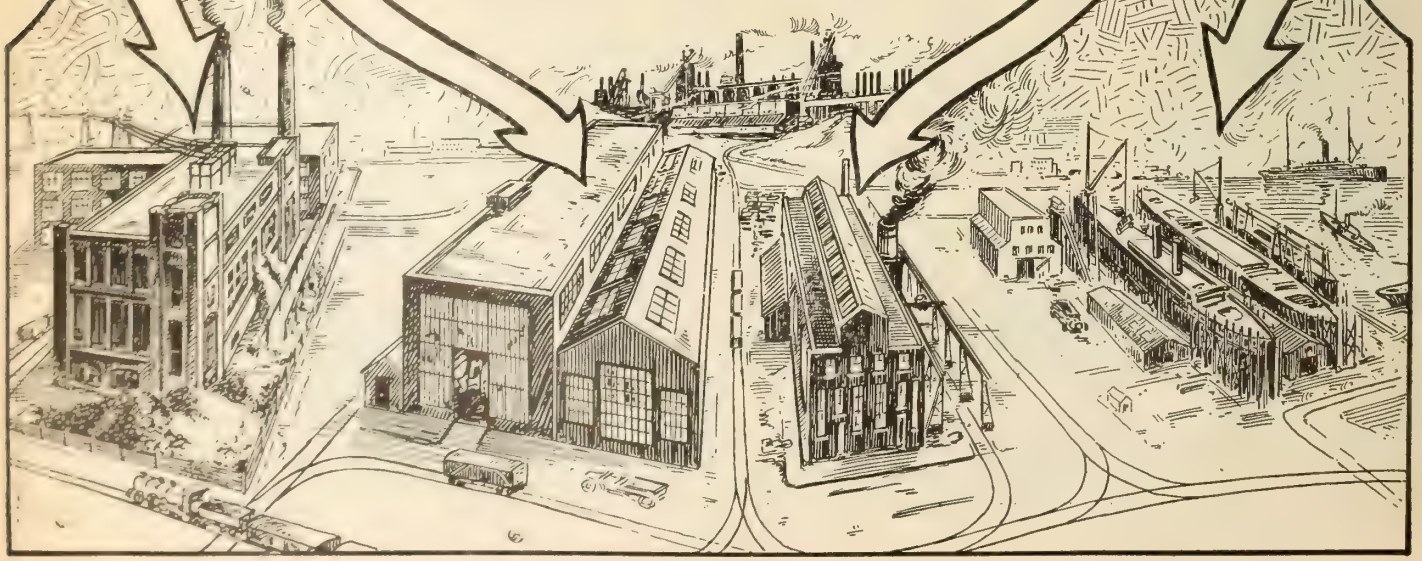
Published by

THE MACLEAN PUBLISHING CO., LIMITED

143-153 UNIVERSITY AVE., TORONTO

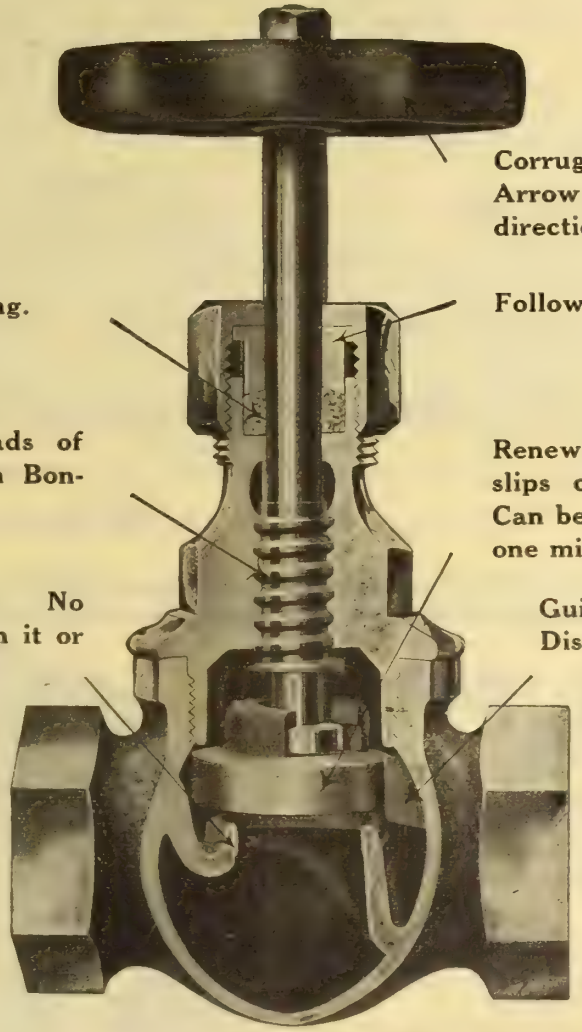
A company whose idea of service has made it the largest concern of its kind in the British Empire.

Thirty years' experience and dozens of practical men in your own line, stand ready to serve you. Let them! Subscribe for your paper to-day.



CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Palmetto Twist Packing.

Follower in Stuffing Box.

At least Four Threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised Round Seat. No sediment can lodge on it or injure disc.

Guide cast on Body holds Disc centrally over seat.

Globe or Angle

Screwed or Flanged

The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

Everything in Mechanical Goods.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

METLSKIN

prevents boiler-scale

by a process which is mechanical, rather than chemical. It forms a minute, grayish-white coating which keeps scale-forming solids from adhering to the boiler metal, and, therefore, these solids must settle to the mud-drum, whence they may be discharged through the blow-off.

METLSKIN is distinctly **not a compound,** nor does it contain any soda ash, graphite, kerosene, or tannin. It works by expansion, without harm to anything save boiler-scale itself.

The Two Months' Test

may be adopted by any reputable concern troubled with scale. METLSKIN will remove the old incrustation safely but gradually, will ultimately produce clean boilers and then **keep them clean.**

Send a post card for terms and full details.

NOPORO

air-proofs boiler-settings

by maintaining an air-tight seal on the exterior surfaces of the brickwork. After a thorough application, by means of a trowel, NOPORO forms a covering that looks and feels very much like coarse, black grain leather. The surface may be whitewashed after an interval of 6 to 8 days, while the material below the surface retains its plasticity. It will not peel, check, or disintegrate, and will **stay put** for years. No further attention need be given it.

An Immediate Saving

may be effected, since NOPORO promptly prevents the entrance of cold-air into the furnace chamber. That means better fuel-combustion, less firing, less coal. NOPORO pays for itself from the first.

Mail a card for prices and descriptive folder.

METLSKIN CO., Inc. Sole Manufacturers ROCHESTER, N.Y., U.S.A.

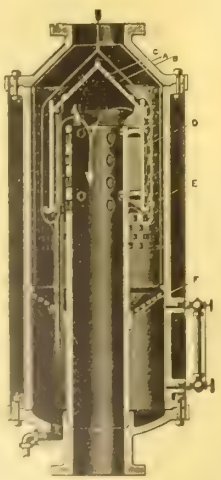
Exclusive Canadian Distributors

CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John Montreal Quebec Ottawa Hamilton Toronto Windsor
Winnipeg Calgary Vancouver Victoria Saskatoon

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

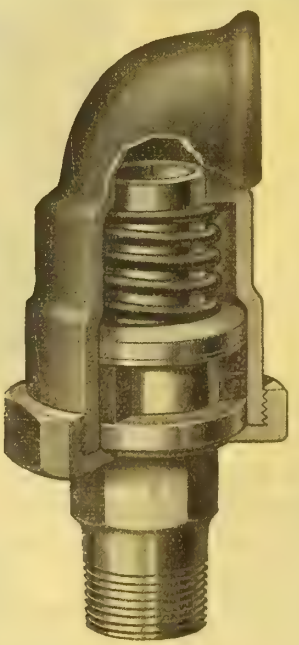
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Power You Pay For

YOU pay for power according to the coal you burn, but you *get* what your belts deliver. A fraction of 1% saved in power transmitted soon pays the cost difference between a poor belt and a good one. One breakdown may wipe out ten times the cost of any belt.

The right belt in the right place boosts profits.

Among Graton & Knight Leather Belts there are *right belts* for every drive, belts that will deliver maximum power year in and year out without a halt.

They do this because they are made from leather—tanned in our own tannery especially for belting purposes. This preserves and intensifies the strength, toughness and flexibility of the hide as worn on the back of an active, living steer.

Skilled workmen make this specially tanned leather into a Standardized Series Leather Belts—belts for every drive standardized in manufacture and in application.

Our booklet, "Standardized Leather Belting," explains how to find the *right belt*. A copy will be sent you upon request.

Engineering Note

Our Engineering Department is at your service to answer any questions you may have about belting and its use. There is no obligation involved.

Here is a 48" 3-ply Heart Brand belt in the mill of Joseph Bancroft & Sons Co., Reading, Pa. More than 3½ years of steady service. Transmitting 300 horsepower at a cost to date of less than one cent per week and good for many years more.

THE CANADIAN GRATON & KNIGHT, LIMITED

OAK LEATHER TANNERS AND BELT MAKERS

MONTREAL, CANADA

Canadian Representatives: Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria. *Branches and Distributors in all Principal Cities.*

Graton & Knight

Standardized Series

MADE IN CANADA

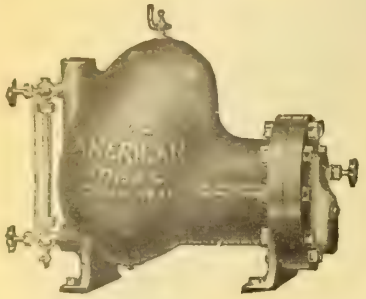
Leather Belting

MADE IN CANADA

Tanned by us for belting use

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Complete Steam Trap Service



means:

Removal of all excess condensation without loss of steam, No maintenance expense.

This service is given by the AMERICAN IDEAL STEAM TRAP.

Saving Steam is saving Coal.

Saving Coal is saving Money.

Saving Coal is more vitally necessary now than ever before.

Write for our Trap Booklet.

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

TESTS OF HIGH-PRESSURE GAUGE GLASS

Temperature:	Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.
Erosion:	No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.
Tensile Strength:	Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.
Service:	Under continuous operating conditions with pressure of 225 pounds, performance equaled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

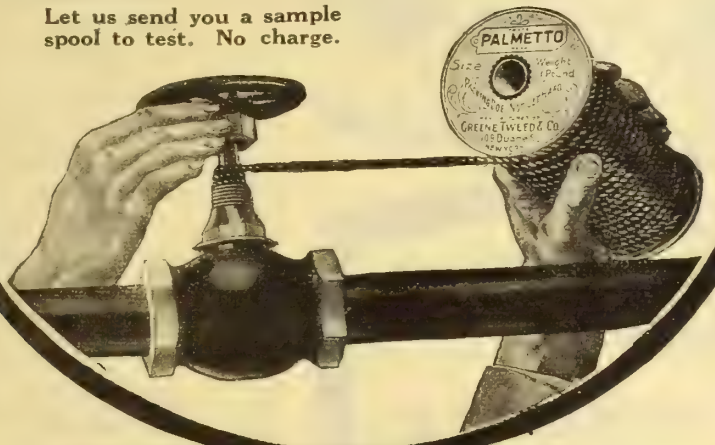
CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

PACK THE SMALL VALVES
WITH "PALMETTO" TWIST and
they will stay packed.

Any Size Valve May Be Packed
from One Spool by Unstranding

Lubricant in each strand keeps stem well lubricated and hand wheel turns easily.

Let us send you a sample spool to test. No charge.



The Long Service Quality of

"PALMETTO"

MEANS REAL PACKING ECONOMY

Greene, Tweed & Co.,
Sole Manufacturers
109 Duane Street,
New York

Canadian Agents: The Canadian-Fairbanks Morse Co., Limited, St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria

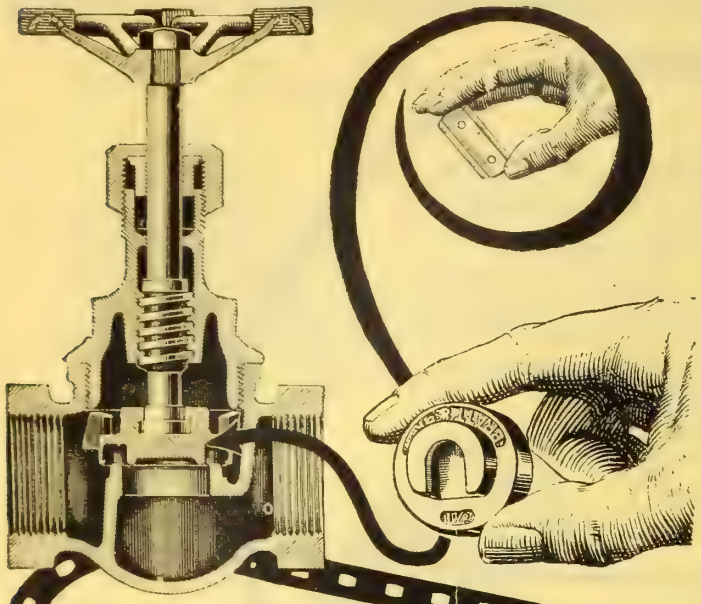
FOR RODS--"PALMETTO" BRAIDED

Rods working against the well lubricated surface of "Palmetto" packing have practically no friction to contend with, which means long life for both packing and rods.

As a packing "Palmetto" is in a class by itself.

Let us send you a working sample to test out for yourself. No charge.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



Like Putting a New Blade in Your Safety Razor

When your safety razor blade is worn out you replace it with a new one—you don't throw the razor away.

The same principle applies to the Pratt & Cady *Renewable* Disc Globe Valve. When the disc becomes worn from hard use you put a new one in its place—you don't throw away the entire valve.

In other words, you simply pay 25c for a new disc instead of $2.50 for an entire new valve in the 1″ size. Then your Pratt & Cady "Renewable" is as good as new.

Old style razors and old style valves have to be discarded entirely when worn past use. Both are a dead loss.

Factories using Pratt & Cady Renewable Disc Valves cut down valve-costs to a minimum.

The operation of replacing a worn disc is a quick one, requiring only a few minutes. And the change can be made without removing valve from the pipe line.

An economy of this kind is worth thinking about. Many plants are saving big sums annually by putting in a "Pratt & Cady" every time an old-style valve goes bad.

Our Valve Book contains some facts that will interest you. We'll send you a copy on request. No obligation.

PRATT & CADY CO. INC.
HARTFORD, CONN.

Manufacturers of Valves, Asbestos Packed Cocks, Feed Water Heaters. Hot-Water Generators, Hot-Water Service Heaters and Power Pumps.

Canadian Representatives:
THE CANADIAN FAIRBANKS-MORSE COMPANY, LTD.
Halifax, Montreal, Hamilton, Saskatoon, St. John, Ottawa, Windsor, Calgary, Quebec, Toronto, Winnipeg, Vancouver.

PRATT & CADY
RENEWABLE DISC GLOBE VALVES

Advertise for Good-Will

"The last twenty years have witnessed a great development of advertising as a selling force," George Frank Lord, advertising manager of the E. I. du Pont de Nemours & Co., told the Pittsburgh Advertising Club.

"I venture to predict that in the next five years advertising will be recognized chiefly as a great buying force. Instead of using advertising to sell merchandise we will use it to buy customers. For the purchase of good-will it will be classified, even by accountants, not as current expense, but as a long-time investment; a sort of bond that yields dependable interest annually and amortizes itself in ten years, but keeps on returning interest indefinitely.

"If advertisers and advertising men will keep their minds fixed on this idea of buying good-will, or buying satisfied customers, instead of selling merchandise, many of the most difficult problems of advertising will disappear. Appropriations will not be based on last year's earnings, the current year's estimate, the sales department's gross margin, or the tentative impulses of the board of directors, but on clear analyses of the amount and kind of good-will needed for the ideal future of the business, the time required or available to develop it, the total amount it will be worth, and how the expenditure of that total will be made in various years.

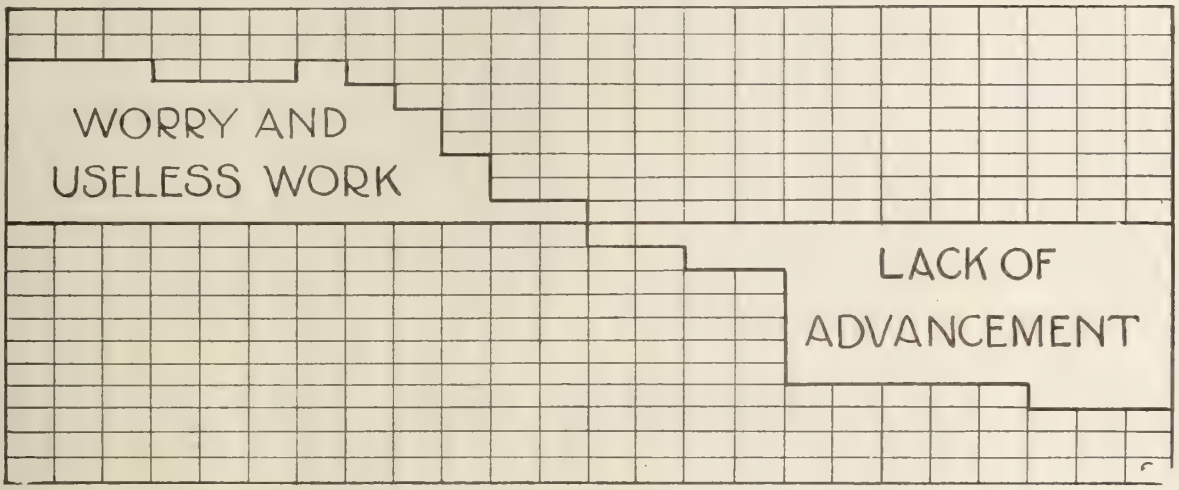
"The advertising policy will not be shifted by the weather, the crops, temporary trading conditions or changes in organization. The business itself will have a definite, enduring policy, and the advertising will express it.

"There will be no lying copy, nor merchandise that is made only to sell, and not to use; because such things do not buy customers and are destructive of good-will, the great asset the advertiser is seeking.

"Whether an advertiser formally adopts the policy of buying good-will or not, the good-will value of his advertising is all he really gets for his money. The advertising that buys satisfied customers adds to his good-will, and that which creates dissatisfied purchasers subtracts from his good-will.

"Success is merely the result of having more plus than minus in the good-will account. Since the whole history of advertising proves this is true, why should we not recognize this truth and consciously get in line with it?"

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS, CAST IRON
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equip. Co., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

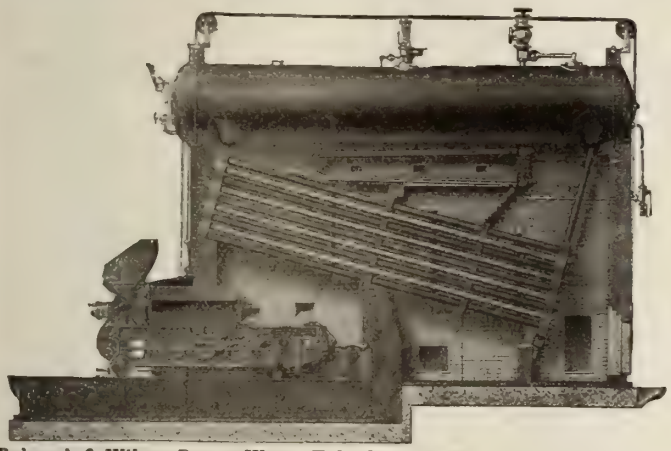
LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

MACGOVERN & COMPANY UNLIMITED POWER MACHINERY

MOTOR GENERATOR SETS

2 and 3 Phase—25 Cycles

D. C. Generator K.W.	Volts	R.P.M.	A. C. Motor H.P.	Volts	R.P.M.
56¼	125		75		480
2—125	125	720	350KW	2300	750
300	275/300	750	435	2300	750
2—300	500	500	550KW	6600	500

2 and 3 Phase—50 and 60 Cycles

20	125	1130	30½	2200	1130
25	125	1200	35	2300	1200
30	125	850	50	550	860
35	120	850	50		850
40	125	1200	75	550	1200
75	110		100	550	
75	125	1140	112	2200	1140
100	125/250	870	150	2300	870
100	550	580	150	2200	580

2 and 3 Phase—50 and 60 Cycles

D. C. Generator K.W.	Volts	R.P.M.	A. C. Motor H.P.	Volts	R.P.M.
100	250	1200	150	2300	
102/510	60/300			550	700/720
2— 75	125	900	150	2300	900
150	500/550	600	200	440	
150	230/275	571	200	2080	
200	220	485	300	440	485
200	125		250	2200	900
200	275		200	2200	
250	250/275	720	350	2300	720
500	560	400	710	2300	400
750	250	720	1100KVA	2300	

Direct Current

5	110	1800	7½		1800
7	300	720	10		720
2— 75	125	900	150KW	2300	900
2—250	125	720	700KVA	6600	720

MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New ork, Pittsburg, St. Louis.

Plants: Brooklyn, N.Y., Lincoln, N.Y., and Linden, N.J.

Buyers and Sellers of New and Used Machinery

A CONTINENT-WIDE SERVICE

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithaca, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
[illegible] Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
[illegible]
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
[illegible]
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Williams Machinery Co., A. R., Toronto

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knigut Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

CANADIANS MUST BE SQUARE

IN the course of an article in January issue of MACLEAN'S MAGAZINE (now on sale), Mr. Lloyd Harris, who was head of the Trade Mission to Great Britain, makes the important statement that "Canada must develop a high standard of commercial morality—she hasn't that standard now." This is a vitally important article, pointing out the tremendous opportunity for profitable trade in Europe that is open to Canada, but at the same time issuing a grave warning as to what we must do, and must not do, if we are to grasp the golden chance.

Mr. Harris shows the opening for permanent trade connections that has come about as the result of war conditions and the "sentimental preference" that Canada now has in Europe—a preference created by the record of our soldiers. His message is one that every Canadian should read—business man or workingman, exporter or laborer.

Other features found in January MACLEAN'S are:

"Politics Under the Shadow"

Dominion politics are summed up by J. K. Munro in his usual pithy and unsparing style. He tells what is happening in Ottawa where the shadow of an impending farmer invasion hangs over everything.

"The Woman's Court"

Mrs. Arthur Murphy (Janey Canuck), the first woman magistrate to sit on a bench in Canada, tells of the operation of the first Woman's Court.

"The Birth of a Labor Party"

Up to the recent election in Ontario, Canada hadn't a real Labor party. As a result of the return of a solid group of Labor candidates, a new party may be said to have been born. J. L. Rutledge gives interesting sketches of the first Labor members.

"A Woman on the Warpath"

Mrs. Nellie McClung, who has figured on the public platform more prominently than any other Canadian woman, tells interestingly of her experiences, particularly with regard to the campaign in Manitoba against the Roblin Government.

Six Bright Stories by Well-Known Authors

The Thread of Flame—By Basil King.
His Majesty's Well-Beloved—By Baroness Orczy.
Spanish Doubloons—By Camilla Kenyon.
The Fall Triumphant—By C. L. M. Brown.
The Empty Chair—By Alice and Claude Askew.
Winning a Post in Fur Land—By Robert E. Pinkerton.

Keep in Touch with the World

The world is being remade in these trying times and the man or woman who would keep up with the march of events, can do no better than read the "Review of Reviews" department in January MACLEAN'S, in which the best articles and most interesting selected from the periodicals of the world are reprinted in condensed form. Look at the list of articles in this department in January MACLEAN'S:

Britain's Supremacy is Threatened
Japan is Fighting For Her Life
Admiral Reveals Vital Secrets
Germany is Still Dangerous
Can Life be Lengthened?
How Ole Hanson Was Elected
The Diamond Market Cornered
Balking Life's Handicap
Britain Must Remain Strong Military Power
The Song of the Bolsheviks
Political Chaos in Britain
The New Roosevelt
Death Rate Exceeds Births
Secrets of "Make-Up."
Revolution Brewing in Egypt

Over 350,000 Canadians Read

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

JANUARY ISSUE *Now On Sale At All News Dealers* **20c**

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co. Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
C. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Showing ease with which Plibrico is laid in place.

PLIBRICO

A High Grade Refractory for Furnace Linings

BETTER THAN FIRE BRICK

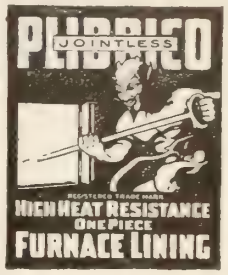
1. It's Jointless.
2. It's Plastic.
3. It's air and gas tight.
4. It will stand 3100° F.
5. It will save fuel.
6. It can be installed by inexperienced labor.
7. It will outlast fire brick.
8. It can be used in any boiler, furnace or oven.
9. It can be used wherever fire brick is used.
10. It can not be excelled for patching broken and burned out linings.

Any Engineer can see the economy and advantage over Fire Brick

Write for book on furnace building

JOINTLESS FIRE BRICK CO.
1130-1150 Clayton St., Chicago

Beveridge Paper Co., Ltd, Montreal. Shell Bar Boico Supply Co., Ltd. Toronto. Canadian Representatives.



Registered Trade Mark

WATER

WE-FU-GO AND SCAIFE

PURIFICATION SYSTEMS SOFTENING & FILTRATION FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA

When Writing Advertisers Please Mention This Paper

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, MULTIPORT

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES

Crane Limited, Montreal.

VALVES, BRASS

Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

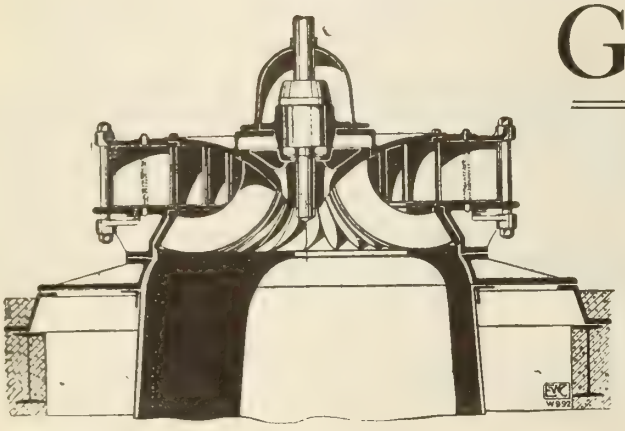
WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Water Turbines



Governors

Pipelines

Turbo Pumps

23-19

INDEX TO ADVERTISERS

A

All-Way Oiler Co. 59
American Steam Gauge & Valve Mfg. Co. 15
Anderson Co., V. D. 48
Armstrong-Cork & Insulation Co. 11

B

Babbitt Steam Specialty Co.... 13
Babcock & Wilcox 73
Badger & Sons, E. B. 45
Bernit, Ernest 43
Betson Plastic Fire Brick Co... 15
Boving Hydraulic Eng. Co. 58
Bowser & Co., S. F. 48

C

Canadian Allis-Chalmers Co... Inside front cover
Can. Assoc. Stationary Engrs... 71
Can. Consolidated Rubber Co.. 8
Can. Detroit Lubricator Co.... 4
Can. Fairbanks-Morse Co. 65
Canadian General Electric Co... Inside front cover
Can. Link-Belt Co. 52
Can. Johns-Manville Co. 40
Can. Steam Boiler Equipment.. 14
Chaplin-Fulton Mfg. Co. 58
Classified Ads. 58
Coppus Engr. & Equip. Co..... 46
Carling Turbine Blower Co 71
Crane Limited 59

D

Darling Bros. .. 48
Dart Union Co. 42
D'Este Co., Julian 51
Department of Labour..... 43
Diamond Specialty Co. 7
Direct Separator Co. 66
Dominion Coal Co. 58
Dunham & Co., C. A. 7
Durabla Mfg. Co. 68

E

Electric Welding Co. 59
Economy Fuse Co. of Can., Ltd. 45
Empire Manufacturing Co..... 3
Escher, Wyss & Co. 78

F

Foyle, W. & G. 44
Frick Co. 11

G

Garlock Packing Co. 6
Garth Co. 58
Goodyear Tire & Rubber Co.... 9
Goldie & McCulloch Co..... 16
Graton & Knight Mfg. Co. ... 67
Greene, Tweed & Co..... 69
Green's Economizer, Ltd..... 50
Gutta Percha & Rubber Co.... 41

H

Hays Corporation, Jos. W. 53
Holmes Metallic Packing Co... 58
Homestead Valve Mfg. Co. 4

I

Inglis Co., John..Inside front cover
International Chemical Co..... 15

J

Jeffrey Mfg. Co. 63
Jefferson Union Co. 1
Jenkins Bros. 49
Johns-Pratt Co., The 55
Jointless Fire Brick Co. 77
Jamison Cold Storage Door Co. 12

K

Kellogg & Co., E. H. 44
Kerr Engine Co. 57

L

Laurie & Lamb 2, 59
Leitch Co., The Arthur S..... 50
Linde Can. Refrigeration Co... 10
Lunkenheimer Co. 60
Long, J. T. 42

M

MacGovern & Co. 73
MacLean's Magazine 75
Magnolia Metal Co. 57
Mason Regulator Co. 50
Mason Regulator & Eng. Co... 51
McAvity & Sons, T. A. 60
Metlskin Co., Inc. 66
Miramichi Quarry Co. 44
Morrison Brass Mfg. Co., Jas. Outside back cover
Murphy Iron Works 63
Mueller Mfg. Co., H. 56

N

Norwalk Iron Works Co. 14

P

Penberthy Injector Co. 54
Philip & Sons, E. J. 43
Pilley Packing & Flue Brush Mfg. Co. 58
Pratt & Cady Co., Inc..... 70
Pyro Products Co.....Front cover

R

Robb Engineering Co. 47

S

Sanford Riley Stoker Co..... 63
Scaife & Sons Co., Wm. B. 77
Schaeffer & Budenberg Mfg. Co. 59
Sexton Co., W. R. 47
Starrett Co., L. C. 13
Sturtevant & Co., B. F..... 5
Steel Mill Packing Co..... 51

T

Trimont Instrument Co. 4

U

Uehling Instrument Co. 4

V

Valve Engineering Co. 45
Victoria Foundry Co. 59
Vilter Mfg. Co. 10
Vorhees Rubber Co., Ltd. 70

W

Wall, W. J. 42
Watson & McDaniel Co. 58
Williams & Co., J. H..... 77
Williams Co., Franklin 66
Wilson Mfg. Co., J. C..... 59

Y

Yarnall-Warring Co. 13
York Mfg. Co. 12

Boilers, Tanks and Engines,

of all kinds, for any service

The Plant of
The John Inglis
Company, Limited
TORONTO,
CANADA

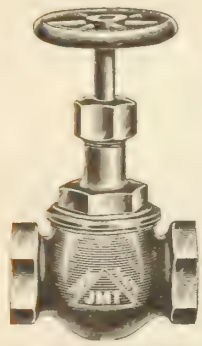
Send Us Your Inquiries

The John Inglis Co., Limited

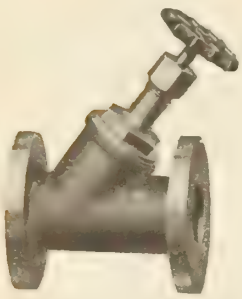
14 Strachan Avenue
TORONTO, CANADA

Representatives in Eastern Canada :
JAMES W. PYKE CO., LTD., 232 St. James St., MONTREAL
Ottawa Representative :
J. W. ANDERSON, 7 Bank St. Chambers, OTTAWA

MORRISON'S



J.M.T. Globe Valve.

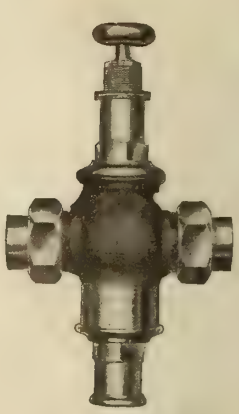


J.M.T. "Y" Valve.

Hose Gate Valve.

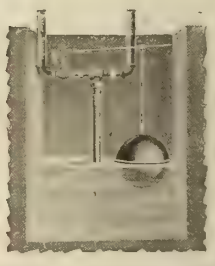
"Beaver" Globe Valve.

Morrison Injector.

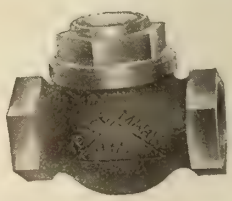


J.M.T. Reducing Valve.

Pressure and Vacuum Gauges



Morrison Automatic Drainer, operates on water pressure.



J.M.T. Check Valve.

STEAM GOODS
and
SPECIALTIES

that meet every requirement of the engine and boiler room, stamped with the Morrison hall-mark of quality and reliability.

Goods that are approved by the Provincial Inspection Departments — with every article tested and guaranteed by us.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West, TORONTO

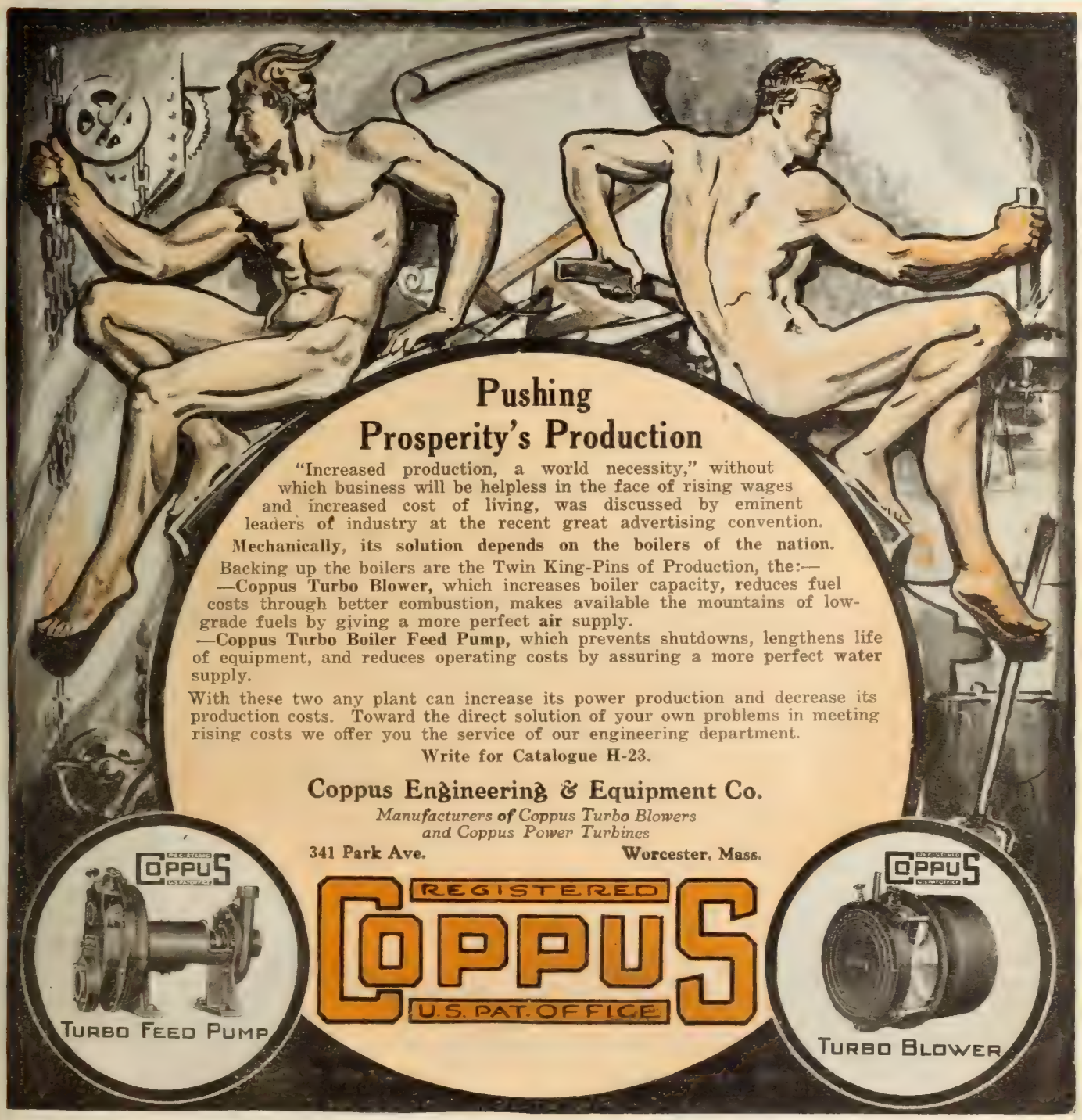
POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 2. Publication Office, Toronto—January 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year



Pushing Prosperity's Production

"Increased production, a world necessity," without which business will be helpless in the face of rising wages and increased cost of living, was discussed by eminent leaders of industry at the recent great advertising convention.

Mechanically, its solution depends on the boilers of the nation.

Backing up the boilers are the Twin King-Pins of Production, the:—

—**Coppus Turbo Blower,** which increases boiler capacity, reduces fuel costs through better combustion, makes available the mountains of low-grade fuels by giving a more perfect **air** supply.

—**Coppus Turbo Boiler Feed Pump,** which prevents shutdowns, lengthens life of equipment, and reduces operating costs by assuring a more perfect water supply.

With these two any plant can increase its power production and decrease its production costs. Toward the direct solution of your own problems in meeting rising costs we offer you the service of our engineering department.

Write for Catalogue H-23.

Coppus Engineering & Equipment Co.

Manufacturers of Coppus Turbo Blowers and Coppus Power Turbines

341 Park Ave. **Worcester, Mass.**

REGISTERED COPPUS U.S. PAT. OFFICE

TURBO FEED PUMP

TURBO BLOWER

Agents for Montreal: MASON REGULATOR & ENG. CO., 135 Dagenais Street

Agents for Vancouver: FRANK DARLING & CO., LIMITED, 1142 Homer Street

Agents for Toronto: ARTHUR S. LEITCH CO., 1001 Kent Building

You can patch up holes in your Boiler Furnace Lining

in a Jiffy

with

PYRO-PUTTY

TRADE MARK REG U S PAT OFF

FIRE BRICK IN PUTTY FORM

The World's Best Furnace Lining Material

PYRO-PUTTY comes to you in a stiff, moist, pliable, "ready to use" condition. PYRO-PUTTY enables unskilled labor to make furnace lining repairs in less time and at less expense than would be possible with standard fire bricks. Simply clean out the breaks in the walls, pound in PYRO-PUTTY with a mallet, smooth it off with a trowel and you'll have a patch that will out-wear the rest of the furnace lining.

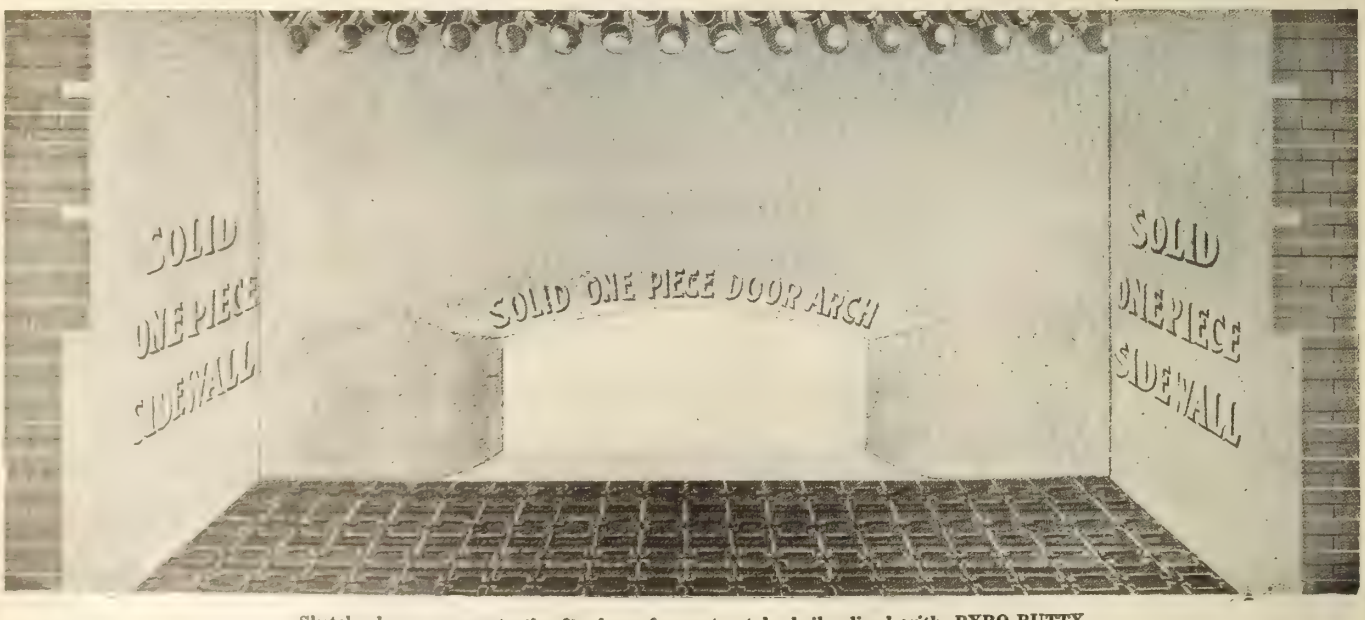
Pyro-Putty is far more durable than standard Fire Bricks for making New Furnace Linings

PYRO-PUTTY should be used, in preference to standard fire bricks, for making complete furnace linings because it is far more durable. And furnaces lined with PYRO-PUTTY are both efficient and economical because there are no joints to let the hot air out or the cold air in.

PYRO-PUTTY is put up in 700-lb. barrels, a barrel being equivalent to 100 standard fire brick. Sketch below represents the fire box of water tube boiler lined with PYRO-PUTTY. Compare it with your own fire box linings—then

ORDER A FEW BARRELS OF PYRO-PUTTY NOW!

"A few barrels of Pyro-Putty should be part of the emergency equipment of every steam power plant"



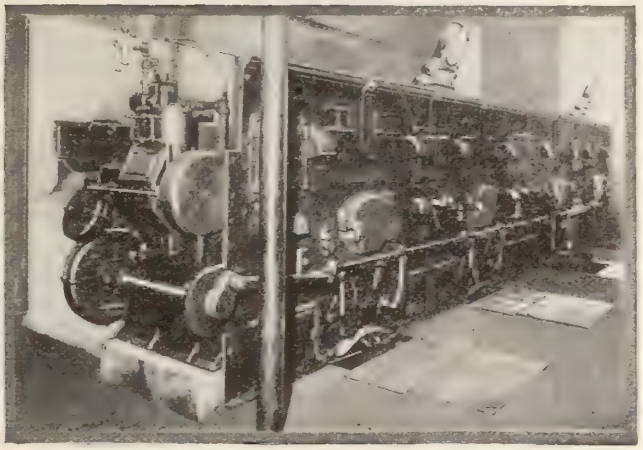
Sketch above represents the fire box of a water tube boiler lined with PYRO-PUTTY.

Write to-day for further information and prices

PYRO PRODUCTS COMPANY

P.O. Box 685, Toronto, Ontario

Before *and* After Installing



DETROIT'S "V" Type Stokers

In the Plant of The Mercer County Light, Heat and Power Company GREENVILLE, PA.

AFTER many disappointments and troubles with their old furnaces and careful study of mechanical stokers, The Mercer County Light, Heat and Power Company selected Detroit "V" Types for their power plant.

Four Stokers were installed early this year, and have been in continuous service since that time.

Mr. R. L. Morsman, Chief Engineer, states:—

". . . we compute that we are obtaining a saving of from 10 to 12 percent of coal over the previous hand fired method.

"We are obtaining a Boiler Horse Power on approximately 3½ pounds of coal of 13,000 to 13,500 B. T. U. This is equivalent to a little better than 72 percent efficiency, which we consider very good for every day conditions.

"The Stokers are giving excellent satisfaction and we would be very glad to recommend them to any of your prospective purchasers."

This sort of testimony, which we are continually receiving from operators of Detroit "V" Type Stokers, is indicative of our reputation in the Power Plant Field.

Catalog P contains full particulars. It will gladly be forwarded on request.

Detroit Stoker Company

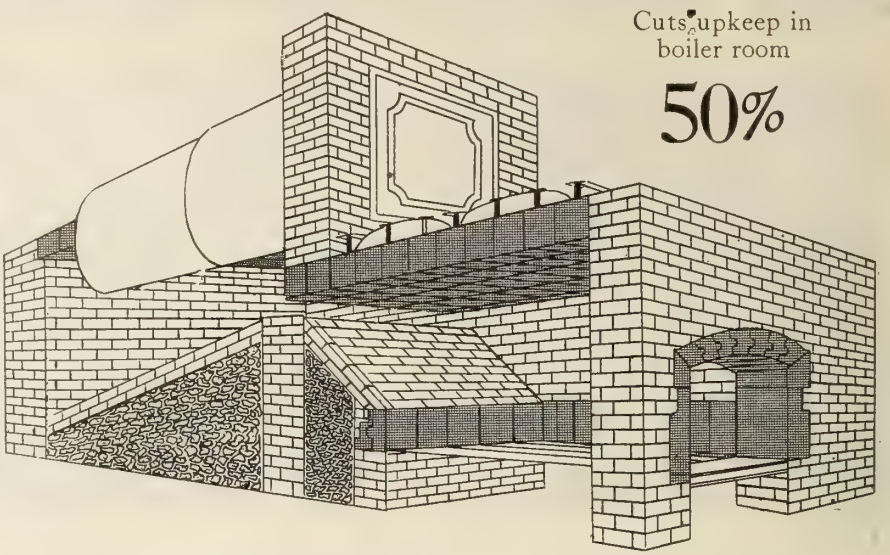
DETROIT, MICH.

BRANCHES:

Chicago, Cleveland, Cincinnati, New York, Pittsburgh, Atlanta, Philadelphia, Boston

GATES Patent Furnace Linings

These are the simplest and most durable linings made. Their use materially reduces the number of joints in the furnace walls, clinkers do not readily form on their smooth and even surfaces and the tongued and grooved joints prevent air leaks, thus the linings not only last longer, but tend to promote better combustion. These blocks are interlocking and made so that any handy man can renew them without disturbing any of the brick work.



Cuts upkeep in boiler room

50%

We Manufacture All Kinds of Special Shape Fire Brick

We contract for and specialize in Boiler Setting, Furnace Building, Oven Work and all kinds of power plant brick work. **Catalogue mailed on request.**

GATES REFRACTORIES Limited
382 ST. JAMES STREET - - - - MONTREAL

HOYT BABBITTS

Perfected by Science and Long Experience

All elements entering into our mixtures are carefully refined and put together in such proportions and in such relation to each other that the best possible alloy is secured for the work which it is designed. **This means long service and low cost of babbitting.**

HOYT'S FROST KING

has been introduced into the most particular power plants in the world and is there to stay. A trial will prove its value.

HOYT'S NICKEL GENUINE

This Babbitt is used chiefly for Gas Engines, Marine Engines and Automobiles and wherever high speed and heavy pressure combine to wear down a bearing.

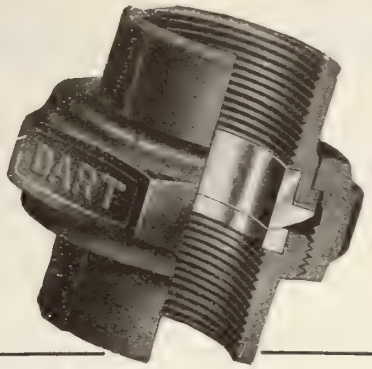
Largest makers of white metals in the world.

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

POWER HOUSE, January 20, 1920, Vol. XIII., No. 2. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

DART UNIONS STAY TIGHT *Permanently*



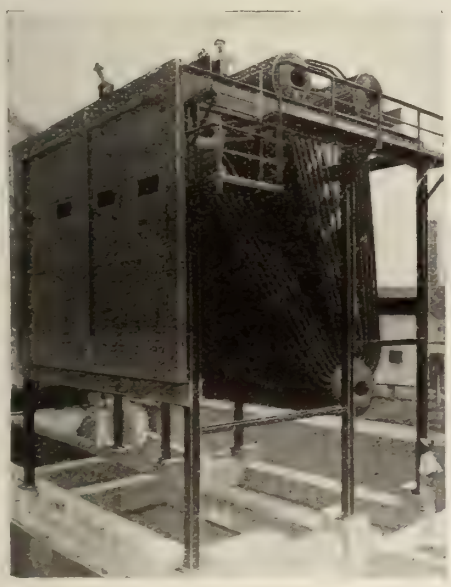
The Joint is
Bronze to Bronze
both face and seat

There is no deterioration at the point where the joint is made—and the heavy iron parts will not stretch or pull apart.

Dart Unions are really trouble-proof and economical.

YOUR JOBBER SELLS THEM

Manufactured by
DART UNION CO., LIMITED
TORONTO, ONT.



Connelly Water Tube Boilers (Patented U. S. & Canada)

are of the 4 drum type, have 100% tube area in the path of circulation, and deliver steam superheated to from 5° to 10° F.

Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally.

Can be built in units from 200 H.P. up to 4000 H.P. and 300 lbs. pressure. 100,000 H.P. in successful operation.

Made and Sold in Canada by E. Leonard & Sons, Ltd.
Established 1834

Branches: Montreal, Que. St. John, N. B.

Agencies: Winnipeg, Calgary, Vancouver.

LEONARD

London Canada

Water Problems

Submit your water problems to

E. J. PHILIP & SONS

Ontario representatives of

Roberts Filter Mfg. Co.

Manufacturers of
Water Filters for

Municipal, Industrial or Residential Uses

Any Capacity

E. J. PHILIP & SONS

57 Queen Street West

TORONTO - CANADA

ENGINEERING EQUIPMENT

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
TORONTO

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

TESTS OF HIGH-PRESSURE GAUGE GLASS

Temperature:	Not affected after 18 two-minute submersions in oil at 380 deg. F., then in water at 40 deg. F.
Erosion:	No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.
Tensile Strength:	Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.
Service:	Under continuous operating conditions with pressure of 225 pounds, performance equaled in every respect the best service ever obtained by any foreign glass.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

NORWALK
AIR & GAS · COMPRESSORS

For Serviceability

Norwalk Four-Stage Air Compressor Driven by Compound Corliss Steam Cylinders.

Serviceability is the ultimate criterion of value in a compressor—or any other mechanical product. The Norwalk means **greatest serviceability**—and, when you are about to make an installation, do not forget that **greatest serviceability means the Norwalk.**

Bulletins on Air, Oxygen, Hydrogen, Acetylene or Carbonic Acid Gas—one or all—sent upon request.

THE NORWALK IRON WORKS CO.

Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

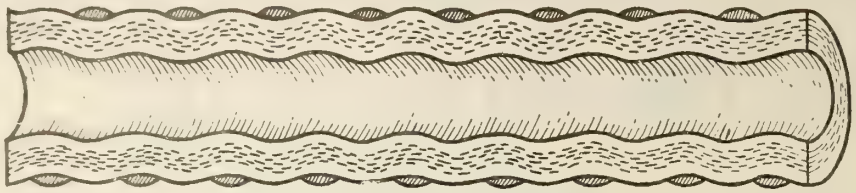
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

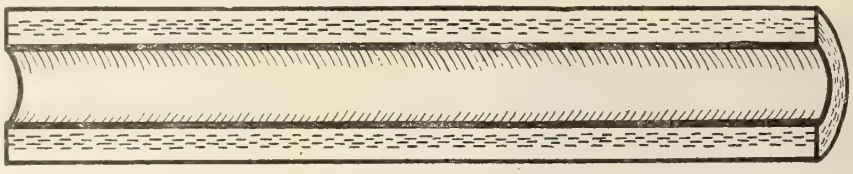
Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street **Toronto**

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.



SECTION OF STEAM HOSE SHOWING THE EFFECTS OF WIRE-WINDING UNDER PRESSURE.



SECTION OF GOODYEAR STEAM HOSE UNDER THE SAME PRESSURE.

Goodyear has made Wire-Winding on Steam Hose Unnecessary

THAT the expansion of steam in steam hose had to be controlled by wire-winding has been long taken for granted by industry. Of course, the wire became bent and the hose choked up; it became too hot to handle; it was inconvenient to cut into shorter lengths; the wire cut through the cover. But it had always been so. And wire-winding seemed essential to protect hose from rough usage and from pressure bursts.

The illustration shows what wire-winding does to steam hose. Under the heat and pressure of use, the hose expands faster than the wire. Bulges and blisters form. The tube cracks and the fabric is weakened.

Goodyear has made wire-winding on steam hose unnecessary. Goodyear has developed a hose fabric strong enough to control steam under high pressure—tough enough to insure long service *without special winding or covering.* Add an inner tube of special compound to resist heat and a tough cover—there you have the story of very long service and very low final cost.

The high quality of Goodyear Steam Hose—the unusual construction, developed solely to meet the severe conditions under which steam hose is used—are but samples of what you will find in all Goodyear Industrial Hose.

Goodyear has scientifically developed a hose for every industrial use. Samples of this hose, and the advice of a trained technical man, are yours for the asking—without obligation. Phone, wire or write the nearest branch.

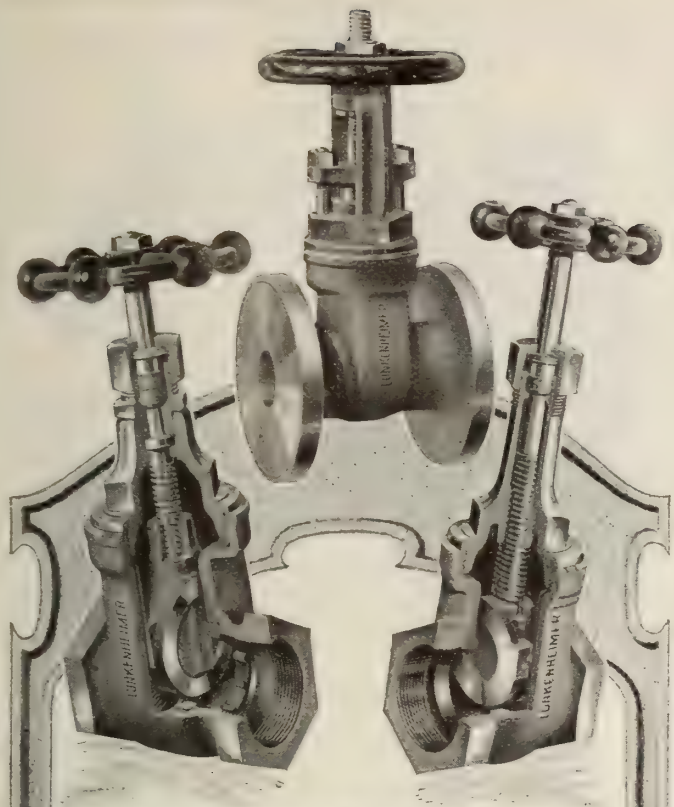
The Goodyear Tire & Rubber Co. of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in other cities.

GOODYEAR

MADE IN CANADA

INDUSTRIAL HOSE



LUNKENHEIMER BRONZE GATE VALVES

have full straightway opening; are double-seated and will take pressure from either end.

Bodies are heavy to resist pipe strains and the valves seat tight without undue pull on the hand wheel.

The DOUBLE DISC type has a ball and socket bearing between the discs, making them self-adjusting and the discs are accurately guided by ribs in the body. Sizes, ¼ to 3 inches, inside screw for working steam pressures up to 150 pounds.

In the WEDGE DISC type, the seats are finished to the exact taper of the disc faces and all parts are renewable, including the SEAT RINGS on sizes one inch and larger. Made in sizes ½ to 3 inches, inclusive, with inside screw and 1 to 3 inches with outside screw and yoke for working steam pressures up to 200 and 300 pounds.

The material and workmanship are of that high order which characterizes all Lunkenheimer products.

Buy the best—they are the cheapest.
Your local dealer can furnish them; if not write us.

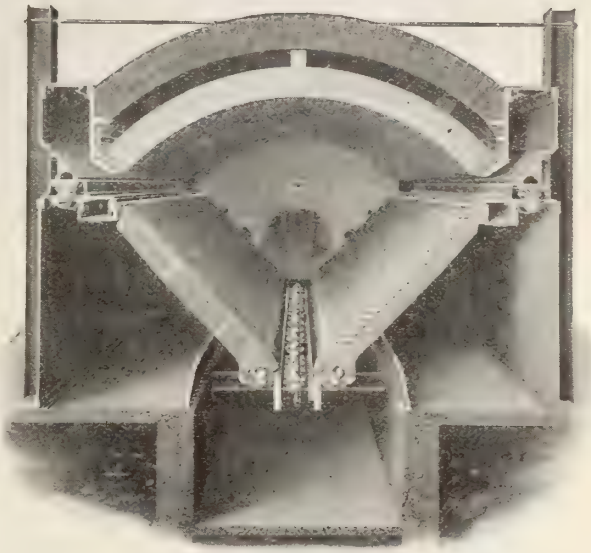
Write for Booklet No. 574-D.C., and list of regulations covering Lunkenheimer Products.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World.

CINCINNATI
New York Chicago Boston London

MURPHY AUTOMATIC FURNACES



STOOD the Test of Time

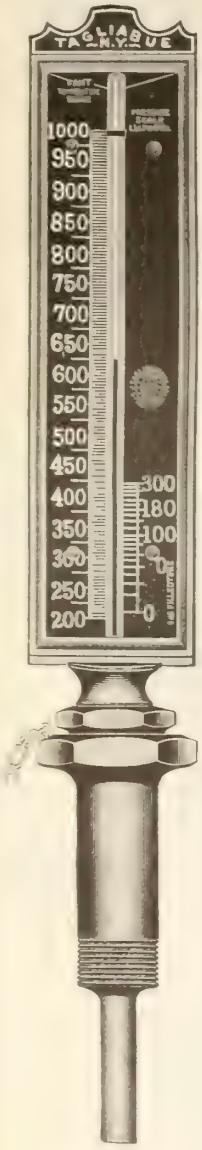
The Murphy Furnace is the pioneer among stokers. It is one of the oldest—and one of the best; 37 years of successful operation—and still going strong. Today over 6,000 boilers are fired by Murphy Furnaces.

Remember that during that time a great many manufacturers have sprung up and died. Time tells—the principle must be sound—the operation successful.

Our engineers have gathered a store of useful information. The Catalog HM-1 is yours for the asking.

For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalog "HR-1".

MURPHY IRON WORKS
DETROIT MICH. U. S. A.



TAG

Indicating Thermometers in the Power Plant

Constant temperature readings are vital to economical power plant operation, and TAG Industrial Thermometers are made especially for power plants.

They are easily attached to steam inlet or exhaust, feedwater or condenser—any place, in fact, where a temperature reading is wanted.

There are many forms of connection; fixed thread, union or separable socket. The glass tube is seasoned so that it cannot change; the mercury in the bulb is the only thing that expands.

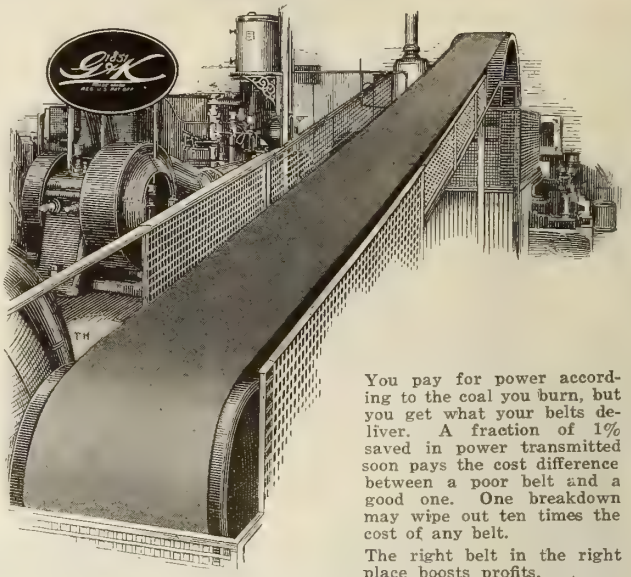
C. J. TAG LIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

The following guarantee covers TAG Industrial Thermometers:

Accuracy—Absolute and Constant
Construction—Highest Grade Workmanship
Material—Most Durable for the Particular Application, and Insurance against loss by breakage in transit.

Catalog P-405 on request.

THE POWER YOU PAY FOR



You pay for power according to the coal you burn, but you get what your belts deliver. A fraction of 1% saved in power transmitted soon pays the cost difference between a poor belt and a good one. One breakdown may wipe out ten times the cost of any belt.

The right belt in the right place boosts profits.

Among Graton & Knight Leather Belts there are right belts for every drive, belts that will deliver maximum power year in and year out without a halt.

Our booklet, "Standardized Leather Belting," explains how to find the right belt. A copy will be sent you upon request.

CANADIAN GRATON & KNIGHT, Limited
MONTREAL, CANADA

Canadian Representatives:
The Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary
Saskatoon, Vancouver, Windsor, Winnipeg, Victoria
Branches and Distributors in All Principal Cities.

Valve Engineering Company

160 King Street West, Toronto

Power House Equipment

"Sold on a Service Basis"

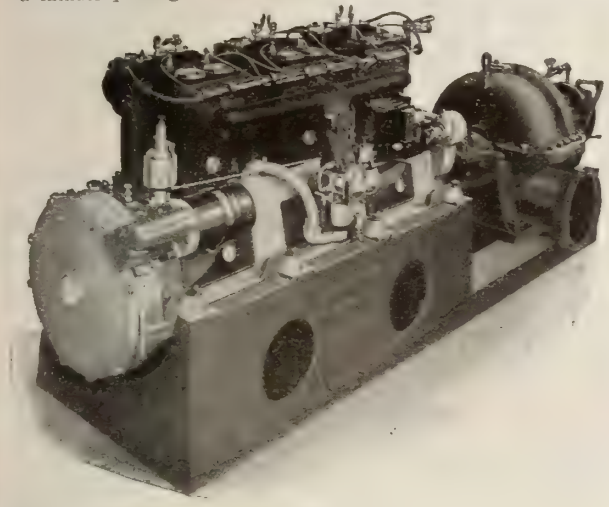
M. J. Keane, for 19 years associated with the Leading Lines in Power Plant Equipment, is now located in Toronto, representing

Penberthy Valves and Injectors,
Steam Traps and Separators,
Vanstoned Pipe and Bends,
Asbestos and Rubber Sheet Packing,
Flexible Metal Hose,
"Witwyte" Packing, "Spando" Packing
Etc., Etc.

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

IF A BUILDING CAUGHT FIRE

Could you press a button and have a thousand gallons of water a minute pouring on the blaze?



Model FC 6-cylinder Sterling engine direct connected to Morris Centrifugal fire pump.- Sterlings are equipped with electric starters and generators. Sterlings start immediatly and their utility is being demonstrated daily in many townships, villages and manufacturing plants.

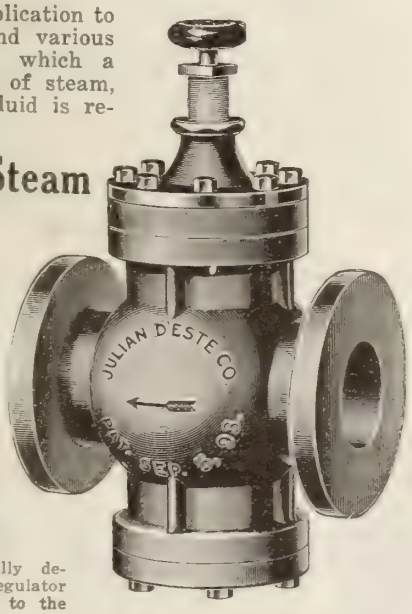
STERLING ENGINE CO.
Dept. C-4
BUFFALO, N.Y.
12 to 300 H.P. Commercial and Marine Engines

CURTIS Engineering Specialties

Universality!

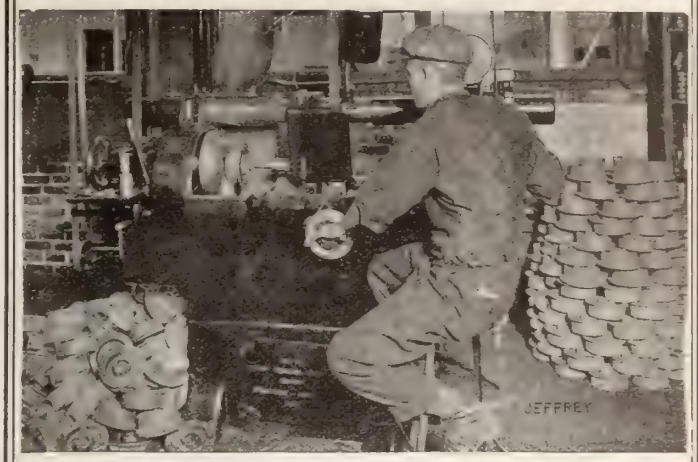
For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip or leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

MANUFACTURED BY THE
JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.



Rollers too Hard to Machine

ANOTHER remarkable feature of the

Jeffrey

Pivoted Bucket Carrier

is the extreme hardness of all wearing parts. For example, the bore of Chain Rollers is ground to size on a special grinding machine. The tough, white iron is so hard that it resists the action of high-grade machine tools.

The Jeffrey Carrier has many other unusual features that make for Reliability and Long Service.

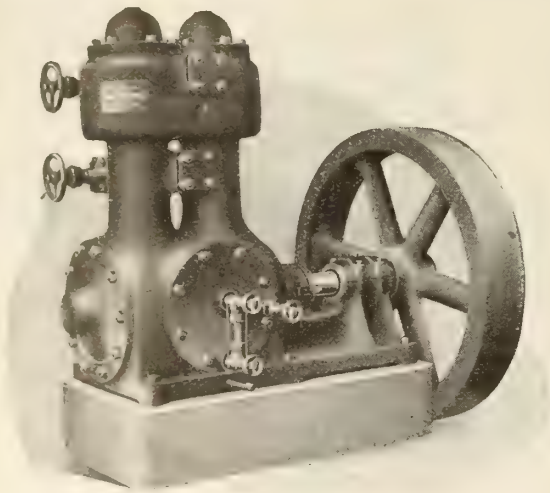
Every worth-while improvement has been incorporated in the design which is the climax of our 20 years' experience as builders of Coal and Ash Handling Machinery.

Our Engineers will gladly study your plant and make recommendations. Catalog No. 210 will give you an excellent idea of the JEFFREY Carrier and its possibilities. Write today.

THE
Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL
CANADA

Handle it Mechanically

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

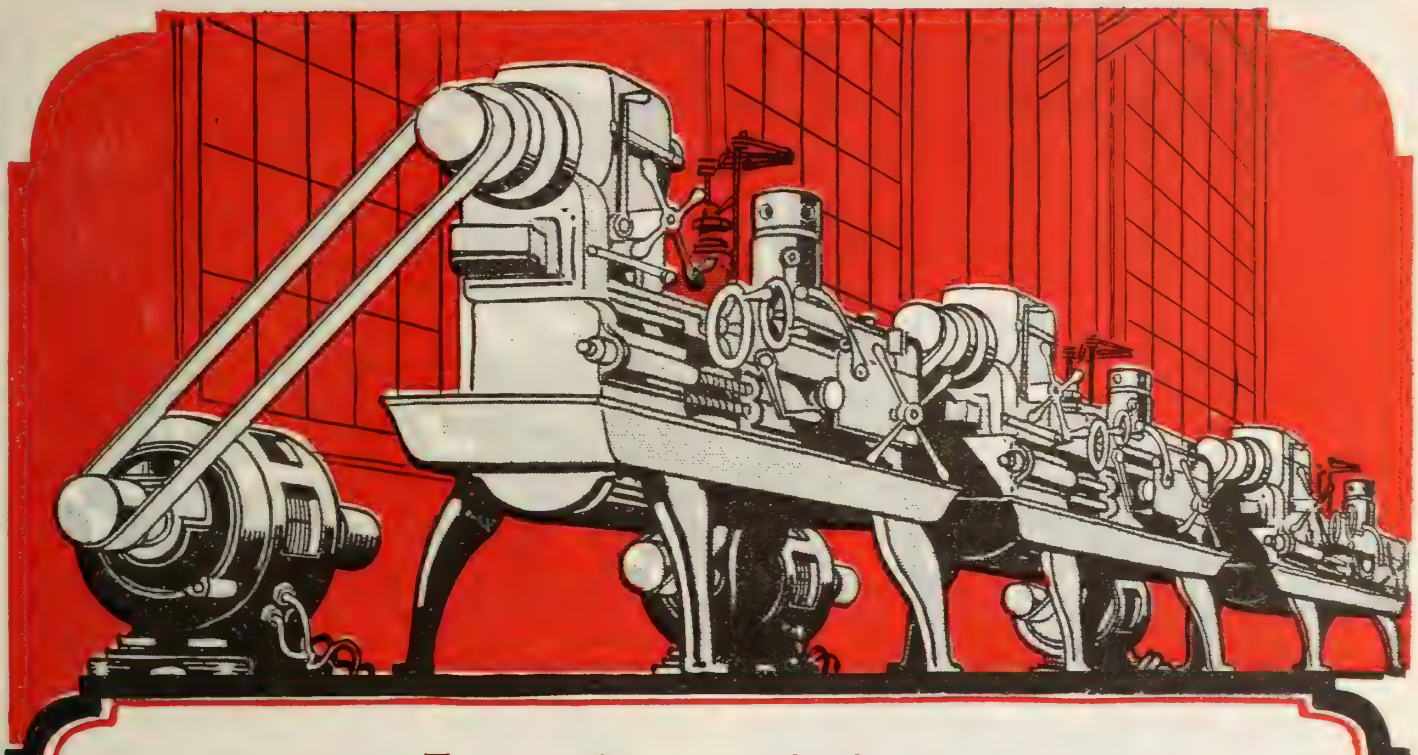
Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes



Every Ounce of Energy

AMONG the most important factors in keeping production up and operation costs down is the efficient transmission and utilization of every ounce of energy developed by power-generating machinery. A high friction load means a corresponding reduction in the power available.

The burden of this rests entirely on the correct lubrication of every machine, axle, pulley and shaft. *Nothing but scientific lubrication throughout your entire mechanical equipment will enable it to contribute its full quota to the success of your business.*

Imperial Lubricants are specially designed for each type of machine under actual service conditions. Their use will bring increased income through greater production, and reduced expenses through smaller depreciation of machinery.

Imperial Lubricants are prepared with infinite care. Each one has real merit as its recommendation. There is the proper lubricant for every individual part of your machinery. They are Canadian made, and their high, uniform quality is assured by the use of only the finest crudes.

Imperial Lubrication Engineers will be glad to consult with your own engineer or mechanical superintendent in deciding the proper lubrication of your machinery. The benefit of their knowledge and experience is yours without charge or obligation.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Ario Compressor Oil

Write us at 56 Church Street, Toronto, or at any of our branches for appointment or lubrication information.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

Burn Low Grade Coal

CUT FUEL COSTS

Burn Refuse

This winter high-grade coal promises to be scarcer than ever, thus higher priced. Many power plants will have to substitute low-grade fuel and to many this will mean the installation of extra boilers to supply the required steam.

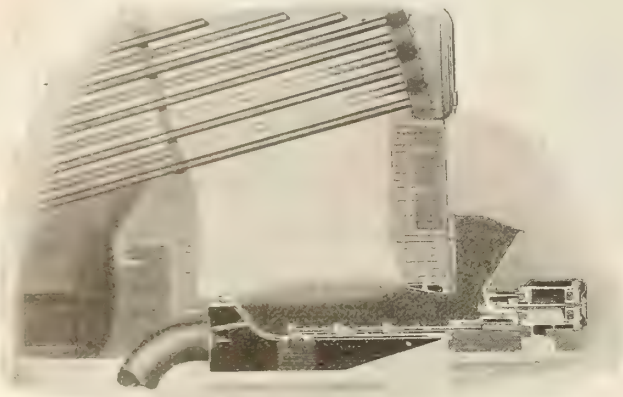
"Jones Underfeed Stokers" will burn low-grade fuel, keeping up your steam pressure and meeting your peak loads without installing extra boilers.

We furnish special stokers to burn Lignite

SMOKE ABATEMENT

The "Jones Stoker" assures proper combustion of fuel which means that the stack will be free from smoke.

The Jones simple construction means durability, no parts move in contact with the fire—no grates to burn out—no sifting of fine coal to the ash pit.



A Jones Underfeed Stoker setting under Water Tube Boiler.

The Jones Underfeed Automatic Stoker

pioneered and developed commercially the Underfeed principle of firing, which is to-day recognized as the most efficient method of stoking.

FACTS AND FIGURES ON REQUEST.

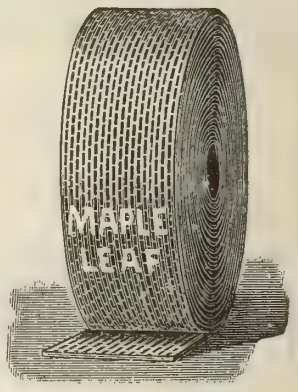
Jones Underfeed Stoker Co.
Limited
37-41 Britain St. Toronto, Ont.

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

THE KEY TO SUCCESS

EXPERT KNOWLEDGE

OF THE PROCESS OF COMBUSTION AND BOILER ROOM MANAGEMENT is absolutely essential for success in the power plant engineering field today. The man that the big fellows are looking for is the man who, first of all, can utilize the last heat unit in the coal he burns under his boilers.

The Hays School of Combustion has provided the means by which this expert knowledge can be easily acquired by any one who will spend a few hours of his spare time to master the simple, interesting and easily understood lessons provided. The correspondence method of instruction is used, which permits any man to proceed according to the time available and his previous study of the subject. It teaches you all about the most up-to-date practice, all about fuels and how to obtain combustion efficiency, and all about boilers and furnaces and how to operate them economically. Every essential detail is supplied in this course, and in such a manner that you will find it more interesting than your favorite novel.

GREATER REWARDS

ARE WITHIN THE REACH OF THE COMPETENT COMBUSTION ENGINEER at the present time than in any other line of endeavor connected with the power plant field. Men who can select the proper kind of coal for each particular plant and condition, determine how it can be most efficiently burned, and, in the final analysis, **GET RESULTS**, with a minimum expenditure for fuel, are the fellows for whom the demand is, and will be, unlimited. If you want to be listed with the top-liners, this is your opportunity.

For the fireman, steam engineer, master mechanic or technical man, or for the young man seeking a lucrative calling, the sure job and the big pay, with all the accompanying advantages, there is no field so ripe—where the prospect of rapid advancement and quick returns is so promising. Employers are seeking greater efficiency in the operation, equipment and supervision of power plants. They want better trained men in the plants and more combustion engineers for consulting and construction work, giving opportunity for every grade of ability. If you have the foresight and ambition to train yourself, the opportunity is yours.

The course is written and arranged by Jos. W. Hays himself—in his well-known interesting and effective way of conveying the desired information. There is not a dull or uninteresting line in the whole course. The practical value of the course is unquestionably assured by the staff of Advisory and Reviewing Editors given below.

Joseph Harrington — David Moffat Myers
Fred R. Low
Arthur L. Rice — Prof. S. W. Parr

The cost is nominal—Payments may be divided up to suit your circumstances—Success is assured—Fill out the coupon and get in the BIG PAY Class.

Hays School of Combustion

STATE-LAKE BUILDING

Chicago, Illinois

CUT OUT AND MAIL

Hay's School of Combustion,
State-Lake Bldg.,
Chicago, Ill.

I am interested in the study of Combustion efficiency and would like a free copy of your prospectus.

Name .....

St. and No. .....

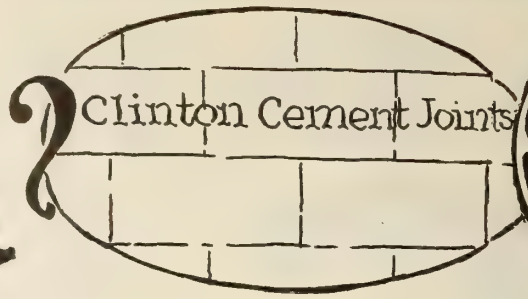
City .....State .....

Position .....

Company .....Date .....

POWER HOUSE

Which ?



CLINTON CEMENT

FIRE clay dries up and sifts out from between the bricks like powder, causing the escape of hot air and interfering with proper combustion by cold air leakage.

Clinton Cement Saves Fuel and Increases Boiler Furnace Efficiency

It makes joints that stay tight. Sets and makes a surface like glass yet allowing for expansion and contraction. Stands a heat up to 3,000 degrees Fahrenheit.

Try it once and you always want it.

A five-pound tin of **Clinton Super-Heat Cement** will be sent you free and all charges prepaid, if you write the

Standard Machinery & Supplies Limited
261 Notre Dame St. West, Montreal

HEATING BY HOT WATER & HOT WATER SUPPLIES

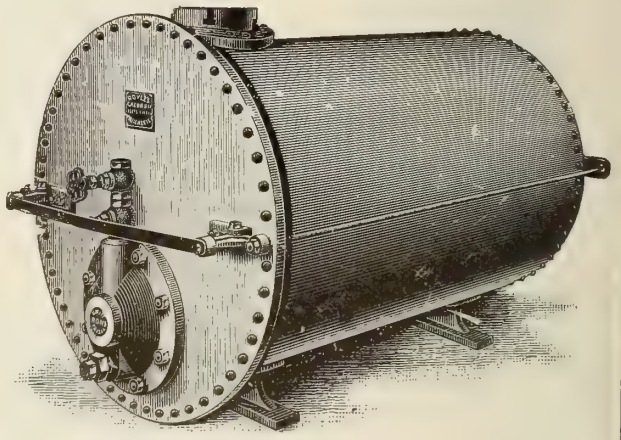
Instantaneous Heater, with connections for Fresh and Salt Water and Steam

HIGHEST EFFICIENCY GUARANTEED

ROW'S PATENT CALORIFIERS are strongly recommended for heating water in bulk for supplying a number of Baths and Lavatories. Also for HEATING CIRCULATIONS for PUBLIC INSTITUTIONS, HOTELS, etc.

ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

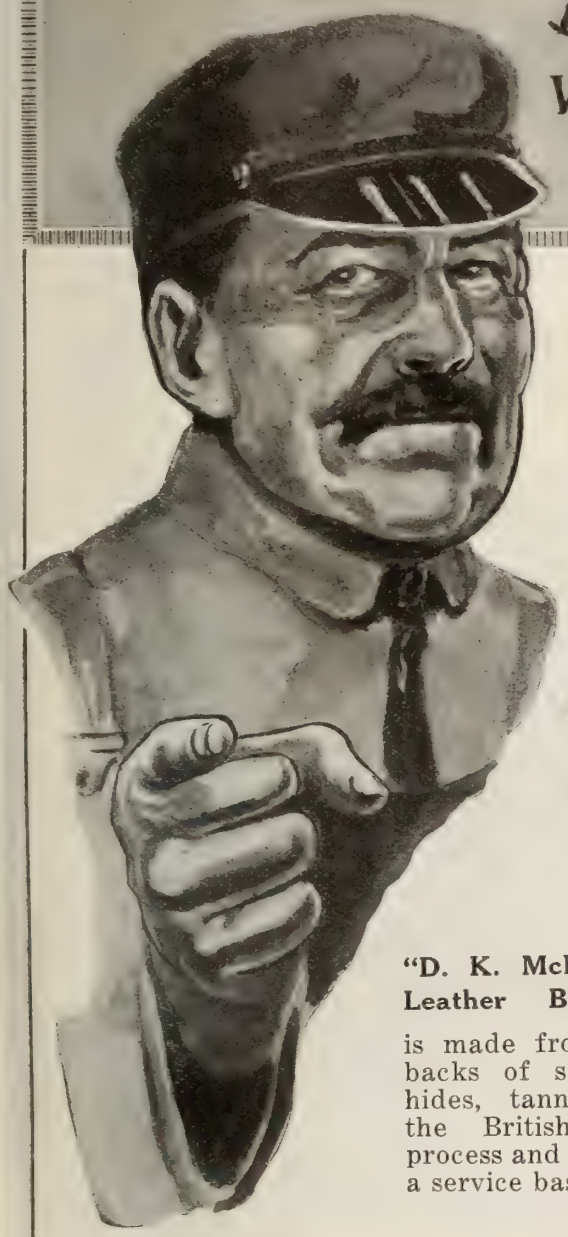
ROW'S PATENT
CALORIFIERS
FEED WATER HEATERS
RADIATORS
Suitable for Hot Water or High Pressure Steam
STEAM and GAS KETTLES
EVAPORATORS
CONDENSERS



PATENT CALORIFIER. STORAGE PATTERN

ROYLES LIMITED, ENGINEERS AND SPECIALISTS **IRLAM, MANCHESTER** ENGLAND

"Belting trouble ends where D.K. McLaren's Belting begins"



"D. K. McLaren's Leather Belting" is made from the backs of selected hides, tanned by the British Oak process and sold on a service basis.

Save Coal!

DON'T WASTE BY BELT SLIPPAGE
WHAT YOU SAVE BY ECONOMIC FIRING

Belt slippage and replacement are reduced to a minimum by the use of

D. K. McLAREN'S

Genuine British Oak Tanned

Leather Belting

A leather belt will transmit 25% more power than the same sized belt of other material. Figure what this cut in coal consumption means under the present high prices and scarcity. "D. K. McLaren's **Leather** Belting" is second to none in quality and service.

A "D. K. McLaren's Leather Belt" will not only cut your belting replacement cost, but will save your coal. When the belting has become worn after long, hard service on the main drive it can be recut and used on lighter drives.

D. K. McLaren's Leather Belting comes through the repeat order acid test with flying colors.

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

HEAD OFFICE AND FACTORY

351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

VANCOUVER, B.C.
849 Beatty St.

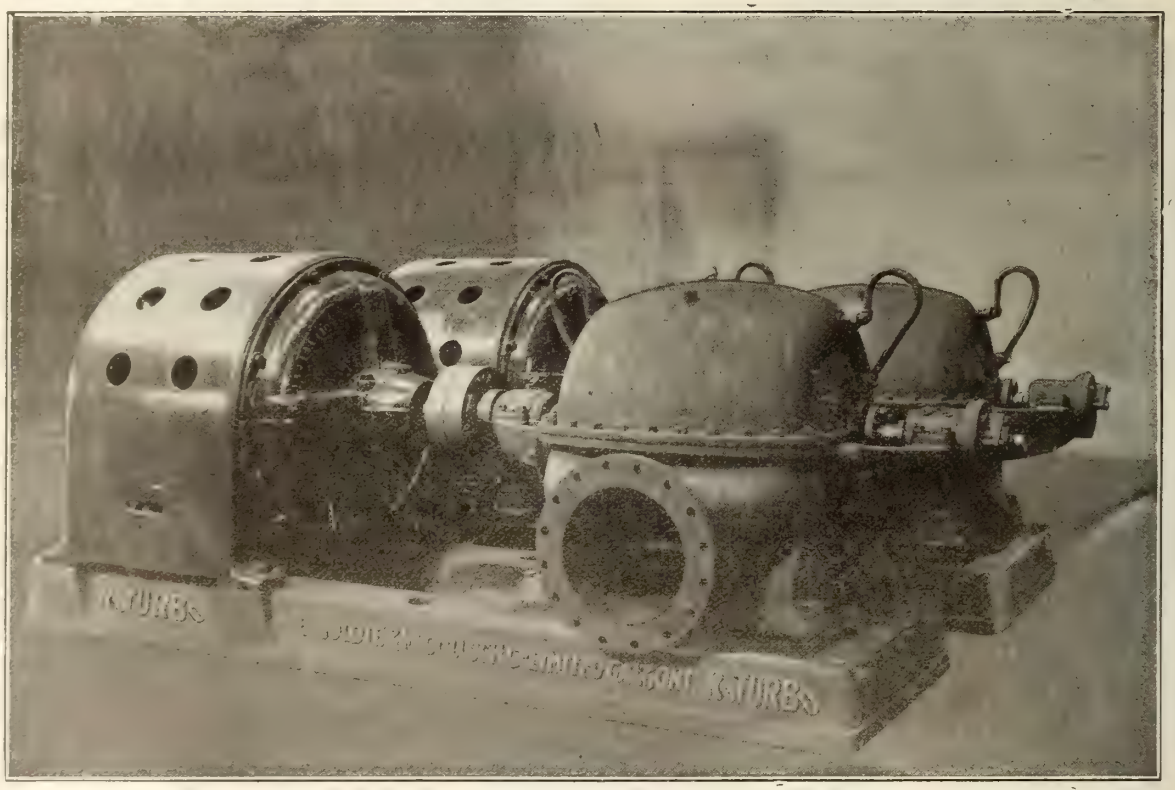
TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 Germain St.

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed b y us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bld'g.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Electrical Energy Generating Stations—I

Dealing With the Design of Power Stations, Both From the Electrical Standpoint and From That of the Prime Mover.

By TERREL CROFT
(Copyright; all rights reserved by the author)

THE procedure which will be followed in describing Electrical Energy Generating Stations is this: First, certain general considerations relating to all generating stations, regardless of the types of their prime movers, will be treated. Second, the adaptability of each of the different classes of prime movers: (a) steam, (b) internal combustion engine, and (c) hydraulic, will be described. Third, stations having steam prime movers will be studied in some detail. Fourth, stations having internal-combustion engine prime movers will be considered. Fifth, hydro-electric stations will be examined.

In Determining the Cost Per Unit of Electrical Energy Generated by a Station a number of factors must be included. Among these may be: (1) cost of fuel, if any, (2) labor cost of attendance and operation, (3) cost of supplies, such as oil and waste, (4) interest on the investment, (5) depreciation, (6) taxes, (7) insurance, and (8) repairs. How all of these factors may be recognized in estimating the total cost is indicated in the example just following. It is obvious that each specific problem must be considered on its own merits. The reasons for this are that the efficiencies of the apparatus involved, the cost of fuel, the cost of attendance and similar elements, will vary widely under different conditions.

Examples of Method of Determining Cost of Generating Energy

The following examples are quoted to illustrate the general procedure and the principal factors involved rather than to emphasize specific values. The problem is this: Which would be more economical under the conditions to be recited, to continue to operate a steam plant or to purchase electrical energy from a central station? The connected load is 275 kw. The maximum demand (maximum load) is 230 kw. The annual energy consumption is 62,700 kw.-hr. There are two generators in the plant, each driven by its own steam engine. No. 1 is a 200-kw. unit. No. 2 is a 75-kw. unit. The charge which the central station would make would be based on (1) a "demand" or "readiness-to-serve" charge of $2 per month per kw. of connected load and (2) an additional "energy" charge of 0.9 cts. ($0.009) per kw.-hr. consumed. All of the connected apparatus is direct current, hence, if central-station energy is purchased, it must be direct current or be converted into direct current for utilization.

Solution.—The following comprises the solution, submitted by H. Berkeley Hackett, to the above example. Owing to th values submitted for maximum demand and monthly energy consumption, it would be erroneous to assume the 10-hr.-day service during 26 days per month, which is the customary working period in manufacturing industries, since on this basis the average hourly load would exceed the maximum demand. In order, however, to reach any conclusion it is necessary to decide upon a daily operating period, consequently it will be assumed that the plant in question operates continuoulys during 365 days per year. While this assumption may not represent actual conditions, it will at least afford a basis for demonstrating the method of computing the yearly cost of generating energy and comparing same with central-station service.

The first step will be to find the boiler capacity required to meet the peak load conditions, in order that fixed charges on these units may be properly accounted for. With a maximum demand of 230 kw., the probable "water rate" of the large engine will be 40 lb. of steam per kw.-hr., consequently the hourly steam consumption under these load conditions is: $230 \times 40 = 9{,}200$ lb. plus 10 per cent. for auxiliaries, pipe line losses, etc., or a total of 10,120 lb. per hr. that the boilers must supply during maximum-demand periods.

Assuming that the steam pressure is 130 lb. gage and that the temperature of the feed water entering boilers is 200 deg., each pound of feed water must receive in the boilers 1024.8 heat units to convert into steam at the assumed pressure. Therefore, the boilers must be capable of furnishing: $10{,}120 \times 1{,}024.8 = 10{,}371{,}000$ heat units per hr. Since a boiler horsepower is equivalent to 33,500 heat units, the boiler capacity required will be: $10{,}371{,}000 \div 33{,}500 = 310$ h.p. Three 150 h.p. water-tube boilers will therefore be considered in estimating the installation costs.

The second step in the calculation will be to determine the yearly coal requirements. With a monthly consumption of 62,700 kw.-hr., the average hourly load of 24-hr. service will be: 62,700 ÷ (24 × 30) = 86 kw. approximately. To allow for load fluctuations on engines and boilers, it will be assumed that the water rate of the engines is 45 lb. of steam per kw.-hr., and that the boilers evaporate 6 lb. of steam per lb. of coal. This evaporation corresponds to 51 per cent. boiler efficiency, assuming the heat value of the fuel to be 12,000.

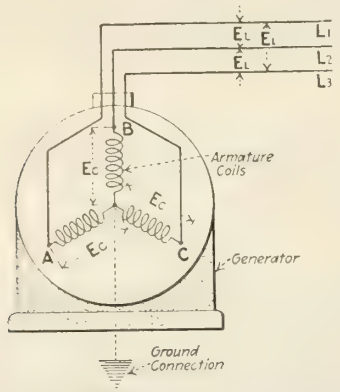


FIG. 1—DIAGRAMMATIC REPRESENTATION OF A STAR OR Y-CONNECTED THREE-PHASE GENERATOR.

On a basis of 8,760 hr. per year, the total yearly steam requirements, including 10 per cent. for auxiliaries, pipe-line losses, etc., will therefore be: 86 × 45 × 8,760 × 1.1 = 37,291,000 lb., and since each pound of coal evaporates 6 lb. of steam, the coal necessary to evaporate this quantity of steam is : 37,291,000 ÷ 6 = 6,215,100 lb., or 3,110 short tons.

Having determined the boiler capacity and the yearly coal requirements it is possible to approximate the yearly operating costs, as given in the following tabulation:

Installation Cost

Apparatus	*Cost*	*Sub-totals*
One 120-h.p., 4-valve engine (erected)	$2,600	
One 320-h.p., 4-valve engine (erected)	5,800	
Foundations	750	
Three 150-h.p. water-tube boilers (erected)	7,500	
Steel stack foundation—breeching erected	2,000	
Feed-water heater—boiler feed and house pumps	1,000	
Piping—covering separators, tanks, etc.	4,000	$23,650
One 75-kw. direct-current generator erected	1,100	
One 200-k.w. direct current generator erected	3,000	
Switchboard and wiring	1,700	5,800
Total cost of plant	.....	$29,450

Generating Cost

Interest on $29,450 @ 5 per cent.	$1,470	
Depreciation on $29,450 @ 6 per cent.	1,770	
Taxes, insurance, etc., on $29,450 @ 1 per	295	$3,535
Fuel, 3,110 tons @ $3	9,330	
Labor (5 operators)	4,600	
Ash hauling	100	
Oil waste, etc.	300	
Maintenance and repairs	600	$14,930
Total annual cost of generating 67,200 × 12 = 752,400 kw.-hr.	.....	$18,465
Cost per kilowatt-hour, in cents = 18,465 ÷ 752,400 =	.....	2.46

Cost of Central-Station Service

The connected load is 275 kw. The primary charge will be $2 per month. The average monthly energy consumption of 62,700 kw.-hr. will be at the rate of 0.9 cts. per kw.-hr. If a rotary (synchronous) converter is installed, the customer will probably be required to pay the conversion losses. With a converter efficiency of 90 per cent., the monthly bill charged against the consumer will therefore be: 62,700 ÷ 0.9 = 69,500 kw.-hr. The annual cost of purchased power will therefore be about as follows:

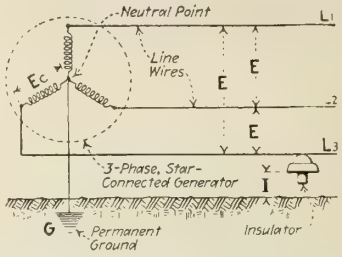


FIG. 2—ACCIDENTAL GROUND ON A GROUNDED-NEUTRAL SYSTEM.

Installation Costs

One 250-kw. rotary converter	$3,000	
Switchboard	1,700	
Total installation cost	.....	$4,700

Operating Cost

Interest, depreciation, etc., @ 12 per cent. on $4,700	$560	
Primary charge—275 × 12 months × $2	6,600	
Current charge—69,500 × 12 × $0.009	7,500	
Night and day attendant	1,700	
Oil, waste, repairs, etc.	70	
Total yearly cost of 69,500 × 12 or 834,000 kw.-hr.	.....	$16,430
Cost per kilowatt-hour in cents	.....	1.97

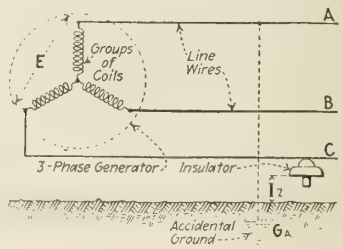


FIG. 3—ACCIDENTAL GROUND ON AN UNGROUNDED NEUTRAL SYSTEM.

In the above estimates no consideration has been given the question of heating. Should the conditions demand this requirement, it will be necessary to make certain additional charges against the central-station estimate in order to obtain a true comparison of power costs. These charges would consist of interest and depreciation on boiler capacity for heating, corresponding to the boiler capacity, available in the private plant for this purpose. Also, a charge for fuel for generating steam, equivalent in amount to the exhaust steam from the engines of the private plant that could be utilized in the heating system. There would be a further charge for labor, maintenance, supplies, etc., in connection with the operation of boilers for heating.

Depreciation of the Equipment of an Electric Plant

In general, plant and sub-station buildings may be assumed to have a useful life of about fifty years, making the average depreciation about 2 per cent. To boilers, piping, generators, electrical equipment, etc., lives of twenty years are assigned. Of these, boilers, piping and generators have net salvage values of 4 to 6 per cent. at the end of that time, thus making their rate of depreciation from 4.7 per cent. to

4.8 per cent. per annum. Allowing 10 per cent. salvage value for electrical equipment, the rate of depreciation becomes 4.5 per cent. Storage batteries, with a useful life of twenty years, go out of service with a salvage value of 17 per cent., making the net depreciation 4.15 per cent. per year. Poles and pole-line equipment are assigned values of 12 per cent. at the end of twenty years' service, resulting in a depreciation rate of 4.4 per cent. Wire, after sixteen years' estimated usefulness, has the high scrap value of 40 per cent., making the depreciation rate 3.75 per cent. Line transformers and customers' meters may be assumed to have the same life as the other electrical equipment named, twenty years, but at the end of that time they have a salvage value of 10 per cent., making the net depreciation rate in the case of these instruments 4.5 per cent.

The Location of a Generating Station is a thing which should be considered most carefully, because if the station is not located intelligently, the cost of the energy generated and delivered by it may be excessively high. In this connection, the following items* are of importance: (1) accessibility, (2) coal and water supply, (3) stability of foundation, (4) facilities for extension, (5) cost of real estate and taxes, and (6) situation should be such that the output of the plant may be effectively utilized.

The following table illustrates a logical and systematic method of tabulating the fixed-charge data when an energy-cost determination is being made. This table shows the values assumed by T. B. Hyde in his solution of the example above proposed. For this complete solution refer to the number of the magazine cited in the footnote.

STEAM PLANT (*Energy Generated*)

A	B	C	D	E	F	G	Fixed charges (per cent.)					X
							I	J	K	L	M	
Item	Equipment	Number	Size	Unit	Unit cost	Total cost	Interest	Depreciation	Insurance, taxes	Maintenance (repairs)	Total	Fixed charges per year
1	Boilers	3	150	B.H.P.	$14.00	$6,300	5	5	1½	6½	18	$1,134
2	Engine	1	320	I.H.P	11.00	3,520	5	5	1	3	14	493
3	Engine	1	120	I.H.P.	10.00	1,200	5	5	1	3	14	168
4	Generator	1	200	K.W.	12.50	2,500	5	5	1	1	12	300
5	Generator	1	75	K.W	13.35	1,000	5	5	1	1	12	120
6	Building					9,000	5	3	1	1	10	900
7	Feedpump					200	5	7	1	3	16	32
8	Feed-water Heater		400	H.P.	1 50	600	5	5	1	3	14	84
9	Piping					2,000	5	7	1	3	16	320
10	Total											3,551

ELECTRIC PLANT (*Energy Purchased*)

11	Building					$3,000	5	5	1	1	10	$300
12	Synchronous converter					2,000	5	5	1	1	12	240
13	Total											$540

Note—The station should, all things being equal, be easily accessible so as to facilitate the delivery of fuel, stores and machinery, while it should be so located that the ashes may be easily removed. If possible, the station should be so located that it may be reached by both rail and water.

The Advantages of Centralization, that its, he advantages which accrue through the concentration of generating equipment into one large plant rather than having it scattered among a number of small plants, may be recited thus†—(1) It is possible to distribute the power economically, (2) because of the diversified nature of the load it is possible to operate the system with a better load factor, (3) purchasing supplies and spare parts at a central point is a decided economic advantage, (4) the centralization of management and operating force reduces the overhead expenses, (5) it is possible to serve certain classes of customers whom the small individual plant could not afford to serve, (6) the lower cost of production, due to centralized service, makes it possible to offer lower rates, (7) consolidation of interests makes possible the financing of improvements, of substitution of new for obsolete apparatus and the extension of service into new territory, and (8) better regulation and better protection can be provided.

*The Location of Power Plants, by J. E. Kearns, of the Boston Edison Company.

†The Location of Power Plants, by J. E. Kearns, of the Boston Edison Company.

General Considerations Relating to the Generating Stations

Direct-Current Voltages and Systems may be divided into two-wire and three-wire systems. Two-wire systems (which are, ordinarily, desirable only for electric-lighting service where the power is transmitted over very short distances) usually

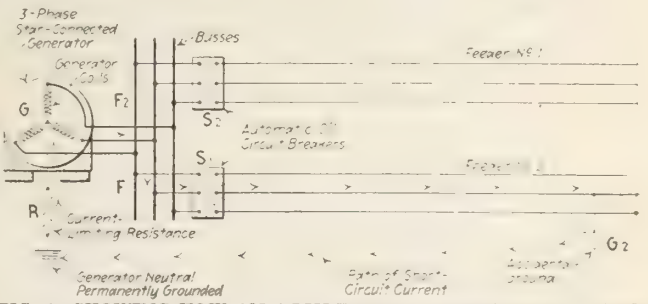


FIG. 4—SHOWING HOW AN ACCIDENTALLY GROUNDED FEEDER WILL DISCONNECT ITSELF FROM THE GENERATOR ON A GROUNDED-NEUTRAL SYSTEM.

operate at 110 volts because 110 volts is, due to economic reasons, the most desirable pressure for operating incandescent lamps in multiple. Occasionally, in a direct-current installation, where the power must be transmitted for a distance of possibly something under a mile for direct-current motors, a 220-volt direct-current system may be installed. If this is done, 220-volt incandescent lamps are used. It is seldom that a two-wire direct-current system is now installed for general electric lighting and power service. Usually, because of the economics which result therefrom, a three-wire system is used. The pressure between the outer wires is 220 volts, and between the neutral and each of the outers, 110 volts. With this system, the incandescent lamps can operate on 110 volts and the motors on 220. The stations in many office buildings, industrial plants and small towns, generate on 110-220 volts three-wire systems. For urban railway service, the standard direct-current pressure is 600 volts. Pressures as high as 1,200, 2,400, 1,500 and 3,000 volts have been applied recently for interurban and trunk line railway service.

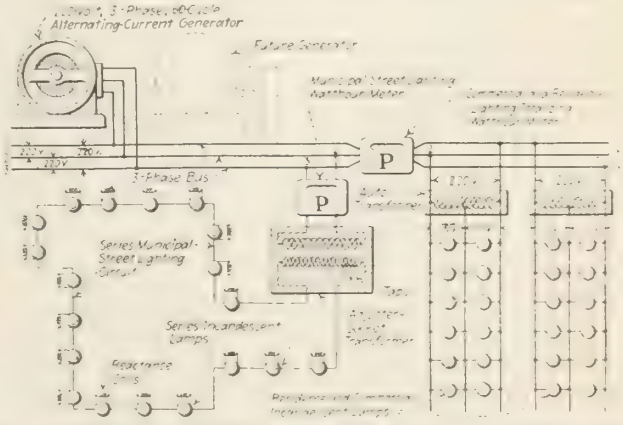


FIG. 5—GENERAL SCHEME OF GENERATION AND DISTRIBUTION FOR A TOWN OF ABOUT 1,000 INHABITANTS OR LESS

The Generating of Alternating Voltages is now, in stations serving large cities or considerable loads of any character, the usual practice—because of the economics which result therefrom. Then, if at any location on the distribution system, direct current is required, the alternating can be converted into direct voltages by using motor-generators or synchronous converters. A large percentage of all generating stations which have been installed recently—this includes many small stations as well as large ones—generate only alternating voltages.

Practically all Alternating-Current Stations Generate Three-Phase. (This refers to stations which have been installed

recently. There are still a number of two-phase stations and a very few single-phase stations in operation.) The reason for this is that three-phase generating and converting apparatus is the most economical and energy can be transmitted more economically with the three-phase system than with any of the others which are utilized directly. The three-phase can be readily transformed or converted into power of some one of the other systems if desirable.

Note.—Even if a large proportion of the output of a station must be transformed or converted to render it available for utilization, it is usually most economical to generate only one kind of energy. That is, for most cases in a station of any size, only three-phase alternating power should be generated. The reason why this plan is ordinarily followed is that with it the generating units can all be operated at

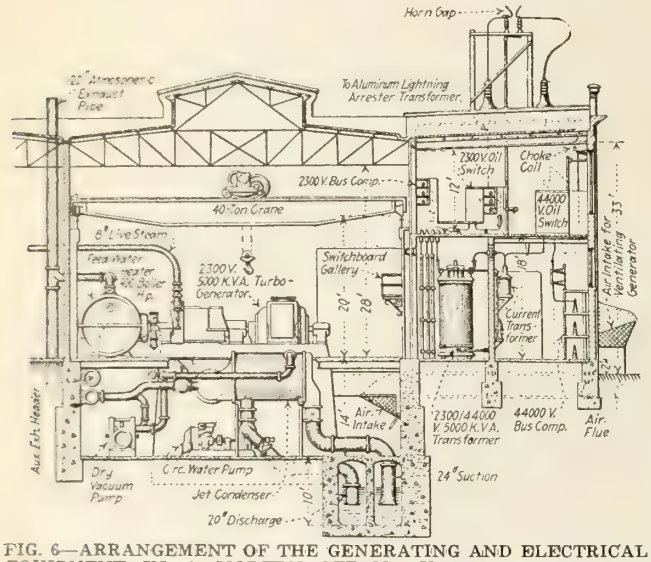


FIG. 6—ARRANGEMENT OF THE GENERATING AND ELECTRICAL EQUIPMENT IN A MODERN STEAM TURBINE GENERATING STATION. (After E. A. Lof, in "Coal Age," Feb. 6, 1915.

greater loads. That is, the individual load factors of the generating units can be maintained at a maximum, due to the advantage that may thereby be taken of the diversity element. Furthermore, where only one kind of power is generated, the investment which must be tied up in reserve apparatus may be a minimum.

Three-Phase Generators are Usually Star Connected* (Fig 1.) because of this method of connection for a given voltage, El (Fig. 1) between line wires, the voltage Ec across each set of armature coils is less than it would be with a delta-connected generator impressing the same line voltage. In view of this, the number of turns in the star-connected generator coils is, for a given line voltage, smaller. Hence conductors of a correspondingly larger diameter can be used for them than would be necessary with a delta-connected machine. Thus a more sturdy and satisfactory mechanical structure results. Furthermore, certain difficulties, due to local currents circulating in the machine windings, which may occur with the delta, are eliminated with the star connection.

Both Grounded and Ungrounded-Neutral Systems are used. Which is preferable must be determined in each specific case after due consideration has been given to the factors involved. There are two reasons for grounding the neutral. One is to limit the voltage, between line and ground, which may be impressed on the insulators and apparatus.

Explanation. If a neutral is grounded, as at G, Fig. 2, it is evident that the electric stress imposed on the insulator at I, between line wire L3 and ground, can never be greater than the voltage Ec which is 0.58 of the line voltage, E. If, however, the neutral is ungrounded as in Fig. 3, and an accidental ground, Ga, occurs, then the line voltage is impressing on the insulator at I2 between the line wire, C, and ground. The line voltage in a three-phase system always equals 1.73 times the voltage to neutral. (The voltage to neutral is shown by Ec in Fig. 2.)

*Some of the material which follows is based on data contained in the article "Generating Stations and Some Features Governing Their Design," by E. A. Lof, of the General Electric Company, published in "Coal Age," Feb. 6, 1915.

The other reason for grounding a neutral is to insure that one of two or more sets of feeders will, by the action of the overload oil circuit-breaker inserted in it, promptly disconnect itself from the station if a ground occurs on that feeder.

Explanation. If an accidental ground, G2 (Fig. 4) occurs on a feeder, F1, supplied by a generator having a grounded neutral, a current will flow through the accidental ground as shown by the dotted arrows. This ground will be of sufficiently low resistance so that the current which flows will be of great enough intensity—(amperage)—to immediately operate the automatic oil switch or oil circuit-breaker, S1. This will isolate F1 from the system. If the neutral were not grounded, the attendants in the station where the generator G was located might not be informed promptly of the existence of the accidental ground, G2.

It follows that, if only one feeder extends from a station to a given load and that continuous service is essential, grounding is probably undesirable. If on the other hand, two or more feeders extend from the station to the same load, then grounding may be desirable. As a rule, it is good practice to omit the grounding of generators where only one or two feeders extend from the station, unless the system operates at a very high voltage. Where the neutral is grounded merely to insure the automatic disconnection of a feeder in the event of a ground on it (Fig. 4), a resistance, R, may be inserted between the neutral point of the generator and ground, to prevent the flow of excessive current in case of an accidental ground, G2, on the line. Such a resistance should be so proportioned that it would permit enough current to flow to operate the automatic oil switches but would at the same time prevent the flow of a dangerously-large current.

The Voltages for Alternating-Current Generators vary with the conditions under which the plant operates. Occasionally where a very small plant serves only an incandescent-lighting load, the generator voltage is 110. More frequently a pressure of 220 is adopted for small plants which serve a three-wire system, the three-wire, 110-220 volts pressures (Fig. 5) being obtained with balance coils located at points near the load. Sometimes, in industrial plants where a considerable number of alternating-current motors are used, 480-volt three-phase generators are installed. Generators for 2,200 to 2,400 volts, three-phase, are very frequently used in towns and small cities for serving a general lighting and motor load. In large industrial plants, three-phase 6,600 volt generators are ordinarily used. A pressure of 13,200 volts is the highest for which it is deemed desirable in the United States to wind alternating-current generators. Hence, a great many machines generate

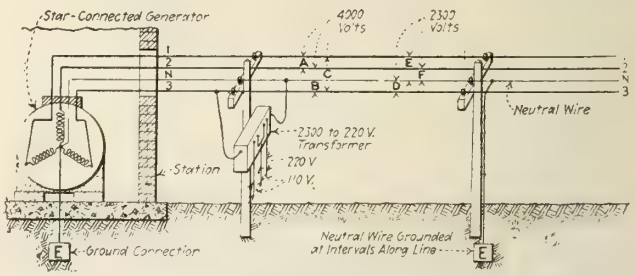


FIG. 7—THE FOUR-WIRE, THREE-PHASE SYSTEM.

at this pressure. Where the transmission distance is sufficiently short, it is economical to use 13,200 as the transmission voltage. In many plants the generation voltage is 2,300 or 2,400 (Fig. 6) and this pressure is raised with transformers to one suitable for the long-distance transmission. The four-wire, three-phase system (4,000 volts between line wires, Fig. 7 and 2,300 volts to neutral) is now being used extensively for local distribution for light and power in cities. In any case, the generator voltage which should be selected is largely a matter of economics.

[To be continued in February 20 issue]

An Iowa inventor has obtained a patent upon a unicycle that is driven by an electric motor and prevented from falling by gyroscopic fly wheels.

Protecting Boiler Drums From Overheating

Common Causes for Bulging—The Superheater—The Three-Pass Setting—The Protection of Boiler Drums—Secondary Combustion

(Reprinted by courtesy *The Locomotive*)

A BULGED spot on a boiler shell is not an uncommon occurrence. We associate it usually with the fire sheets of horizontal tubular boilers, the crown sheet of locomotive boilers, and in general with the furnace tops of internally fired boilers. The cause may be either shortness of water or an accumulation of oil, mud or scale. When a steel plate or a steel tube is exposed to the hot products of combustion on one side, and is covered with water on the other side in a well designed boiler, heat is transmitted from the hot gases and from the radiating fuel bed through the metal to the water at a sufficiently rapid rate to keep the temperature of the metal well below the range at which it begins to lose its strength and becomes soft and plastic. If, however, some substance comes between the metal and the water which cannot remove the heat from the metal as fast as it is received from the fire and the hot gases, the metal becomes gradually hotter till a point is reached at which it is no longer able to withstand the stresses imposed by the steam pressure within the boiler and the plate or tube swells out into a bulge. If the bulged metal continues to receive heat at a faster rate than it can dispose of it the bulge increases in size and the metal wall gets thinner and thinner until it ruptures at the weakest point.

Common Causes for Bulging

There are many different conditions which may result in a bulged spot in a boiler, and since the portion of the boiler directly exposed to the action of the flame and combustion products is usually below the normal water line, we are apt to look for this condition only at such points. The most common cause for bulges below the normal water line of a boiler is of course a deposit of some sort of heat-resisting material on the water side of the metal. This may be an oil film or it may be a deposit of mud or scale matter from the boiler water. In either case if it provides sufficient hindrance to the flow of heat, a bulge will result. These causes have been discussed in the columns of "The Locomotive" for years, and they are very familiar to engineers. Another common cause for bulging and rupturing of boilers is found in some abnormal working condition which permits the waterline to become dangerously low. Under these circumstances as soon as steam and not water covers the surface of metal exposed directly on the opposite side to the heat of the products of combustion, overheating of the metal which will result in bulging and rupture is likely to start because heat cannot flow as readily through a metal and into steam as it can flow through the same metal and into water.

Superheating Surface

To be sure superheaters are made in various ways with special provisions for the rapid absorption of heat by the steam and for considerable reserve strength to resist the tendencies to bulge on the part of the metal, in which heat can be safely and profitably transmitted directly from the hot gases to steam through metal. It is also true that a properly designed vertical fire tube boiler may have a portion of the upper end of the tubes exposed on the one side to the steam and on the other to hot gases, with no serious results. In general, however, a portion of a shell or drum of a boiler, whether of the fire-tube or water-tube type, which is exposed to combustion products on one side and is not covered by water on the other side is apt to prove troublesome, if not dangerous.

Three-Pass Setting

Formerly it was common in some parts of the country to return the gases from an ordinary horizontal return-tube boiler from the front end after they had passed through the tubes directly back across the top of the boiler in a brick flue, of which the upper surface of the boiler shell was a floor, to a stack connection at the back. This arrangement has been known locally as a three-pass setting. It probably succeeded in running without serious injury to the boiler (when it did so succeed) chiefly because the gases were pretty well cooled before they emerged from the tubes at the front end and also because as the boiler shell formed the bottom of the third pass, it must inevitably become heavily blanketed with soot and fine ash in an exceedingly short time. Soot and ash are rather better insulators to heat flow than many forms of pipe covering, and so the top of the shell usually became protected with soot. When it is remembered that if soot enough was deposited on the boiler top to protect the shell plates there would certainly be enough of it to practically prevent any possible economy through the additional absorption of heat from gases by the steam. Also since the supposed extra absorption of heat was the only reason for providing the extra gas pass, a matter of some expense and much inconvenience as such a pass greatly complicates the provision of proper and accessible manholes and the location of a safety valve close to the boiler shell, there is no great difficulty in seeing why its use is rapidly declining even in the regions where it had become a nearly standard method of installing boilers.

The Protection of Boiler Drums

When horizontal tubular boilers are set, care is taken that the brickwork of the settings shall come close enough to the boiler shell so that the points can be tightly packed with asbestos rope. The line at which the brick setting and the shell are joined through this packed joint is about where a horizontal plane through the horizontal diameter of the head would cut the shell, and this is several inches below the usual working water line. In the event of low water several rows of tubes would be exposed to the fire before any unprotected portion of the shell comes in contact with hot gases. However, in some sorts of water-tube boilers the settings are so arranged that parts of the space open to the gases are in contact with portions of the surface of steam drum which are not always covered with water on the steam side. This condition may be aggravated at times of heavy load by the fact that the water line is not uniform throughout all parts of a water-tube boiler, but may rise, due to the effect of the rapid circulation in some of the tubes and drums, or in some other portion of the boiler, only to correspondingly fall at other points. The amount of this rise and fall varies with the rapidity of the circulation and the load on the boiler. A further condition to be reckoned with is the fact that although where the rate of combustion is moderate and the furnace conditions good, combustion may be completed long before the gases reach the relatively out-of-the-way corners where the shell surface is exposed above the water line. Still, under overload conditions, or with poor firing, an entirely different set of circumstances may arise.

Secondary Combustion

It is not uncommon for a portion of the fuel bed to give off combustible gas in a solid stream at a rapid rate. This solid stream may easily pass through a considerable part of the combustion space without burning. It will do this for example if it is not properly mixed with air, for gas cannot burn without air, no matter how hot the surroundings. If such a stream of hot combustible gas gets up into the corners of the setting and there finds air which is perhaps leaking through small cracks in the brick or tile, it will often burst into flame and burn strongly at these points, notwithstanding that it has come a long way from the main part of the fire. Such burning of combustible gas, when boilers are being forced, on coming in contact with air, is the thing which is occasionally seen as a flame at the top of the stack, especially in the case of gas retorts and foundry cupolas, and is known as secondary combustion. It should be clear that if secondary combustion occurs in a corner of a boiler setting alongside of a portion of the boiler shell and above the water line, serious and perhaps dangerous bulging of the shell is the result

to be expected, probably also followed by a more or less violent rupture. Indeed such a rupture might easily be sudden and large enough to start a boiler explosion, for once released, there would be abundant energy stored in the hot water and steam within the boiler to continue the destruction.

The Obvious Cure

In any case even if the rupture was a small one resulting only in the gradual release of the steam from the boiler, the accident would prove inconvenient and expensive. The means for preventing such accidents is simple and should be obvious. It consists merely in carefully studying the setting of a boiler to see if it is possible that the water line in ordinary operation can drop low enough to expose portions of the shell unprotected by water to the gases. If this is possible the setting should be changed immediately so that this contact will become impossible.

TWO FLYWHEEL EXPLOSIONS

On June 17, at the water and light plant of the City of Douglas, Georgia, the governor belt broke on a 200-horsepower Corliss engine and as a result the engine overspeeded and the flywheel burst. The consequences are indicated in the accompanying illustrations. Fortunately there were no personal injuries, but we are informed that the resulting property damage has been estimated at from $10,000 to $12,000.

The flywheel was 14 feet in diameter, and when it exploded two pieces, each weighing about 1,000 pounds, were thrown through the roof of the engine room and came to rest some 200 yards distant.

The accident occurred at two o'clock in the morning, and it is said that at that time the night engineer was at a well at the back of the engine house getting a drink of water. He realized that something had gone wrong and was about to return to his post to stop the engine. Before he could do so, however, the lights went out and the flywheel burst.

Another flywheel exploded on July 10, at about 11:45 p.m., at the plant of the O'Bannon Company, West Barrington, R. I. The plant was operating night and day at that time, and the accident occurred during the night lunch hour. Four persons were injured, none of them seriously, and considerable property damage resulted. The engine of which this flywheel was a part is also of the Corliss type and is of 250 horsepower. The speed was regulated by a belt-driven ball governor. The flywheel was 16 feet in diameter with a 25-inch face, and was made in two sections. It had been inspected recently and pronounced in good condition. A speed of 80 revolutions per minute was allowed, although the ordinary running speed was slightly lower than this. The wheel was of substantial construction, with ribbed spokes cast solid, a large hub, and plenty of metal and ribs underneath the face.

All of the spokes broke off quite near the rim, except one which parted near its junction with the hub. The rim broke into numerous pieces which, in flying about, tore down steam pipes, pulleys, and shafting, and demolished walls and ceilings. One of the fragments was found in an apple orchard nearly 300 feet from the engine room.

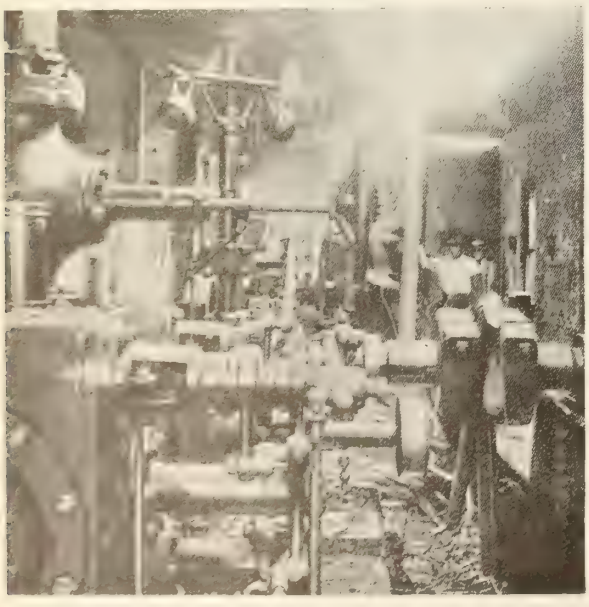
We have no definite information at this time as to the cause of this second accident, but the opinion has been expressed that something was wrong with the governor. It had been the custom for many years at this plant to remove the load from the machines during the lunch hour and to leave the engine running under governor control. This time, however, the governor apparently failed to perform its proper function.

These two flywheel explosions, which occurred within a month in widely separated localities, show that the possibility of such mishaps is ever present. Explosions of this nature are due to numerous causes, and sometimes they occur in spite of all precautions. Many of them may be prevented, however, by installing suitable safety devices and keeping the wheels and the safety devices in good working order at all times.

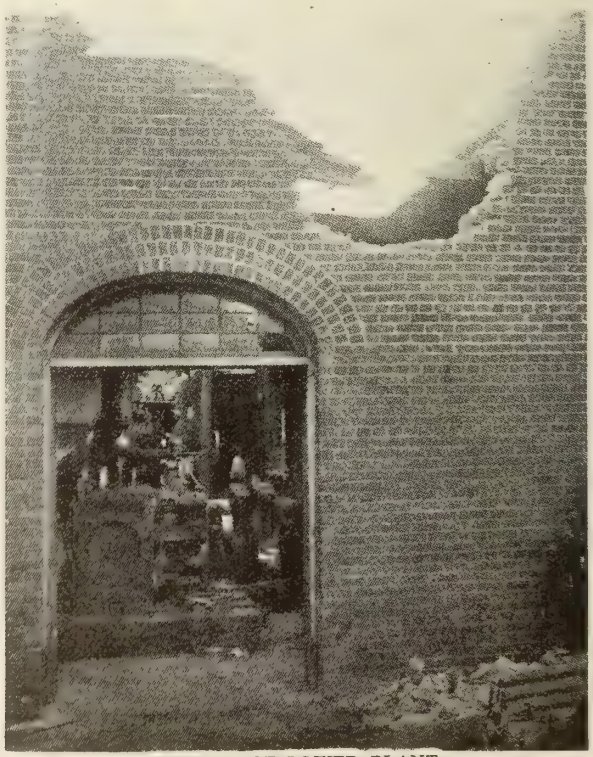
We are indebted to "The Travellers Standard" for text and illustrations of this article.

CONDENSERS, PUMPS, COOLING TOWERS, ETC.

Revised and enlarged Bulletin No. 112-B, entitled "Condensers, Pumps, Cooling Towers, Etc.," has just been published by the Wheeler Condenser & Engineering Co., Carteret, N.J. This bulletin illustrates the latest developments in condenser practice. It shows a surface condenser containing 50,000 square feet of surface. Sixteen condensers, of approximately this size, are now under construction. These will contain, approximately, 1,000 miles of Crescent Brand tubing drawn in the large Wheeler tube mill. The bulletin shows photographs of a number of actual installations of surface condensers. It illustrates and describes surface condensers, jet condensers, barometric condensers, the Wheeler-Edwards air pump, the Wheeler rotative dry vacuum pump, the Wheeler turbo-air pump, the patented Wheeler steam jet air pump, Wheeler centrifugal pumps for all services, jet condensers, barometric condensers, etc.



VIEW OF ENGINE.



EXTERIOR OF POWER PLANT.

The Principles of Heat and Thermo-Dynamics

The More Elementary Principles of Heat and Thermo-Dynamics Are Here Explained in Such a Manner as to be Helpful to the Engineer Going Up for Examination

By T. H. FENNER

BEFORE going into the study of the theory of heat, a few words on the means of measuring sensible heat, or temperature, are necessary. The thermometer is merely a glass tube, placed on a graduated scale, with a bulb blown on the bottom of the tube to form a reservoir. This reservoir contains a volatile liquid, usually mercury, the rate of expansion of which is known. There are three scales in use, the most commonly used of which is the Fahrenheit scale. This scale has a zero mark, which is 32 degrees below the freezing point, and the boiling point, which is 212 degrees, or 180 degrees above the freezing point.

The Centigrade scale is the one in use for scientific purposes, and also in some countries for general engineering purposes. The zero point for this scale is also the freezing point, and the boiling point is at 100 degrees.

The third scale is called the Reaumur, the zero and freezing point of which are the same, but the boiling point is at 80 degrees. This last scale is practically obsolete as far as any engineering purposes are concerned.

It is well that the student should know how to convert a reading on one scale to the equivalent reading on either of the others, and a little thought will show how this can be attained. The number of degrees between the freezing and boiling point on each of the three scales bear a definite relation to the others. For instance, the number of degrees on the Fahrenheit scale between these two points is $212 - 32 = 180$. On the Centigrade scale it is $100 - 0 = 100$, and on the Reaumur scale it is $80 - 0 = 80$. We have, then, 80:100:180 or 4:5:9. For instance, the number of degrees on the Centigrade scale between freezing and boiling points is $\frac{100}{180}$ of those on the Fahrenheit scale. $\frac{100}{180}$ in its lowest dimensions is $\frac{5}{9}$. If we have a reading on the Centigrade scale of 40 the corresponding reading on the Fahrenheit scale would be found as follows: Let t = Fahr., and t_1 = Cent. Then $t = \frac{9}{5} t_1 + 32$.

Substituting figures, we get $t = (1.8 \times 40) + 32$, so the Fahrenheit reading will be 104 degrees. Conversely, 104 degrees Fahrenheit can be converted to Centigrade by reversing the formula. In this case the reading will be $\frac{5}{9}$ of the Fahrenheit, and the 32 degrees on the Fahrenheit scale must be subtracted from the Fahrenheit temperature before multiplying. Thus $t_1 = \frac{5}{9} (t - 32) = .55 (104 - 32) = .55 \times 72$, which gives 39.6 Centigrade. The difference can be accounted for by carrying the recurring decimal further, as for instance:

$$.5555\ (104 - 32) = 39.996.$$

The conversion from the Reaumur to Fahrenheit is made in the same way, though the proportion in this case is 80 : 180 instead of 100 : 180. The expression would thus be, if the Reaumur reading was 40, and using t for Fahrenheit, and t_1 for Reaumur:

$$t = (t_1 \frac{9}{4}) + 32$$

$$= (40 \times \frac{9}{4}) + 32$$

$$= 122 \text{ Fahrenheit.}$$

Conversely, $t_1 = \frac{9}{4} (t - 32)$

$$= \frac{1}{9} (122 - 32)$$

$$= \frac{4}{9} \times 90 = 40$$

Converting Centigrade to Reaumur is exactly the same excepting that the addition or subtraction of 32 is not necessary.

For instance, if Reaumur reads 60, then Centigrade will be $60 \times \frac{5}{4} = 75$, while the converse would be C = 75, then R will be $75 \times \frac{4}{5} = 60$.

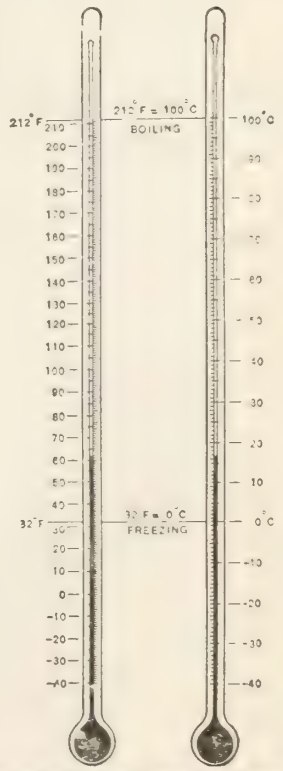
The conversion from Centigrade to Fahrenheit and vice versa will be the one most often used. It is easy to remember, as $C. = \frac{5}{9} F.$ and $F. = \frac{9}{5} C.$ The addition or subtraction of the 32 must be watched carefully. When converting from Centigrade to Fahrenheit add the 32 to the product of $\frac{9}{5}$ C., but when converting to C. from F., subtract the 32 from F. before making the multiplication. The formula is easy to remember:

$$\text{Degrees C.} = \frac{5}{9} (F - 32)$$

$$\text{Degrees F.} = \frac{9}{5} C. + 32.$$

The reason for the addition or subtraction of 32 when making conversions into or from Fahrenheit is simple. The ratio of Centigrade or Reaumur to Fahrenheit is calculated from freezing to boiling point, and while this includes zero on the first two, the freezing point on Fahrenheit is 32 degrees above zero. Hence the correction.

The ordinary mercury thermometer is not capable of measuring temperatures above 350 degrees to 400 degrees. When higher temperatures are to be taken by



COMPARISON OF CENTRIFUGAL AND FAHRENHEIT THERMOMETER SCALES.

means of a thermometer, such as a chimney or economizer gases, a modification of the ordinary instrument must be used. This special instrument is made with a seal of nitrogen gas on top of the mercury column. The effect this has is to create a pressure when the mercury expands, and this increased pressure raises the boiling point of the mercury, which at atmospheric pressure is 662 degrees. Another means of meas-

uring high temperatures is by means of the pyrometer. This is an instrument which utilizes the property of different metals to set up a difference of electric potential, when connected together through a galvanometer and exposed to the heat. This instrument is used to take furnace temperatures, etc.

Knowing that sensible heat can be can be measured by means of suitable instruments, and that heat, both sensible and latent, has a definite unit, the British thermal unit, corresponding to 778 foot pounds, we can go on to consider the different ways in which heat is transferred from one body to another.

Transference of Heat

There are three ways in which heat is conveyed from a hot body to one of lower temperature. These are by radiation, conduction, and convection, and these will be studied in detail.

Radiation is the means which is most often observed by the average person. It is the means by which we get the heat of the sun on to the earth. Rays of heat are always thrown out from a hot body, and will enter a cold body, or heat the air in its immediate proximity. It is the property of heat to radiate from a hot body which is taken advantage of in the use of heating coils in a building. It is also the property that causes the engineer immense loss if not guarded against, in places where it is not wanted. That is why boilers must be lagged, steam pipes and steam cylinders covered, and feed-water heaters protected with heat insulating or non-conducting compositions. Radiation losses are very serious and cannot be too carefully watched. For instance, the average loss per square foot of bare pipe per hour per degree difference of temperature, with steam at 100 lbs. gauge, is 2.75 B.t.u. Suppose we have a 4-inch steam pipe, the outside diameter of which is 4½ inches. The circumference of this pipe will be $4.5 \times 3.1416 = 14.137$ inches. A length of pipe 10 inches long will contain a square foot of surface. If the temperature of the steam is 338 degrees and the air 60 degrees, the difference is 278 degrees. The total B.t.u. lost per hour on this one square foot of pipe is 746. It would only take about seventeen square feet of this bare pipe to radiate as many heat units as are contained in a ton of coal. Does this make you realize the importance of radiation? However, this property of radiation is also useful as we have already seen in heating buildings. It is also seen in boiler furnaces, where the heat from the fire radiates on to the shell of the boiler, or the plates of the furnace. The firebrick lining of the furnace absorbs heat to a certain point and then radiates or reflects the heat rays striking it. When the fire is burned down and gone out this hot lining radiates the heat it has absorbed during the time the fire has been going.

Conduction

We have said that the fire radiates its heat on the plates of the boiler. How, then, does the heat reach the water contained therein. Obviously it must pass through the plates, and this process is known as conduction. The plate immediately in contact with the flame or hot gas from the fire becomes warm, and immediately begins to communicate the warmth to the molecules or layer of metal immediately in touch with it. This process goes on through the thickness of the plate till the heat applied at one side is conducted through to the other. Now various metals have different degrees of heat conductivity as they have of electrical conductivity. For instance, copper is a good conductor of electricity. That is, a current can be sent along a copper wire more easily than along an iron wire. Heat is conducted more quickly through copper than through iron or steel. Asbestos is almost a non-conductor, or the best insulator known. Following is a list of various metals, with their conducting powers. These are expressed in units of heat conducted through a plate of the material one inch thick, for one square foot surface per hour, the difference in temperature being 1 deg. on the different sides of the plate:

Copper	515
Iron	213
Lead	113
Stone	16.7
Glass	6.6
Brick	4.8

Convection

There remains the third method of heat transference, namely, convection. The heat has been radiated from the fire on to the plates, and has passed through the plates by conduction. If it is not taken away by some means the plate will go on absorbing heat until the point is reached where it will melt, or become fluid enough to be distorted. This is what happens when boiler furnaces are bulged, or collapse. However, if the plate is in contact with the water the water will absorb the heat. This will result in the water immediately in contact with the plate becoming lighter than the overlaying water. It will therefore rise, and its place will be taken by cooler water. The warm water, rising, will convey the heat to the water surrounding it, and thus a circulation or convection of heat by means of streams of warm water will be commenced. This will continue until the fire is allowed to die out. It is on the rapidity and diffusion of these streams of water that the effectiveness of a boiler greatly depends, and the design of boilers has been influenced by attempts to get the best circulation. It was on this factor that the inception of the water tube boiler depended. It is poor circulation which is the only real disadvantage of the Scotch type of boiler.

The effect of the application of heat to a body, whether a solid or fluid, or a gas, is to agitate the molecules composing the body and increase their vibrations. They thus tend to occupy more space, which causes the whole body to expand, and this expansion may be linear or volumetric. Similarly, with one or two notable exceptions, subtraction of heat causes a contraction of the body acted upon and this expansion and contraction is a very important item to the engineer.

The most notable exception to the rule of contraction during cooling is the case of water. At 39 deg. Fahr., water is at its maximum density, and addition or subtraction of heat above or below that point causes it to expand. This accounts for the terrific force exerted by water freezing in a confined space, such as a cylinder or pipe, the force exerted by the molecules of the water in expanding being sufficient to break the strongest container man can devise.

Expansion Through Heat

In the case of water expansion takes place with addition of heat until a point is reached, according to the pressure it is subjected to, where it changes its state and becomes a gas. Iron or steel or any metal expands with heat, the molecules becoming less homogeneous, or we may say, more widely separated, the earlier evidences of this being the softening of the metal. This enables it to be worked easily, being in a more or less plastic state. Carry on the heating process further, the molecules become entirely separated and the metal becomes fluid and can be poured, like water. It changes its state. Gases under the influence of heat retain their state, but increase their volume very rapidly unless prevented by being confined. In that case they increase in pressure. Solids expand less rapidly than gases.

Expansion through heat may take place in either of three ways, linear, surface or by volume. Of course, the latter includes the other two. Linear expansion is half the surface expansion, and one-third the cubical expansion. There is a definite amount of expansion per degree temperature to all substances. This is known as the co-efficient of expansion. For instance, the co-efficient of expansion of wrought iron is .000006, which means that for each degree Fahr. added, the material will stretch that part of its length. Suppose we have a bar 24 inches long at a temperature of 40 deg., and it is heated to 80 deg. The heat added is 40 deg. The co-efficient for one degree multiplied by 40 gives the co-efficient for 40 degrees. That is $.000006 \times 40 = .00024$. Now this is the fraction of the original length that is added, so we have $.00024 \times 24 = .00576$. This added to the original length gives 24.00576 as the new length. This is true, whether feet, inches, or miles are used as units. A handy rule is when an increase of temperature takes place in a bar to find the new length L, the original length being l, and the increase of temperature t°, and co-efficient of expansion C. $L = l\ (1 +$

ct°). If the bar is acted on by a decrease of temperature, shortening from L to l, then $l = \frac{L}{1+ct°}$

The co-efficients of linear, surface, and volumetric expansion of solids, liquids, and gases, are to be found in tabulated form in most engineering handbooks. Some of the more important metals have the following co-efficients: Wrought iron and steel, .0000065; cast iron, .0000055; brass, .00001. The expansion of steam pipe lines, boiler plates, steel rails, steel bridges, is something which comes under the notice of every engineer daily, and which he must take precautions against in designing and erecting. In some cases this property of expansion and contraction of metals becomes a valuable aid to the engineer, as for instance, in securing crank webs to crank shafts, fly wheels to shafts, and liners to shafts.

Specific Heat

While the subject of specific heat may be followed back to highly scientific investigations, it is not necessary for the engineer who is dealing with practical problems only to go into such refinements. Specific heat, like specific gravity, is used to enable us to compare the various materials to a standard base. Water is the standard for specific gravity, which is to say that 1 cubic foot of water at its greatest density, 39.2 deg., has a weight of 62.425 lbs., usually written 62.5. One cubic foot of cast iron weighs 450 lbs., and, compared to a cubic foot of water, is 7.2 times as heavy, therefore we say its specific gravity is 7.2. One cubic foot of charcoal weighs 27½ lbs., and its specific gravity is .441.

In considering specific heat, we may call it capacity for heat of different bodies. Take again water as a standard, but in this case water at atmospheric pressure and at 62 deg. Fahrenheit. This temperature is taken because the B.t.u. is calculated on the amount of heat required to raise one pound of water one degree from 62 deg. to 63 deg. Now if we want to raise the temperature of a bar of iron, a column of mercury, or a cylinder full of air, it is obvious that they will not each require the same amount of heat. If the bar of iron weighs five pounds and we want to raise its temperature 5 degrees, the amount of heat we must put into it will compare to the amount of heat necessary to raise a like weight of water the same amount, as its specific heat does to 1. The specific heat of iron is .1138. Then we have

$$.1138:1::X:5 = .569$$

As the reader may easily see, the heat required to raise any substance any amount may be found by multiplying its weight by its specific heat and the number of degrees to be raised. For instance, supposing we want to raise 100 pounds of iron 100 degrees in temperature, what number of B.t.u.'s would we need?

$100 \times 100 \times .1138 = 1138$ B.t.u.

The specific heat of water above or below 62 deg. varies from the standard, and this is taken into account in the compilation of steam tables. For instance, water at 212 deg. Fahr. and atmospheric pressure is, according to the scale, just 180 deg. above 32 deg., and would therefore require for one pound 180 B.t.u. However, the heat required is actually 180.531, thus showing that the specific heat is slightly greater than at 62 deg. Fahr. As both temperature and pressure increase, the specific heat rises. Water at a pressure of 300 lbs. per square inch absolute has a temperature of 417.371 deg. That is, it is 385.371 deg. above 32 deg., which is the point always measured from. The quantity of heat required is, however, 390.933, a difference of 5.562 B.t.u. per pound. The temperature of the steam at this pressure is of course the same as the water it is made from . When steam is heated above the temperature corresponding to the pressure, it is said to be superheated, and in this state its specific heat is less than that of water.

As an example of the application of specific heat to practical problems, take the case of different substances at different temperatures mixed together, and it is required to know what the final temperature will be. The most familiar instance, of course, would be that of steam and water. Suppose we have ten pounds of water at 62 deg., and we mix with it 5 pounds of steam at 100 lbs. pressure, what would be the temperature of the resulting mixture?

t = temperature of mixture.
t_1 = temperature of water.
t_2 = temperature of steam.
w_1 = weight of water.
w = weight of water.
s_1 = specific heat of water.
s = specific heat of steam.

Then $t = \frac{w_1 s_1 t_1 + w_2 s_2 t_2}{w_1 s_1 + w_2 s_2} =$

$$\frac{10 \times 1 \times 62 + 5 \times 1.0077 \times 316.893}{10 \times 1 + 5 \times 1.0077}$$

which, worked out, gives 147.4 deg. as the result of the mixture.

Again, suppose we had 100 lbs. lead, 75 lbs. zinc, and 25 lbs. tin, at the melting point and mixed them together, we would get

$$t = \frac{w_1 s_1 t_1 + w_2 s_2 t_2 + w\ s\ t}{w_1 s_1 + w_2 s_2 + w\ s} =$$

$$\frac{100 \times .0314 \times 626 + 75 \times .0956 \times 680 + 25 \times .0562 \times 446}{100 \times .0314 + 75 \times .0956 + 25 \times .0562}$$

$= 486.4$ deg.

In considering the effects of adding heat to gases, we must first explain what is meant by absolute zero of temperature. It has been found that if a cubic foot of gas is raised from 32 deg. Fahr. to 212 deg. Fahr. at constant pressure, it expands to 1.366 cubic feet in volume. That is to say, that in adding 180 degrees to the temperature, the volume has been increased .366. Then, for each degree, the volume increases $\frac{.366}{180}$. That is $\frac{.366}{1000} \div 180$, which, comes to $\frac{1}{491.8}$ or $\frac{1}{492}$ of its volume of 1 deg. temperature. Now this is found to be a uniform addition over the range of temperature taken, and so is assumed to be uniform over any greater range. Supposing instead of the gas being heated it were cooled from 32 deg. downwards. If each degree cooler reduced the volume by $\frac{1}{492}$, when it had been cooled to 492 deg. below zero it would have no volume. Of course, this temperature could not be reached actually, as gases liquefy before reaching so low a temperature, but this assumption is made to enable us to have a definite working point to start from. Supposing we reached this point where there was no volume, obviously there could be no temperature. Therefore, the absolute zero of temperature on the Fahrenheit scale is assumed to lie at a point 492 deg. below freezing point, or 460 deg. below zero.

On the Centigrade scale the absolute zero is at 273 deg. below zero. In theoretical studies of heat, it is the absolute temperature that is used, and it is usually denoted by the capital T.

Expansion of Gases

Gases, in being subjected to heat, differ from solids or fluids in that they possess elasticity and are capable of being compressed. That is, if we take a cubic foot of a gas and enclose it in a cylinder having a weightless and frictionless piston, and apply heat to it, the expansion of the gas will raise the piston. If, now, instead of allowing the piston to rise freely we should place weights on it, the gas cannot expand. In this case, the addition of heat will result in an increase of pressure instead of an increase of volume.

Now this increase of pressure or volume as the case may be is in direct proportion to the absolute temperature.

This may be stated as follows: If a gas is heated while remaining at constant volume, its pressure will increase directly in proportion to its absolute temperature.

If a gas is heated while remaining at constant pressure, its volume will increase directly in proportion to its absolute temperature.

If the gas is cooled the same law applies.

Take a concrete instance as an illustration.

Suppose we have a certain volume of

gas at a temperature of 212 deg. Fehr. and it is heated while remaining at constant volume to 250 deg. Its pressure at 212 deg. is 14.7 lbs. Its absolute temperature is $212 + 460 = 672$. When raised to 250 deg. its absolute temperature is $250 + 460 = 710$. The pressure will be then

$$14.7 \times \frac{710}{672} = 15.5$$

If we have 5 cubic feet at a temperature of 150 deg. and it is raised to 200 deg., the pressure remaining constant, the volume will be

$$5 \times \frac{200+460}{150+460} = 5 \times \frac{660}{610} = 5.405 \text{ cu. ft,}$$

There is a further application of specific heat. When dealing with gases there are two specific heats, one applicable to a gas at constant pressure, and one to a gas at constant volume. These bear a definite relation to each other, and their properties must be understood before the practical study of heat as applied to the steam engine can be examined.

The expansion of gases is governed by two laws, that of Boyle, and that of Charles. Boyle's law states that, "At constant temperature the volume of a gas varies inversely as its pressure."

The law of Charles states that, "Equal increments of temperature give equal increments of volume when pressure remains constant."

These laws are applied to perfect gases, and before proceeding further we will define what is understood by a perfect gas. When work is done on a gas, such as in compressing it, energy is expended. All this energy would appear in the gas as heat if it were a perfect gas. Air is spoken of as a perfect gas, but is not quite so, for at certain pressures a portion of the heat dependent on it does not appear. It is expended on overcoming the friction of the molecules of the air itself, and is absorbed in them. It may be said that no perfect gas has ever been obtained. A perfect gas is sometimes spoken of as a gas that follows Boyle's and Charles' laws.

If a gas is placed in a cylinder, covered with a weightless piston, and heat is applied to it, it will expand. In order to do this, the gas must expend some of the energy divided from the heat applied. Another portion of the heat goes to raise the temperature.

Now, if the same amount of gas is confined in the cylinder and heat supplied to it, but expansion prevented, less heat will be required to raise it to the same temperature as in the first case. This is because the gas is confined, and the molecules cannot lengthen their path when heat is applied to them. The heat that is expended in the first instance in increasing the path of vibration of the molecules of the gas is now conserved. The difference in the two amounts of heat can be defined as the specific heat. If the heat required to raise the temperature of the unexpanding gas is 1, then the heat required to raise the expanding gas will be 1.405. This figure is the one for air, but is very nearly that for several other gases.

To get a proper understanding of the relation of specific heats, and their uses in thermo-dynamical problems, we will follow out the equations of the two laws already mentioned.

Take Boyle's law first: "At constant temperature the volume of a gas varies inversely as its pressure." That is to say, that if we have a volume of gas, say, 2, and a pressure equal to 4, the product of pressure and volume, as long as temperature remains constant, will always be 8, no matter how the pressure and volume may vary. For, if we increase the volume to 4, we decrease the pressure to 2, and if we increase the pressure to 8, the volume decreases to 1. This is expressed mathematically by the term $p\,v = p_1\,v_1 =$ constant. Substituting the figures as above, $4 \times 2 = 2 \times 4 = 8$. The product remains the same.

The law of Charles deals with a gas at constant pressure, the volume and temperature being the varying properties, or a gas at constant volume, the pressure and temperature varying. The amount of variation depends on the absolute temperature.

If a gas at constant pressure, p, is heated so that its volume is increased from v to v_1, the temperature will have increased from T to T_1. The capital T represents, in all cases, absolute temperature. The expression for this condition will be

$$\frac{v_1}{v} = \frac{T_1}{T} \text{ or } v_1\,T = v\,T_1$$

If the gas is kept at constant volume, and temperature added so that the pressure is increased, then the equation is

$$\frac{p_1}{p} = \frac{T_1}{T} \text{ or } p_1\,T = p\,T_1$$

The equation, or we might say the characteristics of a perfect gas, as expressed in an equation, is obtained by combining the equations of Boyle's and Charles' laws. We have seen that gas at a pressure p and volume v, at constant temperature, changed to pressure p_1 and volume v_1, changes its volume in direct proportion to the change in pressure, and we expressed it as

$$p\,v = p_1\,v_1$$

$$\therefore\ p_1 = \frac{p\,v}{v_1}$$

Now, by Charles' law, equal increments of temperature produce equal increments of pressure at constant volume. So, if we have a volume of gas at pressure p_1 which is increased in temperature from T to T_1 and remains at constant volume, increasing in pressure from p_1 to p^1, we have

$$p_1 : p^1 :: T : T_1$$

$$\text{or } p_1 = \frac{p^1\,T}{T_1}$$

The combination of these equations $p_1 = \frac{p\,v}{v_1}$ and $p_1 = \frac{p^1\,T}{T_1}$ gives $\frac{p^1\,T}{T_1} = \frac{p\,v}{v_1}$ and expressing them both in terms of p v by transferring we get

$$\frac{p\,v}{T} = \frac{p^1\,v^1}{T_1}$$

This may probably be made somewhat more clear by taking a numerical example. If we have one pound of a gas, say air, at a pressure of 15 lbs. per sq. in. absolute, and a volume of 12 C. F. and absolute temperature of 520 deg. Fah., this will correspond very closely to air at normal pressure and temperature. Supposing the volume is increased to 18, the temperature remaining constant. Then, by Boyle's law,

$$p\,v = p_1\,v_1$$

$$15 \times 12 = p_1 \times 18$$

$$\frac{15 \times 12}{18} = p_1$$

$$\text{and } p_1 = 10$$

If the volume remains constant at v_1 and the pressure and temperature are increased from p_1 to p^1 and T to T_1 we get

$$\frac{p_1}{p^1} = \frac{T}{T_1} \text{ or } \frac{10}{p^1} = \frac{520}{T_1}$$

Assume that the pressure is increased to 15 lbs., then

$$\frac{10}{15} = \frac{520}{T_1}$$

$$\text{then } T_1\,10 = 520 \times 15$$

$$T_1 = \frac{520 \times 15}{10}$$

$$T_1 = 780$$

$$\text{Now } p_1 = \frac{p\,v}{v_1} \text{ and } p_1 = \frac{p^1\,T}{T_1}$$

$$10 = \frac{15 \times 12}{18} \text{ and } 10 = \frac{15 \times 520}{780}$$

$$\text{so } \frac{p\,v}{T} = \frac{p^1\,v^1}{T^1}$$

Substituting figures

$$\frac{15 \times 12}{520} = \frac{15 \times 18}{780}$$

which, reduced to its lowest fraction, is

$$\frac{9}{26} = \frac{9}{26}$$

or, transposing

$$15 \times 12 \times 780 = 15 \times 18 \times 520$$

$$180 \times 780 = 7800 \times 18$$

$$18 \times 78 = 78 \times 18$$

Now, if T remains constant, p and v alter in inverse proportion to each other. If p and T alter, v remains constant, and if v and T alter, p remains a constant, so the expression

$$\frac{p\,v}{T} = \frac{p^1\,v^1}{T^1}$$

is a constant. So we may denote it by a symbol R and the expression is put

$$\frac{p\,v}{T} = R$$

so that $p\,v = R\,T$ and $p^1 v^1 = R\,T^1$

This is called the equation of the gas. The value of R can be found for any gas, if we know the volume of 1 pound. For instance, air at 14.7 lbs. absolute pressure has a volume of 12.39 C. F. Then $p\,v = R\,T$, and if the temperature is 32 deg. Fahr. or 492 absolute, we have

$$p\,v = R\,T$$
$$14.7 \times 12.39 = R \times 492$$
$$R = \frac{14.7 \times 12.39 \times 144}{492}$$
$$R = 53.43$$

We have been dealing with only one pound of the gas. If we have any larger quantity, say w pounds, then the formula will be $p\,v = w\,R\,T$, or for air

$$p\,v = w \times 53.43 \times T$$

As an example, if we have a cylinder of compressed air containing 10 lbs. air at a temperature of 100 degrees, and a gauge pressure of 100 lbs. per sq. in., what is the volume?

$$p\,v = w\,R\,T$$
$$144 \times 114.7 \times v = 10 \times 53.43 \times 560$$
$$v = \frac{10 \times 53.43 \times 560}{114.7 \times 144}$$
$$v = 18 \text{ C. F.}$$

Do not forget that pressures and temperatures are absolute, and, therefore, 14.7 must be added to gauge pressures and 460 to thermometer temperatures. Also, the pressure per square inch must be multiplied by 144 to bring it to square feet, as we are dealing with volume per cubic foot.

In speaking of a perfect gas, we said that all the heat put in would show as energy. No gas being perfect, some heat is lost in overcoming internal resistance in the gas itself. We therefore can express the action of the heat as applied to a perfect gas by a formula.

If H = total heat
S = heat used in increasing temp.
I = internal work
W = external work

Then $H = S + I + W$.

If the gas were perfect, then I would not appear and $H = S + W$.

From this we see that the heat applied to a perfect gas, which expands against a resistance, will be partially absorbed in doing external work. This heat will no longer be in the gas. The heat remaining will be the difference between the total heat applied and that used for external work, or

if $H = S + W$, then $S = H - W$.

Any alteration in the internal energy of a gas is that induced by a change of temperature, for, if a gas is changed in volume or pressure without the addition or subtraction of temperature, the internal energy remains the same.

The specific heat of a gas at constant volume is denoted by the symbol C v, and at constant pressure by C p. If expressed in foot pounds instead of heat units, the symbols are K p and K v. The specific heat of air at constant pressure is .2375, and at constant volume .1689. Now, multiplying these figures in each case by 778, the equivalent of 1 B.T.U. in foot pounds, we get 184.77 and 131.4. Therefore. C p = .2375 ; C v = .1689 ; K p = 184.77; K v = 131.4.

The specific heats under the two conditions have been determined by careful experiment. The specific heat at constant pressure being .2375, and at constant volume is .1689, then the ratio is:

$$\frac{Cp}{Cv} = \frac{.2375}{.1689} = 1.405$$

Taking the ratio in ft. lbs. instead of heat units we get the same result:

$$\frac{Kp}{Kv} = \frac{184.77}{131.4} = 1.405$$

This specific heat ratio has to be taken into account when considering the action of steam expanding and doing work in a steam engine.

Adiabatic Expansion

Expansion of a gas takes place in one of two ways. If it expands in a closed vessel which is an absolute non-conductor of heat, it will do work without either losing or gaining heat, to the walls of the vessel. Some of the heat will be transformed into work, but none will be lost. This is termed an adiabatic expansion.

Isothermal Expansion

In an isothermal expansion the gas expands at constant temperature, or we may say without loss or gain of temperature. In this expansion the pressure and volume always vary inversely, and $Pv = S$. If we have a cylinder, fitted with a piston, and an indicator is attached, we can move the piston up and down, and if the temperature of the air in the cylinder is kept constant, the pencil will trace a curve, following the same line at every repetition. This curve will be a graphic representation of the variation of pressure and volume, and will be an isothermal curve. The curve obtained by the indicator if the piston were moved rapidly in and out, so that the temperature was raised by the work done on the air, and this heat had no time to be dissipated by radiation, would be steeper than the isothermal. It would be adiabetic. The curve obtained in an actual engine is neither adiabetic nor isothermal but lies between the two.

The Working Cycle

As we have seen in an earlier article, heat and work are mutually interchangeable. This principle is borne out in the steam engine by supplying heat to a working fluid, which changes its heat into work by expanding against a piston, which drives a crankshaft. The heat is supplied by the combustion of fuel under a boiler, evaporating the water and forming steam, which is the working fluid. In the supplying of the heat to the water there is loss due to the inefficiency of the boiler, and from the boiler to the engine there is loss through radiation. In the engine itself there is further loss due to condensation on cylinder walls and passages. A very small portion of the heat contained in the steam is utilized in performing work, the larger part being rejected to the condenser with the exhaust, or to the atmosphere with a non-condensing engine. It will thus be seen how very imperfect as a heat engine, our steam engine really is. The internal combustion engine is much more efficient, the combustion of the fuel taking place in the working cylinder itself. This eliminates a considerable amount of the losses which are encountered by generating steam in a separate vessel. In the internal combustion engine the losses are due to the heat carried away by the jacket circulating water, and that rejected in the exhaust.

In neither of the cases just quoted have we completed the cycle. In a surface condensing steam engine the condensed steam from the engine is returned to the boiler by the fuel pumps. This makes a complete cycle from boiler to engine, engine to condensor, and condensor to boiler. In the engine exhausting to atmosphere and in the internal combustion engine the cycle is not followed through.

A closed cycle is any cycle in which the working fluid returns to its original state. The ideal cycle as described by Carnot is one in which this condition is fulfilled.

In this we have a cylinder, the walls of which are absolute non-conductors, fitted with a non-conducting piston, moving without friction. The bottom of the cylinder is conceived to be a perfect conductor, that is, it offers no resistance to the passage of heat. This cylinder contains one pound of a substance or gas. There is a source of heat, with which the cylinder bottom can be placed in communication, and a refrigerator, or cold body, also capable of being placed in communication with the cylinder bottom.

We will suppose the cylinder bottom to be placed in communication with the source of heat, the gas or substance contained in the cylinder being at the same temperature as the latter. The gas will receive heat and expand, doing work, but the temperature will remain constant. At a certain point the cylinder is removed from the source of heat, and the gas is allowed to expand, doing work, by which a certain amount of heat is changed into work, but none is lost to the cylinder walls or piston, and none is received. The cylinder is now placed in communication with the cold body or refrigerator, and the substance compressed, the heat developed by the work done on the substance being given up to the refrigerator, so that the temperature remains constant. The cylinder is again removed from the refrigerator and the gas is compressed, without receiving or losing heat from any outside source, till its pressure and temperature is again the same as at the starting point. Now, let us follow these four stages out, and see if we can apply the teaching of the previous articles to them.

First, we have an expansion without loss or gain of temperature, which is an isothermal expansion, and follows Boyle's law $p\ v_1 = p_1\ v_1$.

We then have a further expansion in

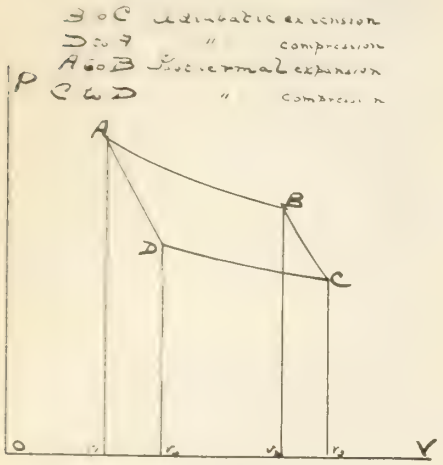


DIAGRAM OF CARNOT CYCLE

which the substance does work, the pressure and temperature drop, but no heat is lost or gained. A certain amount of heat is changed to work, but none is lost, this corresponding to an adiabatic expansion. The equation for an adiabatic expansion must be corrected to take in the ratio of the specific heats of a gas at constant pressure or constant volume.

$$1.405 \qquad 1.405$$

This becomes $pv. \quad = p_1 v_1$

In these two expansions the substance has done work on the piston, and from a temperature corresponding to that of the source of heat, it has dropped to that of the refrigerator or condensor. The piston now does work on the gas, compressing it, the heat of compression passing through the bottom of the cylinder to the condensor, this again being an isothermal compression, as the temperature remains constant. The last stage is compression of the gas to its original point, the heat of compression being retained, raising the temperature to that of the source of heat. This is an adiabatic compression. Now, the heat added to the gas has all been added at constant temperature, and the heat rejected has been rejected at constant temperature. The efficiency of the cycle is governed by the difference between the high absolute temperature and the lowest absolute temperature. This can be expressed by the formula:

$$\frac{T_1 - T}{T} = E.$$

The accompanying diagram shews the Carnot cycle in graphic form. The indicator card obtained from a steam engine resembles this in general form. The isothermal lines, however, are straighter. The action of steam in a steam engine will be discussed in a later article.

"Will say one thing about POWER HOUSE, which is my motto, and that is: If it is not in POWER HOUSE, it is not worth knowing."

W. L. GOODWIN FORECASTS ENORMOUS ELECTRICAL INDUSTRY

THE part Hydro-Electric development is playing in the industrial economy of the Province of Ontario was very strikingly portrayed by the banquet given by the associated electrical organizations in Toronto on Friday, Jan. 16. Over six hundred were present, representative of the following organizations: The Toronto Section of the American Institute of Electrical Engineers, the Association of Municipal Electrical Utilities of Ontario, the Canadian Associated Manufacturers of Electrical Supplies, the Electrical Supply Jobbers' Association, and the Ontario Association of Electrical Contractors and Dealers.

Brig.-Gen. C. H. Mitchell, Dean of the Faculty of Applied Science and Engineering, presided, and with him at the head table were His Honor Lionel H. Clarke, Lieutenant-Governor of Ontario; Sir William Hearst, Mayor T. L. Church, Senator Frederic Nicholls, Prof. A. B. Macallum, K. J. Dunstan, T. A. Russell, P. W. Ellis, Colonel Carmichael, of the Ontario Government; Arthur Hewitt, Major R. W. Leonard, Prof. T. R. Rosebrugh, Col. Alex. Fraser, A. F. Wickson, James White, and Monro Grier, K.C.

Sir William Hearst, in replying to the toast to Canada, said that, looking at the large audience, he now fully realized what electricity meant to Canada. The future of Canada meant the development of its resources. Both the home and the factory were dependent on electricity. Canada was proud of its electrical development and its water powers, and had achieved in the direction of electrical development more than any other country in the world. There was, however, much more left to be done in the development of the white coal. When the ordinary coal and peat were all gone Canada's rivers would all be producing electric power. Referring to the present industrial outlook, Sir William said that everyone looked for a time of depression after the war, but he was glad to say that the output of Canadian factories was only limited at the present time by the amount of raw material they could obtain. He thought the country could look forward to an era of great prosperity in which electricity would play a great part. He contended there was nothing to prevent Canada from a wonderful advancement if the people practised harmony and co-operation.

W. L. Goodwin was the speaker of the evening, and in his address he made a strong appeal for co-operation amongst the varied electrical industries of the province. The electrical industry promised to be a very big thing in the province and publicity would be needed by the industry to drive home to the people all the manifold advantages of electric energy for the home and factory.

There was nothing, however, to be gained by the fighting now going on between public and private interests. There was room enough for both, and both would be needed.

These two branches of the industry, he stated, instead of fighting, should be supporting each other, and should be united in one big campaign to further both their own interests and the interests of the consumer of electrical energy. Plenty of illustrations of the folly of the electrical people engaging in private wars, instead of combining in a big educational campaign which would benefit all, had been furnished in the United States, and this warring of factions, which should be allies, had done much towards retarding the growth of electrical enterprises.

More Power Needed

As Mr. Goodwin viewed it, Ontario is far short of the development she should enjoy electrically. His inquiries had told him that the great bulk of the electricity developed in the province is used in the large centres of population, and even at that, the amount of energy available falls far short of meeting the demands. He appreciated that much of the difficulty was doubtless due to the fact that the demand for electricity had grown during the war, when there were a great many industries engaged in war production, and that since a shortage of power originated during the war, they had never been able to catch up. At the same time, Mr. Goodwin declared that in two years from now, or in ten years, or twenty, or fifty, there will be the same shortage of power, if the various interests insist upon fighting each other. His message, accordingly, was that those engaged in the development of power should look to the future and should plan five or ten years ahead. Particularly did this message apply to the Hydro-Electric Commission, for he pointed out that while the people of different communities may be slow to get the electrical idea, they will be almost insatiable once they get it. The people, as a whole, would have to be educated up to the point of appreciating the value of electrical power, not only for the lighting of their homes and the running of railways, but also for the operation of home conveniences. Going back to the situation in Ontario, Mr. Goodwin repeated that there is still a shortage of power with very little used in the rural districts, and he asked the electrical men present to try to imagine just how great would be the shortage when

the people of the country suddenly became alive to the value of electricity in the home and made their demands. The only possible answer could be greater production.

To the generators of electrical power it might not seem reasonable that they should increase their production when there is not a demand, but Mr. Goodwin declared the experience of the American power companies had taught that it was wise to look ahead; and had taught them that if they looked ahead and educated the public at the same time they would always find that the demand would keep pace with production, if not keep ahead of it. As yet, he added, the electrical industry is only in its infancy, even across the line. He looked forward to the time when all the railways would be electrified, and when that takes place, he declared, it will require more electricity for that use alone than is now used in the whole country. He predicted that the same thing would occur in Ontario, so his appeal to the electrical men was to approach the question not only from the economical standpoint, but also from the standpoint of conserving the nation's supply of fuel. As one simple illustration of the infant state of electricity, Mr. Goodwin stated that electric washers, as home conveniences, should be installed in every household, whereas now they are in less than one per cent. of the homes in the province.

Using Compressed Air for Cleaning Purposes

Explaining How Walls, Ceilings, Windows, Shafting, Electric Motors, Generators, Transformers, Machine Tools, Patterns, Core Boxes, Benches, etc., Can be Quickly Cleaned by Compressed Air

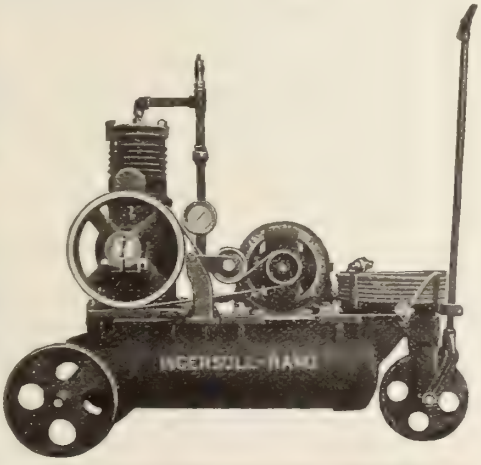
By F. A. McLEAN

THERE are many places in the modern machine shop and industrial plant where compressed air can be appled to considerable advantage for such work as cleaning walls, ceilings, windows, shafting, electric motors, generators, transformers, machine tools, patterns, core boxes work benches etc., as well as for blowing scale from steam hammers, stamping dies, drop presses, etc. One blast of compressed air, properly directed, will instantly clean the cuttings from a bored or drilled hole that would require the expenditure of many minutes' time by the old method of fishing them out with a magnetized file, or a piece of wire, and at the same time the lathe, milling machine, boring mill, or drill press, can be kept entirely free from chips and dirt without the necessity of using a brush or pieces of cotton waste. The equipment is simple and easily installed, and it is usually found that its first cost is quickly absorbed by the reduction in fire hazards and the added convenience and increased efficiency of the plant as a whole.

Most metal working concerns now use electrcity extensively, some operating their own plants, and others using power obtained from central stations or Hydro-electric plants, and it is often found that the motors become clogged up with dust and dirt, causing them to heat up through the reduction of the openings provided by the manufacturer for ventilating purposes, and increasing the liability of burned out coils should they be overloaded at any time, as the additional heat cannot be readily dissipated. Sometimes the motor bearings are oiled too much and the surplus oil gets into the windings, and combines with the dust and dirt to form a mixture whch readily absorbs moisture and shortens the life of the insulation, causing short circuits or grounds to the frame.

While all motors should be cleaned frequently, those installed in foundries and pattern shops, or in places where dust and moisture are always present, should receive more careful attention. Unfortunately, cleaning by hand is often exceedingly difficult, as the ventilation openings are usually too small to admit a brush, and the motors themselves are sometimes located on ceilings or in such cramped places where space in the building is at a premium, that it is almost impossible to get at them without a lot of trouble and inconvenience.

Under such conditions, the air jet has many features which make it of considerable value for this work. In shops where a stationary compressed air power plant is not already in use for operating air hoists, pneumatic tools, sand rammers, etc., a small compressor of the portable, or semi-portable type for belt or electric drive, with a capacity of 3 to 45 cubic feet of free air per minute, at a pressure of 100 pounds per square inch and a receiver holding from 50 to 150 cubic feet, (depending on the amount and frequency of the cleaning to be done), can be purchased at a reasonable price. Where a stationary compressor is already in use it will usually be more convenient to pipe the air about the plant, making suitable openings for hose connections in the various departments where the cleaning is to be done; although in the case of large plants it is sometimes a good plan to use a portable outfit as well. In large plants where there are a considerable number of motors in use, it is a good idea to number them consecutively by means of small brass tags attached to the frames, or by painting the number on the casing. These numbers should then be entered on cards on which a complete record is kept of the date each motor was inspected and cleaned, when it was repaired, and any other information which may seem desirable.

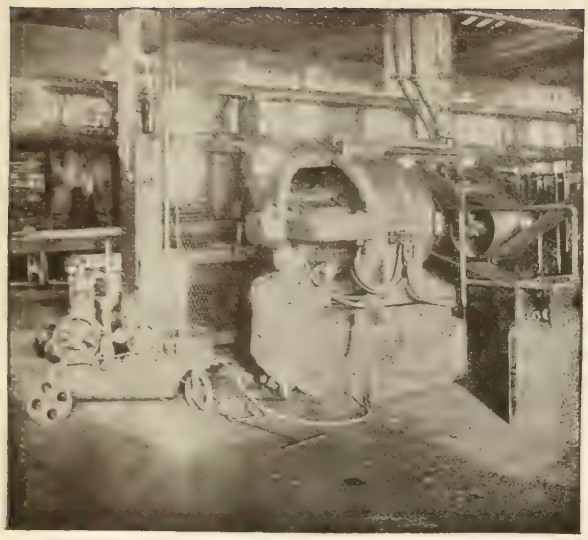


PORTABLE MOTOR-DRIVEN COMPRESSOR OUTFIT.

For blowing out motors and generators, cleaning machine tools, or blowing chips from drilled or bored holes, a nozzle of the blow gun type is the most suitable. The blow gun consists of a solid casting with a metal to metal valve seat, and having no springs, gaskets, or other delicate parts, it is durable, foolproof and not liable to leak. It is shaped in such a way as to lend itself to convenient handling, and the long lever makes it easy to operate, and the short lift ensures prompt closing of the valve when released.

These valves are obtainable with either metal or fibre nozzles of any desired length, the former being suitable for use around machine tools, or general use, while the latter is designed for use on electrical machinery. The principal advantage of this type of valve is, that it does away with the necessity of kinking the hose to stop the flow of air, and operates considerably faster than the ordinary globe valve, with consequent saving in air consumption. In addition to the blow gun it is also possible to buy several styles of self-closing nozzles of more elaborate construction, which work on a somewhat similar principle.

After a motor or generator has been thoroughly blown out it is a good practice to spray the winding with a high grade of air drying varnish, at intervals of six months or a year, depending on



CLEANING A D.C. MOTOR WITH AN AIR JET.

the conditions under which the machine is forced to operate. Before putting on the varnish, which should be applied by a compressed air plant sprayer, it will be found preferable to thoroughly clean the windings with gasoline applied with the paint sprayer, or with a double-barrelled or atomizing nozzle. There are a number of different sizes and styles of paint spraying outfits on the market, and as they can often be used for finishing parts of the product as well as on many other painting jobs around the plant in addition to this work, they usually pay for themselves within a very short time, as the following examples tend to show: From tests made by a large stove manufacturer, it was found that one man with an air brush could paint 100 standard kitchen ranges with air-drying enamel while 30 or 40 were being done by hand. In an electrical equipment factory, a single air brush operator lacquers 3,000 electric light sockets per day, instead of 500 or 600 by hand. With 10 air brushes a maker of brass bedsteads finishes 400 beds daily. An expert hand-painter will enamel from 150 to 200 lamp shades in a day, while, with an air brush, an average workman will turn out from 800 to 1,000 pieces per day.

The outfit illustrated in figure 5 is known as the "Spraco" and has proved very satisfactory in the service of the N.Y.N.H. & H.R.R. for spraying electrical machinery, as well as painting with cold water paints, etc.

The grade and composition of the varnish to be used will depend on whether the motor operates under normal conditions, or is exposed to chemical fumes of either an acid or an alkaline nature. In any case it is best to get in touch with the manufacturer of the motor, giving him an idea of the conditions under which it is used, and then rely on his recommendations in this respect.

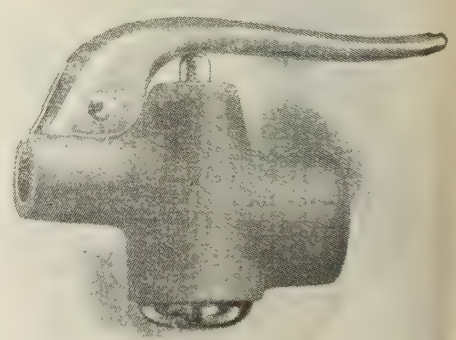
For cleaning motors mounted overhead, ceilings, shaftings, pieces of brass or iron tubing as long as required, may be attached to the blow gun, and since the volume of the air required is not great, the tubing should be of small diameter for ease in handling and economy in air consumption. The end of the tubing may be bent to any desired shape which experience shows to be best suited for a particular purpose. When surfaces of considerable area, such as walls, ceilings, windows, etc, are to be cleaned, a suitable nozzle may be made by bending three or four inches of the tubing at right angles and plugging the open end after a number of small holes have been drilled in the short leg of the ell to form an "air brush." Before using a nozzle of this type, the air pipes should be blown out before attaching the hose in order to prevent dirt or scale in the pipes from clogging the small holes. Nozzles of this style may often be advantageously applied to certain types of annealing and hardening furnace doors, where the men in attendance are exposed to intense heat each time it is necessary to inspect the interior of the furnace. The nozzles are usually placed below the furnace door in such a way that the streams of air rising upward form an air curtain or screen, which effectively protects the operators against the intense heat and prevents the escape of flames each time the door is opened. When used for this purpose the air jet is superior to both water-cooled doors, which only afford protection as long as they are closed, and to exhaust blowers, which subject the workmen to too sudden changes of temperature.

One of the advantages which the air jet has over practically all other methods of cleaning, and which makes it of particular value to a manufacturing concern, is its ability to dislodge dirt and dust while machinery is running, thus keeping the machinery clean, while in no way interfering with its rate of production. While this feature is of considerable value in the metal working plant, it is of even greater importance in some industries, such as textile and paper mills, where the machinery is generally operated 24 hours a day and a few minutes' shutdown every few hours in order to clean the machinery, results in a material reduction in the output per day.

The air pressure required will depend on the nature of the work to be done, 10 to 35 pounds being suitable for blowing light particles or painting motors, etc., while for heavy, oil-laden dust and dirt, pressures of 60 to 100 pounds are more effective. Cleaning is accomplished by the sharp impact of the air upon the material to be removed, and with a suitable pressure this is accomplished as effectively with a small jet as with one of larger diameter. Nothing will be gained by using a large volume of air when a small one will do, as a heavy blast may scatter the dirt instead of merely dislodging it. When cleaning machinery it is advisable to start at the top of the machine and work downward, thus avoiding the necessity of going over any part a second time. It will sometimes be found necessary to instruct the operator how to manipulate the nozzle to the best advantage, so as to avoid blowing the dirt into the bearings of the machine. Should this trouble occur, it may be overcome by employing a lower air pressure. In attaching an air-cleaning nozzle over a machine permanently, care should be taken to suspend it in such a manner that it will not be in the operator's way. It is often possible to hang the hose from a point overhead and toward the rear of the machine, so that it will fall back out of the way when released. The hose should be long enough to reach to the lowest part of the machine to be cleaned, and as it is subjected to considerable wear, it is best to use either the wire wound or armored type, in the 3-8 of an inch size, as this is amply large for most cleaning purposes and is very easily handled.

It sometimes happens that employees who have not been properly instructed, remove the cleaning nozzles, thinking that they will be able to do better cleaning. Others will enlarge the opening in the nozzle by filing, with consequent increase in the air consumption, as may be readily understood by reference to the accompanying table. These troubles may be prevented by placing a reducer in the air supply line, or inserting a hardened steel bushing in the tip of the nozzle. The most effective way of combating these abuses, however, is to instruct the operators carefully and then see that these instructions are carried out.

The air as taken from the ordinary receiver is usually in satisfactory condition for ordinary cleaning purposes. Where some of the older types of compressors are in use, however, oil is used.

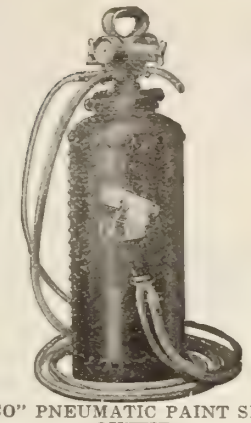


A CLEANING NOZZLE OF THE BLOW GUN TYPE.

too copiously in the air cylinder, resulting in small particles of oil being blown from the nozzle. For ordinary cleaning around the shop this is not objectionable, but for use on fine work, or when cleaning surfaces which are to be painted or varnished, and in textile and paper mills, it is necessary to have the air absolutely free from oil. An oil separator placed in the supply line will remove practically all of this oil, and when it is desirable to thoroughly clean the air, it may be passed through muslin or other light cotton cloths as well.

When cleaning motors before varnishing, and on some other classes of machinery, it is best to use a double-barrelled nozzle, the upper tube of which is connected to the air supply, and the lower by a piece of flexible tubing to a tank containing gasoline, oakite, or some other form of cleaning solution, thus effectively cleaning parts of a machine which could not otherwise be properly cleaned by either method alone.

In factories operating on steam power, compressed air may be readily used for blowing soot and dirt from the boiler flues, etc., for which purpose it will be found much more convenient than steam. The necessity of keeping the heating surfaces of the boiler free from soot is of especial importance when the present high cost of fuel is taken into consideration, as a layer of soot 1-32 of an inch in thickness will reduce the efficiency about 9½ per cent., while, if this accumulation reaches a depth of as much as ¼ inch, the reduction in efficiency will be 80 per cent. or more. When steam is used for cleaning the boilers the water of condensation is usually an objectionable feature, and it is necessary to use heat-proof hose, or insulate the nozzle in some way, so that the operator will have no difficulty in holding it. The ease with which an air hose may be handled, and the absence of moisture in the jet, makes the job much cleaner, and as it facilitates quick work, the men responsible for the care of the boilers feel more inclined to clean them frequently, with consequent increase in the amount of steam produced from each pound of coal consumed.



"SPRACO" PNEUMATIC PAINT SPRAYING OUTFIT.

When at first glance the cost of installing a pneumatic cleaning system may seem unwarranted, this is, however, not the case, as the correct basis for figuring the relative cost and value of the equipment should be the saving that can be effected by its use rather than the actual amount of money involved in its installation and maintenance.

The increase in production which results from the ability to keep the machinery in the plant thoroughly cleaned while it is in operation, will often pay the cost of supplying the air, and at the same time pay a good rate of return on the money invested in the necessary equipment. In many plants where compressed air cleaning systems have been installed, new uses for the equipment have been discovered, which were not thought of at the time the installation was made, and larger outfits have been purchased, as a result of the good service rendered by the smaller units.

FLOW OF AIR FROM A RESERVOIR THROUGH AN ORIFICE

IN CUBIC FEET OF FREE AIR PER MINUTE FOR VARYING DIAMETERS OF ORIFICE AND GAUGE PRESSURES

Diameter of Orifice Inches.	Receiver Gauge Pressure.								
	2 lbs.	5 lbs.	10 lbs.	15 lbs.	20 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
1/64	.038	.0597	.0842	.103	.119	.133	.156	.173	.19
1/32	.153	.242	.342	.413	.485	.54	.632	.71	.77
1/16	.647	.965	1.36	1.67	1.93	2.16	2.52	2 80	3.07
1/8	2.435	3 86	5.45	6.65	7.7	8.6	10.	11.2	12.27
1/4	9.74	15 40	21.8	26.70	30.8	34.5	40.	44.7	49 09
3/8	21.95	34.60	49.	60.	69.	77.	90.	100.	110.45
1/2	39.00	61 60	87.	107.	123.	138.	161.	179.	196.35
5/8	61.00	96.50	136.	167.	193.	216.	252.	280	306.80
3/4	87.60	133.	196.	240.	277.	310.	362.	400.	441.79
7/8	119.50	189.	267.	326.	378.	422.	493.	550.	601.32
1	156.	247.	350.	427.	494.	550.	645.	715.	785.40
1 1/4	242.	384.	543.	665.	770.	860.	1000.		
1 1/2	350.	550.	780.	960.					
2	625.	985.							

	45 lbs.	50 lbs.	60 lbs.	70 lbs.	80 lbs.	90 lbs.	100 lbs.	125 lbs.
1/64	.208	.225	.26	.295	.33	.364	.40	.486
1/32	.843	.914	1 05	1.19	1 33	1.47	1.61	1.97
1/16	3 36	3.64	4.2	4 76	5.32	5.87	6.45	7.85
1/8	13.4	14.50	16 8	19.0	21.2	23.50	25.8	31.4
1/4	53 8	58.2	67.	76.	85.	94.	103.	125
3/8	121.	130.	151.	171.	191.	211.	231.	282.
1/2	215.	232.	268.	304.	340.	376.	412.	502.
5/8	336.	364.	420.	476.	532.	587.	645.	785.
3/4	482.	522.	604.	685.	765.	843.	925.	
7/8	658.	710.	622.	930.	1004.			
1	860.	930.						

TABLE SHOWING FLOW OF AIR.

W. L. ABBOTT JOINS HAYS' SCHOOL OF COMBUSTION

The Hays School of Combustion announces that Mr. W. L. Abbott, Chief Operating Engineer of the Commonwealth Edison Company, Chicago, has associated himself with the Hays Course in Combustion Engineering as Reviewing and Advisory Editor.

Mr. Abbott is widely known for his contributions to engineering literature and his eminent position in the power plant operating field. His co-operation with the Hays School in the training of Combustion Engineers adds weight and authority along practical operating lines to the teachings of the institution and rounds out the faculty, which includes beside Mr. Joseph W. Hays, the author of the course, the following men who are well-known in combustion lines:

Joseph Harrington, Fred R. Low, David Moffat Myers, Professor S. W. Parr, Arthur L. Rice.

The Hays School is fortunate in being able to secure the co-operation of men of such standing without remuneration of any sort. These men recognize the need of training for the cause of fuel conservation and are contributing their services without any charge. This enables the school to distribute the course at a comparatively low cost to the student.

A great interest is being shown in this work and men in every conceivable position related in any way to the use, handling or purchase of fuels, from all parts of the country are enrolling in large numbers. Power plant executives and public utility operating concerns are joining in the effort to advance the cause by making it possible in many cases for their employees to secure training at the expense of the company .

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol XIII. TORONTO, Jan. 20, 1920 No. 2

PRINCIPAL CONTENTS

Electrical Energy Generating Stations 25
Protecting Boiler Drums From Overheating 29
The Principles of Heat and Thermo-Dynamics 31
Using Compressed Air for Clearing Purposes 37
Editorial 40
The Terrific Punch of a Small Boiler 41
New Equipment 42
Operators' Point of View 43
Selected Market Quotations 38

Something For Nothing

IN THESE days of high fuel costs it is no cause for surprise that consumers will carefully study any means of getting better results from the fuel they use. There is plenty of room for legitimate methods of fuel conservation, the efficiency of the average steam plant being of a very low order. Unfortunately, the situation also gives opportunity to the charlatan who is anxious to benefit humanity by a wonderful preparation, which gives heat value by being merely sprinkled on the fuel. The peculiar part of it is that they are able to not only sell the stuff to supposedly hard-headed, though frequently gullible business men, but to get signed statements claiming that the stuff does what it is supposed to. These quacks and their fuel-saving nostrums appear from time to time in different parts of the country. They flourished a brief space and vanish, only to re-appear far from the scene of their former labors.

The basis of all fuels is carbon. The composition of coal is carbon, hydrogen, oxygen, nitrogen and ash. The proportion of carbon varies with different coals, but may be taken as being from 75% to 90% of the total. The heat value of coal, which means the heat available from the combustion of one pound of coal, is anywhere from 9,000 to 14,000 British thermal units, depending on the relative amount of carbon, hydrogen and ash. Oil fuel has a higher heat value than coal, owing to it being without any ash content. It runs as high as 22,000 British thermal units to the pound.

In a recent case we have seen, the vendor of one of these heating compositions claims, by the use of his preparation, to have raised the heat value of the fuel by 50%, and have lowered the ash content of the fuel. Now the ash content of a fuel cannot be lowered. It is there. What may happen is that some ash will fuse at a lower temperature than others, and a higher proportion of unburned carbon may be carried off by it. Providing that the furnace was working at its best efficiency, the only way that heat could be added to the fuel would be by adding some chemical of a tremendously high heat value. Hydrogen has the highest heat value of any chemical, and that is already contained in the coal, and furthermore, could not very well be applied in the form of a solution. Common salt will make a pretty flame when thrown on the fire, but the added heat is nil. In fact, it will probably extract heat in changing its state. There is nothing to back up the claim of added heat value in the case we mention that would receive any consideration from an engineer. If anyone comes to your factory trying to sell a compound that will cut the coal bill in half, insist on him bearing the expense of a properly conducted evaporation test by an independent engineer of recognized ability. If the seller is willing to do this, then enquire into the cost. If anyone buys a cheap compound, or a dear one, for that matter, with the idea he is going to save half his fuel bill, or one-quarter of it, he must be of a highly susceptible nature, and a good subject for a gold-brick artist.

The Future of Electricity

THERE is food for thought in the statement made by U. L. Goodwin, at a recent meeting in Toronto, that it was doubtful if the generation of electricity could keep pace with the demand. Two years from now, or in ten years, or in twenty or fifty, there will still exist the same shortage of power if far-seeing plans are not laid for the future. The time will undoubtedly come when every source of waterpower available at a reasonable cost will be utilized, and that to the utmost.

Reasoning from the above statement it will be possible to predict the changing nature of stationary engineering and to realize how important a knowledge of electrical engineering will be to the stationary engineer.

Steam power will never be entirely superseded, for there is no more economical way of generating power when the exhaust steam can be utilized for heating and other purposes. Many industries throughout the country still retain their steam plants, and many of the newer ones are installing up-to-date equipment of this nature in their power plants, but, in almost all the newer installations of any size the power, no matter how generated, is transmitted by electrical means.

This affects the operating engineer, and it is necessary for him to learn something of the operating characteristics of electrical machinery. He need not know how to design a generator or transformer (only a few in the electrical profession can, it is their job), but he should have a sound grasp of the fundamental principles and should be able to operate and care for the apparatus under his charge intelligently.

His knowledge of this subject should be of a similar nature to that possessed on steam engineering. The designing of a boiler or engine is seldom done by the operating engineer, but no one knows better than he how to operate them.

The Terrific Punch of a Small Boiler

Explosion in Small Shop Where Vulcanizing Was Done Opens Up a Question of Interest—Terrific Power Released Does Great Damage

By T. H. FENNER

IF there are still sceptics on the subject of the dangers of small vessels containing water and steam under pressure and temperature conditions it is surely not through lack of object lessons.

The latest of these demonstrations occurred in Toronto very recently, much to the detriment of the building in which it occurred. Fortunately, or we might say, almost miraculously, it was not accompanied by any loss of life or limb. The case referred to was the explosion of a small cast-iron vessel used for vulcanizing automobile tires, and it was situated on the second floor of a garage and service station on Jarvis Street, Toronto.

The apparatus consists of a cast-iron vessel of square cross-section in the lower part, the upper part being made a semi-circular shape, to conform to the shape of the tire. There are three sections, so that three tires can be handled at once, and the vulcanizing is performed by the heat of steam circulating round the inner surface of the moulds. This steam is generated from the water contained in the lower portion of the apparatus, and the necessary heat is applied by a gas flame on the bottom. The lower part, which is practically a cast-iron boiler, is filled with water through a funnel, and holds probably 50 lbs. of water. After filling, the funnel is removed and the hole plugged. A safety valve set to blow off at about 40 lbs. per square inch, and a steam gauge are fitted.

Where the Valve Stops Work

The pressure used will, of course, never exceed the pressure at which the valve is set, unless something prevents the valve from working. Evidently something of that nature happened in this case, for while the attendant, fortunately for himself, was temporarily absent, an explosion occurred. The result was the complete demolition of the vulcanizer itself, the shattering of every window on the second floor, and the splitting of the front wall of the building from top to bottom.

A very respectable effort for a couple of pails of water, was it not?

As a bystander remarked, one would wonder how such a little thing could do such enormous damage. However, a little study will dispel the wonder, and probably bring home to many more or less complacent users of boilers the nature of the forces they are handling.

We may fill a boiler, or other vessel, with water and then, by means of a pump, produce pressure high enough to rupture the tank. No explosion happens. Why? Because there is no latent energy contained in the water to cause one. The vessel ruptures, and the pressure disappears. The energy contained in the water has been used up in overcoming the resistance of the material to rupture. That is why testing of boilers is always done by means of hydraulic pressure. Water being practically incompressible, a stroke or two of the pump is sufficient to increase the pressure after the vessel is once filled.

But When Heat is Applied!

Now, let us take a vessel, and partially fill it with water, which we proceed to heat, until some of it evaporates, and steam is formed. Instead of the water possessing no latent energy it will possess an enormous amount. To raise one pound of water one degree requires one heat unit, and this heat unit represents the same amount of work as the raising of 778 lbs. one foot high. In other words, the heat unit, known as the British Thermal Unit equals 778 ft. lbs. Now, to change one pound of water at 40 degrees Fahrenheit into one pound of steam at 40 lbs. per square inch gauge pressure requires approximately 1,161 B.T.U's, equivalent to 903,258 ft. lbs., or energy sufficient to raise 1,000 pounds 903 feet high. Now, to come back to our little vulcanizer, which seemed so small as to be harmless. Assuming it held 50 pounds water, and 10% of this had become steam at 40 lbs. per square inch gauge pressure. We would have 5 lbs. steam containing 5,805 B.T.U's. We would have 45 pounds of water at 40 lbs. pressure, the temperature corresponding being 285°F.

Let's See Just What Happens

As the initial temperature of the water is taken at 40°, the quantity of heat in the water would be $45 \times (285-40) = 45 \times 245 = 11,025$ B.T.U. Now, we can neglect the energy lost in breaking the vessel, as we have no means of estimating it, and we will assume that all the energy of the steam and water is available to do its worst to whatever obstructs it. Steam occupies, roughly, 1,600 times the volume of the water from which it is formed at atmospheric pressure. The first thing that happens when the vessel breaks is the reduction of pressure. Now, the water, which is at a temperature of 285° at 40 lbs. pressure, is considerably above the temperature of steam at atmospheric pressure. Therefore, a considerable amount of water will become steam, and will want to increase its volume 1,600 times when it does so. Let us see how much. We have available altogether $5,805 + 11,025 = 16,830$ B.T.U's. Each pound of water in becoming steam at atmospheric pressure will absorb 966 B.T.U's. Therefore, 16,830 divided by 966 will give us the amount of water that becomes steam at atmospheric pressure, roughly, 17½ lbs. One pound of steam at atmospheric pressure contains 1,146 B.T.U's, and 17½ lbs. contains 20,055. All this heat energy is available to remove anything that wishes to prevent the expansion.

See What We Have Now

Translated into foot pounds, the energy is 15,602,790. That is, enough to raise 7,800 tons one foot high, or 1 ton 7,800 feet high. The volume of 17½ lbs. steam at atmospheric pressure is 460.25 cubic feet. That means that in order to occupy that volume that much air had to be displaced, and anything that tried to confine it had to go. Luckily there were plenty of windows, which yielded easily, but not enough, as witness the broken wall. It is no wonder that the place looks as though it had been struck by a shell.

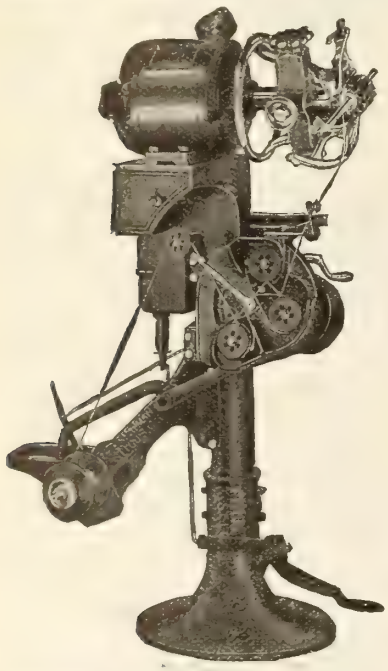
Do not despise the boiler because it is only a small one!

TEN times as much alcohol to be used under prohibition than formerly. This is the prognostication of a member of the American Chemical Society, at a symposium held on the question of alcohol. However, this quantity will not be made up into seductive cocktails, or sympathetic gin rickies. It will be used to propel vehicles, boats, and other power-users when the petroleum supplies become less. There are a number of new sources for the supply of alcohol, one of them being the nippa palm. This palm yields about 15% sugar, which can be fermented. This source alone would give 50,000,000 gallons of alcohol a year.

Progress in New Equipment

NEW ARMATURE WINDER

The P. E. Chapman Electrical Works, of St. Louis, Mo., announces a much more complete model of the Chapman Adjustable Bipolar Drum Armature



GENERAL VIEW OF THE WINDER.

Winding Machine, in their style 3 as shown herewith. This model in addition to being adjustable in a few minutes for any style and size of random wound bipolar drum armatures and any size of wire from No. 20 to No. 36, has some special features enabling it to wind a very great amount of wire into armature slots without pounding the wire, and also has some unique lead forming and handling features reducing the labor on this part of armature winding.

Driving motor, controller, turn counter and other necessary parts are all integral parts of the machine, in fact, the machine is complete in itself.

A new automatic dynamometer controlled real holder and tension device has been perfected, which it is claimed stops all spool troubles and enables quick starting, high speed, great tension and quick stops, so that only about five seconds are required to wind in a coil. This reel holder and tension device are simultaneously adjusted for any sizes of wire by a simple crank, and once adjusted needs no further attention until reel is empty. It is said the announcement of this device has been held back long enough to prove the machine a success in actual practice. In one case an output of nearly 600 per day was obtained where the estimate was 200 to 250. It is claimed that the output of the machines runs into hundreds of armatures per day on many sizes and kinds of armatures; that the saving over hand winding usually is anywhere from 10 to 30 to 1 or even better. It is claimed that the machine is easy to operate, well and strongly built; that it is useful both in the job shop and in the factory. The machine is also useful for winding field coils, smaller armature coils, etc.

ELECTRIC WATER HEATER

The Bridgeport Machine & Tool Mfg. Co., Inc., of Bridgeport, Conn., have recently placed on the market an electric heater which can be used for the heating of water in factories, etc.

This device claims the following features: Clean, sanitary, and sterilized hot water, boiling hot if you desire, instantaneously, then natural cold water through the same faucet. A double valve faucet does not allow the cold water to pass over a red-hot resistance element. The same device will operate on either alternating or direct current.

To install, first remove the ordinary faucet and mount the Geyser. It is equipped to take standard ½-inch pipe. The name plate designates the voltage and amperage, which is all that is necessary to ascertain the proper size wire to be used for connecting direct from the meter to our device.

BRIDGEPORT WATER HEATER

The two voltages supplied are their

110 Volt	60 Amp.
220 Volt	30 Amp.

but they can supply any voltage desired.

COMMISSION OF CONSERVATION, OTTAWA

[Tenth Annual Report]

Students of Canada's resources and of the problems associated with their efficient development will find a serviceable addition to the literature on this subject in the tenth annual report of the Commission of Conservation.

A concise review of the year's work is furnished by Mr. James White, assistant to the chairman. A series of unusually informative contributions includes "Housing, Town Planning and Municipal Government," by Mr. Thos. Adams; "Medicine in War," by Dr. C. A. Hodgetts; discussions of various phases of forest conservation, by Mr. Clyde Leavitt, Dr. C. D. Howe and Mr. Roland D. Craig; and of agricultural investigations, by Mr. F. C. Nunnick. Particularly timely studies of the water-power and fuel situations in Canada are presented by Messrs. Arthur V. White and Leo G. Denis.

This publication will not disappoint the very wide circle of readers to whom it affords an instructive annual resume of problems and progress in respect to the intelligent use and study of our natural resources.

NEW PUBLICATION ON UNDERFEED STOKERS

The "Westinghouse Underfeed Stoker" is the title of a 36-page, 8½ x 11-inch booklet, with an attractive three-color cover, just issued by the Westinghouse Electric & Manufacturing Company.

Under the head of "Details of Construction," it gives a comprehensive description of the leading features of design contributing to the efficiency and reliability of operation. The interconnection of grates and tuyeres and the arrangement of brackets, gears and fuel deflecting plates, are clearly described.

The subjects of "Efficiency" and "Capacity" are taken up together with "Flexibility." Curves setting forth extensive performance data relative to these subjects and others are used to amplify the text.

The Operators' Point of View

GRADED CERTIFICATE CORRESPONDENCE

The Editor:

In your issue of November 20th appeared a letter signed by Chief regarding graded certificates, and a reply to a letter signed Justice. I am opposed to granting certificates in any form to any engineer that is afraid to write on examinations. Chief stated in his letter that Justice was a would-be engineer and a Bolshevik. I am very much surprised to hear Chief express himself in such a manner to a brother engineer. Justice states that some engineers understand engineering from the letter A to the letter Z. Such engineers should not be afraid to write on examinations, and I do not see where graded certificates are going to be of any use to the engineers of Ontario if certificates are going to be granted to men or engineers without writing on same. If such is to be the case, why not give us all firsts and seconds. School teachers and professional men do not get certificates without writing on examinations. Engineers are carrying very responsible positions, where they are responsible for the lives of hundreds of employees. I think very strongly on the same lines as Justice No. 2. If engineers want certificates to hold down the big jobs, let them get down to business and write for their exams., and not try to get them from the Government on the excuse of not being able to figure out the technical points in the graded certificates. As for myself, I have held both hoisting and stationary certificates since 1912 and I feel that I have still a lot to learn about engineering, but I am not afraid to try and get a higher graded certificate than I was able to obtain at first. AN ENGINEER.

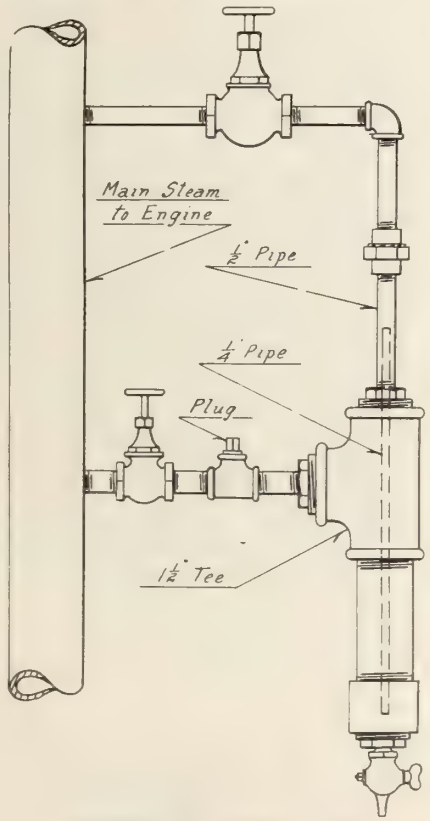
HOME-MADE LUBRICATOR

I see many hints well worth while in "Power House." I am passing along one which you may find to be worth while.

The parts are in most storerooms, and if not, the local hardware usually stocks the fittings. It is the best substitute I have seen for the purchased lubricator.

Half-inch pipe was used, and quarter-inch was forced into the half-inch, after the bushing was on the half-inch pipe to prevent it bursting. The small pipe was made long enough to go up the half-inch pipe a piece, and to reach almost to the bottom of the 1½-in. nipple and coupling. It was not a steam-tight fitting by any means, but it did the job.

The plug in the ½ in. tee is for filling, and if the valves are regulated closely one filling will last two to three hours (the lower valve should be opened first), and water will condense as in up-to-date articles. Any size fittings would do; I used the sizes specified in the sketch.



EXTERIOR OF POWER PLANT

Some time ago I had considerable trouble with packing for a plunger working in coal oil and gasoline. I had some good packing but it was not just the right kind apparently.

An old head told me to get some soap and moisten it until it was soft and slimy, then take candle-wicking or asbestos and draw over the soap until the soap was well worked in. I used this and have had no further trouble. Of course, good packings of all kinds are usually in stock, but sometimes a fellow gets caught. A. O. STONE.

SHOULD VALVES BE SET WITH NO LEAD?

There has been some correspondence in the "Marine Review," of Cleveland, relative to the question of lead on marine engine slide valves.

The first letter published was from Mr. Harry Stone, and appeared originally in "The Bulletin" of the Lake Carriers' Association. Mr. Stone argued that lead on a slide valve was not only of no advantage, but a detriment. He spoke of the result of excessive lead being the pushing back of steam to the boiler by the piston. He also claimed that by eliminating lead a smoother running engine could be obtained, and the revolutions increased. He goes on record as being distinctly opposed to lead, and claims that all text-books which advocate lead, and all teachers who uphold it, are fundamentally wrong.

This letter brought forth a reply from S. H. Hunter, a veteran engineer of the Great Lakes. Mr. Hunter, while agreeing that excessive lead is detrimental, suggests that to get the best results, negative lead, or no lead at top, with ample lead at bottom, is required. He draws attention to the obliquity of the connecting rod affecting the equal distribution of steam at top and bottom ends of the cylinder. He also states that he would like some more reasons from Mr. Stone as to why he is opposed to lead.

Looking over these two letters, it would seem to the writer that both gentlemen had overlooked the fundamental object of lead. Lead is given to a valve primarily to eliminate the wire drawing, which would occur if the valve started to open at the same instant as the piston began its stroke. It must be borne in mind that the piston has travelled a considerable portion of its stroke before the maximum port opening is attained. That is the reason for adopting poppet and Corliss valves in stationary engines. They have the faculty of quick opening, thus tending to keep the admission line on the indicator card a straight line till cut-off takes place. Now, in considering lead of a slide-valve the two gentlemen have evidently neglected the fact that the edge of the valve which governs lead also governs cut-off. Therefore, in raising the valve up so as to obtain negative lead on top, they hasten the cut-off and reduce the maximum port opening. The inside edge of the valve which governs the exhaust has also been raised, and what happens then? Release takes place earlier and compression later. The effect would be in an engine of usual design a very much distorted card, with

a by no means equal steam distribution. As regards the piston pushing the steam back into the boiler, the writer cannot conceive of such a happening. The aim striven for in most engines is to have the compression pressure rise to that of the receiver pressure at the instant the valve opens to admission. This is shown on the indicator card by the compression curve running smoothly into the straight line. As the pressure in the boiler is always appreciably higher than that in the receiver, there can be no pushing back. If we have excessive lead, which also gives late exhaust release and excessive compression, there is a temporary rise of pressure above the receiver pressure, forming a loop at the top of the card. The result of absence of lead would be the very quick drop of the steam admission line from the commencement of the stroke, with a corresponding reduction of area of the indicator card. This means less work and less revolutions.

A certain amount of cushioning is necessary, both to check the inertia of the moving parts and to fill the clearance space with steam. If this is not done, the clearance must be filled with live steam, a dead loss. The functions performed by the steam and exhaust edges of the valves should be differentiated, and excessive compression should not be confused with excessive lead.

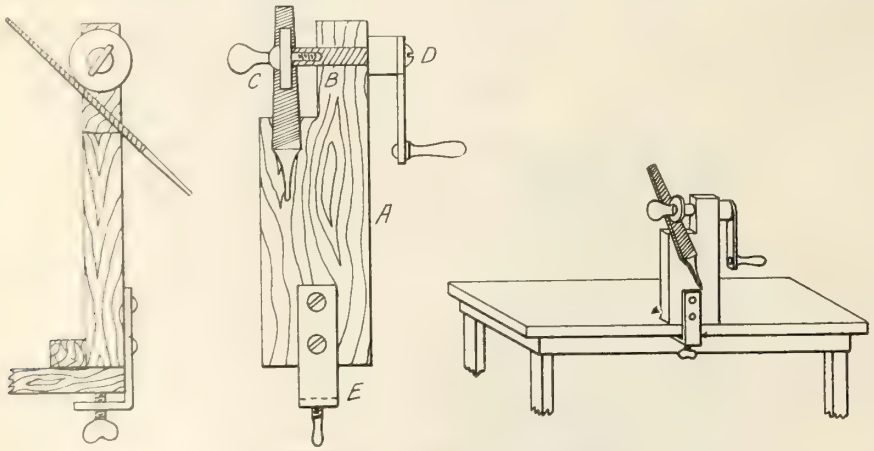
Correspondence on this question will be welcomed.—Editor.

TRIMMING DEVICE FOR WASHERS

The illustration shown is a simple device made from the spindle of a discarded tap for trimming water-tap washers to proper size when they are too large. In many institutions where a great number of taps are in use and of many different sizes, it is quite difficult to have always on hand the exact size to fit them all, making it necessary to trim them down to fit. It is almost an everyday occurrence to renew several washers, and many are made of such hard material that it is very difficult to cut or trim with a knife. They are also a very awkward thing to hold in the fingers to trim and will be a poor job when done. Take a piece of board about 7 in. long, 1 in. thick, 2½ in. wide, cut to the shape shown at A. Bore a hole through the board at the top the size of the spindle with the small end extending ½ in., as shown at B. The washer is fastened to the end of the spindle with a screw to which a small wing handle is soldered, as shown at C. The handle is made of a piece of light flat iron fastened to the other end with a screw, shown at D. The article is fastened with a clamp to a table or bench, or may be fastened to the wash basin or sink if there is nothing else at hand. By holding a file against the washer underneath as shown, and turning the handle, it is quickly and neatly trimmed to the desired size. This little article is not expensive and is easily made, and will be found very useful where there is work of this kind to be done.

J. O. McDONNELL.

Toronto.



TRIMMING DEVICE FOR WASHERS.

1920 CONVENTION OF C.A.S.E.

The 31st Annual Convention of the Canadian Association of Stationary Engineers will be held in Woodstock, June 22, 23 and 24, 1920. In connection with the Convention, the Annual Exhibition of Power Plant Equipment and Supplies will be held.

The industrial development of Ontario has been unprecedented. Numerous new factories are being erected, which will require hundreds of thousands of dollars' worth of equipment, and older factories are extending to adequately take care of new business.

Committees are at work advertising the Convention, and great interest is already being manifested in it.

Any information regarding the Exhibition held in connection with the Convention of Engineers will be cheerfully supplied by the Secretary.

The Editor—It appears to me, when reading the Stationary Engineers' Act, that any employer can hire any man as fireman for six months and at the end of that term discharge No. 1 man and hire another; what advantage has No. 1 fireman in paying five dollars for a certificate, or what is the necessity of it? Information will be gladly received by me through POWER HOUSE.

ENQUIRER.

ENGINEER WINS PLACE ON BOARD OF WATER COMMISSIONERS

The engineer for many years has been content to take a back seat and to let others do the governing of the country. This, needless to say, has been a mistaken inaction on his part and one very much to the detriment of his own interests. The engineer, too, is capable of bringing much of experience and knowledge to bear on the subject of government. municipal or otherwise, and in many cases could replace those of a legal

DAVID L. WEBSTER

turn of mind to advantage.

It is refreshing to note that one city at least in Ontario — Brantford — has now an engineer on the Water Commission.

The many friends of David L. Webster, formerly chief engineer of the waterworks pumping station of the same city, will be glad to learn that he has been successful in contesting the election for this position.

Mr. Webster based his campaign upon the advisability of electing a man who was a trained mechanical engineer, who had years of practical experience, and who knew the waterworks plant thoroughly. It was also contended that a number of costly mistakes had been made in the installation of new equipment and in following the advice of outside engineers not thoroughly acquainted with the system.

D. L. Webster was formerly engineer at the waterworks plant, suceeding his father, the late David Webster, who was for thirty-five years in charge. The son took up a course of study in mechanical engineering at McGill after leaving the public schools and Collegiate in Brantford, later being employed in the machine shop of the Waterous Engine Works. Mr. H. F. Morris secured the contract for the filtering galleries at the Brantford waterworks plant, and engaged Mr. Webster. In 1910 the water commission secured his services, appointing him to succeed his father on the latters' death.

Mr. Webster, since leaving the water-

works system as their engineer, has been engaged in a consulting practice. He is second vice-president of the Canadian Association of Stationary Engineers.

J. H. Williams & Co., makers of Superior Drop-Forgings and Drop-Forged Tools, with works at Brooklyn and Buffalo, N.Y., have just issued a catalog—4x6—106 pages, fully illustrating and describing their standard stock specialties. These include several lines of new goods, viz: "Agrippa" Turning-Tool Holders, Set Screw Pattern, "Agrippa" Boring-Tool Posts, "Vulcan" Forged Cutter Tool Holders and several new assortments or sets of Drop-Forged Wrenches. The book contains, also, a description of the drop-forging process in very simple, non-technical terms for the benefit of those not conversant with its details.

The American Steam Conveyor Corporation, Chicago, announces that the Atlas Machinery and Supply Company are now handling the sale of the American Steam Ash Conveyor in their St. Louis territory. This company has offices at 1416 Syndicate Trust Bldg., St. Louis, Mo., and is a new sales organization in that vicinity.

It is headed by Mr. Wm. H. Patton, who recently returned to the United States after two years' service in the army, during which time he was in nine branches of the service, gaining experience of great practical value.

The Link-Belt Company have issued Book No. 375, dealing with labor-saving elevators and conveyors. Bag pilers of various types are shown together with bag conveyors and telpherage systems. Bale and barrel handling equipment is also described, together with conveyor systems for other forms of containers, such as bottles, rolls, bags, etc. Book No. 380, also just recently issued, deals with electric hoists and overhead cranes. This book is also fully illustrated and descriptive of the use of this class of apparatus in general industry.

BOOK REVIEW

The Coal Consumption of Power Plants and Bonuses for Coal Saving, by Robert H. Parsons. Price 1/- net. The Electrical Review, Ltd., 4 Ludgate Hill, London, E.C. 4.

This monograph of 23 pages, as its name indicates, is devoted to a most important phase of power plant management. It has been written with a view to presenting in handy form the method of establishing and utilizing standards of power plant efficiency devised by the author and used with success. In many large power stations a continuous check upon the efficiency of their operation is now maintained by the method advocated.

The Quigley Furnace Specialties Company, New York, have issued two Bulletins on "Powdered coal flows like water" and "The Quigley powdered fuel system." The former is descriptive of the compressed air transport system used by this firm, while the latter is of a more general nature. Both contain valuable information concerning this type of fuel-burning apparatus.

THE CANADIAN GENERAL ELECTRIC CO.

Have issued Catalogue No. 20 for 1920-21. The matter has been carefully arranged and indexed, and the volume will be found ont of the most complete and reliable guides available on high-grade electrical supplies.

A Real Service to Engineers

IT is good to have come to our ears words of praise from readers of POWER HOUSE, and many such intimations of satisfaction reach us these days. It is pleasing to note the large number of readers who remark that it is not only in the editorial pages but also from the advertising pages that considerable information may be gleaned.

> It is the policy of POWER HOUSE to advocate "efficiency in power plant equipment and service" in the editorial pages, telling "how" and "why" this or that ought to be done, and then through the advertising columns directing attention as to "what" to do it "with."
> The "advertised" way is the better way—because by advertising the chip is placed on the shoulder!

One subscriber told us recently: "POWER HOUSE journal has solved many a problem for me. I wouldn't miss reading POWER HOUSE from cover to cover for the world." More of our engineers and apprentices could very well profit by this tip. Subscribe for and read POWER HOUSE, 'twill make better conditions of mind and ideas for personal development on the job.

Now, we thank all our readers for their good words—to us.

But—we do want you to tell the other fellow, too. It's only by so doing that the real service of POWER HOUSE can be extended.

The subscription price for POWER HOUSE is now two dollars per year. The journal is issued twice a month.

Saves Money—Saves Steam—Saves Time

The Steam Trap Sarco saves money--because it costs but one-third as much as cumbersome float or bucket traps.

It saves steam because it positively does not leak.

And it saves time because it is so easy to install and operate. No supports, building up, pit digging or floor space required. Simply put it at any angle anywhere on the line. It has no complicated system of floats, valves and other parts to get out of order and require constant adjustment.

The Steam Trap Sarco is a simple, compact Steam Trap that does its work efficiently and promptly. It releases condensate as soon as it gathers. Lines are kept drained of all condensate all the time. It requires no storage space. It works on the simple, unfailing thermal principle of expansion and contraction. It has but one moving part and that is practically free from wear.

Made in sizes from 3/8 to 3" for any given pressure up to 200 lbs.

Write today for a Sarco on 30 days' free trial and interesting Booklet "J."

Sarco Company, Inc.

239 Broadway, New York City

Ellicott Square, - Buffalo
Majestic Bldg., - Detroit
Williamson Bldg., Cleveland
Monadnock Bldg., Chicago
Drexel Bldg., Philadelphia
Peacock Bros., - Montreal

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Add 5% to list above.

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 67	99 74
	Standard	Lapweld
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 75
Steel bars, base, Toronto....	4 75
Steel bars, 2" to 4" base.....	6 00
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 75
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$7 00	$6 75
Sheets, Black, No. 10..	6 50	6 50
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.		9 25
Premier, 10¾ oz.....		9 65

PROOF COIL CHAIN B

¼ in.	$13 00
5-16 in.	11 00
⅜ in.	10 00
7-16 in.	9 80
½ in.	.....
9-16 in.	.....
⅝ in.	.....
¾ in.	.....
⅞ in.	9 20
1 in.	9 10
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.....	....
Royalite, per gal., bulk.....	22½
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.....	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$	2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and leg screws.....	30
Stove bolts	50
Plate washers	50
Machine bolts, 7-16 and over	10
Machine bolts, ⅜ and less..	20
Blank bolts	25
Bolt ends	10
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex., blank.....add	1 75
Nuts, hex., tapped.....add	2 00
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	43
Emery Cloth .....list plus	37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.....	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 11
Wood alcohol, per gallon...	2 00
Whiting, plain, per 100 lbs..	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$	42 50	$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1'' rd..$	0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING.

Standard	10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Plaher bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	80
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

METALS

Lake copper .....$	24 25	$25 00
Electro copper	24 00	25 00
Castings, copper....	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided .....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila....	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.

JACKLIFT

—your way to lower labor costs and bigger profits

It can be done—that's why every pulp and paper mill in the United States is using the Jacklift and the platform system for handling pulp and paper. And now the Jacklift is being made in Canada for Canadian Pulp and Paper Manufacturers and other manufacturers who wish to reduce their inside trucking costs.

The Jacklift and platform system in your plant means the easier handling of loads, the quicker movement of materials, less labor, greater economy and less possibility of accidents or damaged materials.

Four Vital Points of the Jacklift

High Lift

A clear lift of 2½ inches by four easy strokes of the handle operating an ordinary jack.

Easy Lift

Four times the handle moving means a lifting ratio of 1 to 35. A girl or boy can easily handle one of these machines with heavy loads.

Angle Lift

The handle will operate at any angle up to 90 degrees as easily as straight away. This, as all of our salesmen know, is impossible with any other truck.

Straight Lift

The Jacklift rises and lowers the load in a straight line—a great convenience, as every other truck operator will tell you.

These four vital points, not contained in any other truck, place the Jacklift in a class away above all competition, and yet the price is practically the same as the other machine.

Made in Canada and sold by

The Canadian Fairbanks-Morse Co., Limited

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON WINDSOR
WINNIPEG REGINA SASKATOON CALGARY VANCOUVER VICTORIA

OPPORTUNITIES

WANTED

Representatives to handle special line of British made "Elastic Steam Jointing Cement" (for all joints) and Iron Cement for casting, etc. Exclusive territory offered parties conversant with trade. Replies treated confidential. Apply Box 151, Power House.

BOOKS

on all branches of Engineering and every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT
Books Bought Best Prices Given

W. & G. FOYLE, Ltd.
121-125, Charing Cross Road, London, England

Get Bigger Pay

through ELECTRICITY

You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied.

Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship, please, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature _____
Occupation _____
Employed by _____
Residence _____
Reference _____

"New Truths and Old Fallacies" is the title of a booklet just being issued by the Magnolia Metal Company. It discloses an instructive information concerning babbitt metals not generally known or divulged. It is revolutionary in its departure from the generally accepted ideas and practices regarding babbitt metals and users and buyers will doubtless find it a useful guide in selecting such products. Commencing with this issue, and in the first issue each month thereafter, until completed, the content of this booklet will be published serially and in the meantime anyone interested in procuring the booklet, containing the complete article, can do so by applying to the Magnolia Metal Co., 226 St. Ambroise St., Montreal.

PRATT & CADY OPEN NEW BRANCHES

Announcement has just been made by Pratt & Cady Co., Inc., of Hartford, Conn., of the appointment of Mr. E. Coit Magens as director of sales; Mr. O. Lamson Beach, as manager Metropolitan Store, 259 Canal Street, New York City; Mr. Quay T. Stewart, as sales representative, Minneapolis, Minn; Mr. Henry J. Bride, as sales representative, Hartford, Conn.; also the opening of branch stores at 529-531 Arch Street, Philadelphia, Pa., Mr. H. H. Freund, Jr., manager; 505 Mission Street, San Francisco, Cal., Mr. C. R. Mendelson, manager.

In addition to their established lines of renewable disc globe valves, renewable seat gate valves, regrinding swing check valves and asbestos-packed cocks, the company now also manufactures the Davis & Berryman line of feed water heaters, hot water generators and power pumps, having purchased this business from I. B. Davis & Son, the original manufacturers.

In addition, Pratt & Cady have further extended their line by the more recent purchase of a welded steel tubing business and will continue manufacturing welded steel tubing in the various diameters and gauges, and fabricating the same into parts used by manufacturers of bicycles, motorcycles, automobiles, vacuum cleaners, metal bedsteads, etc.

WANTED

Power House Engineer, holding second-class Provincial certificate as assistant to chief engineer, for large industrial plant near Montreal, must be experienced in the operation of D.C. generating sets, transformers, air compressors and hydraulic pumps. Permanent position for the right man. Applicants speaking English and French given preference. State experience, qualifications, age and salary expected. Box 206, Power House.

WANTED

First-class machinery draftsman, by large Canadian in city near Toronto. In making application give details of experience, age and salary desired, etc. Apply Box 205, Power House.

REPORT OF "WILD-LIFE" CONFERENCE

The importance of the wild life of Canada has been recently emphasized by the phenomenal advances of prices at the recent fur sales. High prices have, as might be expected, resulted in an intensified campaign of hunting and trapping of our fur-bearing animals. At present, the market readily absorbs all the furs offered, and the high prices put a premium upon indiscriminate slaughter with the danger of extinction or of depletion of our fur-bearers to the point where recuperation becomes impossible.

In 1913 the Commission of Conservation made a survey of the fur trade, and published a report entitled "Fur-Farming in Canada." In February last the Commission, in conjunction with the Advisory Board on Wild Life, called the first National Conference to consider the large subject of the conservation and protection of wild life. Representatives of the Provincial Governments, the Dominion Government, and sporting and game-protective associations were present. A number of the leaders in this movement from the United States also attended.

The report of this conference has just been issued by the Commission and should be in the hands of not only those interested in the fur trade, but of every lover of wild life. Reliable evidence was adduced of the perils which threaten our fur-bearing animals. The ravages of the "game-hog" are graphically described by Dr. Hornaday, Jack Miner and others.

In contradistinction to the above, it is a pleasure to read of the results obtained by Mr. Jack Miner and Miss Edith Marsh in protecting wild birds in sanctuaries on their respective properties.

Regulation of the fur trade and methods for the collecting of fur statistics are interestingly dealt with, and the organization of local game protection associations is strongly recommended.

The report explains the scope of the Migratory Bird Treaty, the measures taken to enforce its provisions, and other appurtenant data with which the sportsman should be familiar.

The Commission of Conservation is endeavoring to interest the public in wild life protection. The publication of the report of this conference and subsequent conferences will give the necessary stimulus to this important work.

New Coal Operators' Association.—The coal operators in Alberta have split their organization, and a new one has been formed called the Red Deer Valley Coal Operators' Association. Out of 42 members in the original association, 19 resigned, among them being W. R. Wilson, the president. His place has been taken by O. E. S. Whiteman, manager of the International Coal & Coke Company, Coleman, Alta.

FIREBRICK WORK

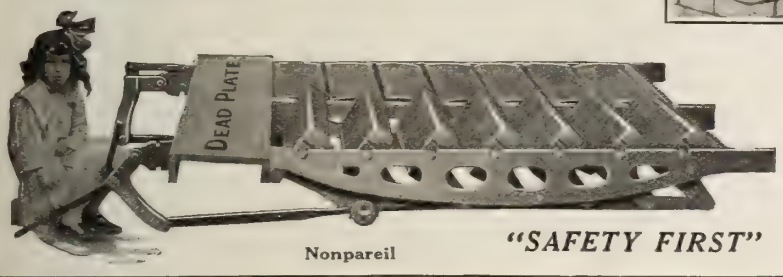
Boiler Settings Built to Last

We are commonly known amongst the trade as "SAFETY-FIRST SEXTON." Why?—because we take extreme care with our work down to the last detail. Firebrick work is our specialty and when we complete a job it can be relied upon.

NONPAREIL

Shaking and Dumping Grates Solve Fuel Problems

Shaking Grates will reduce your fuel expense 10%. To prove this install the grates on a 30-day trial basis. Write for our proposition.



Nonpareil

"SAFETY FIRST"

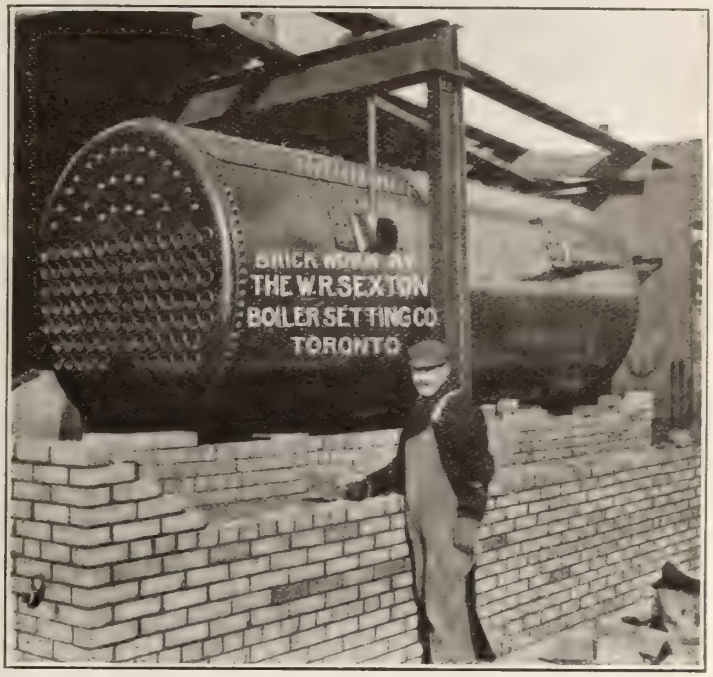
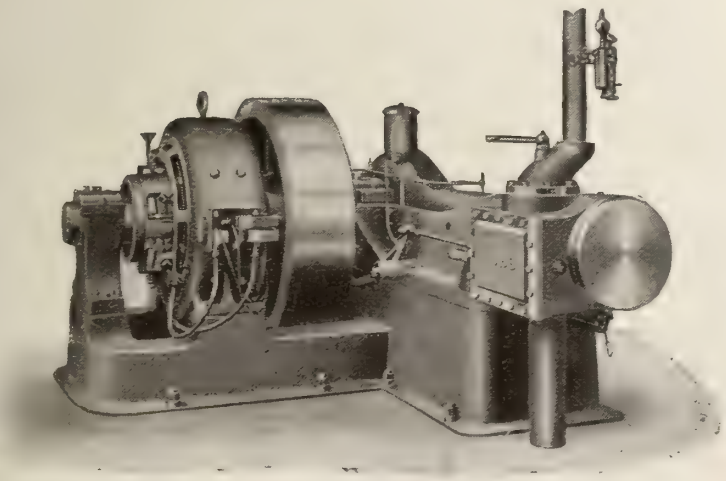


Illustration above shows SEXTON brick work in civic asphalt plant, City of Toronto. Nonpareil Shaking and Dumping grates are also used in this plant. **Write for details.**

THE W. R. SEXTON BOILER SETTING COMPANY

127 D'Arcy Street, Toronto

ROBB POWER PLANTS



Engines

Corliss, slide valve, vertical, horizontal simple and compound.

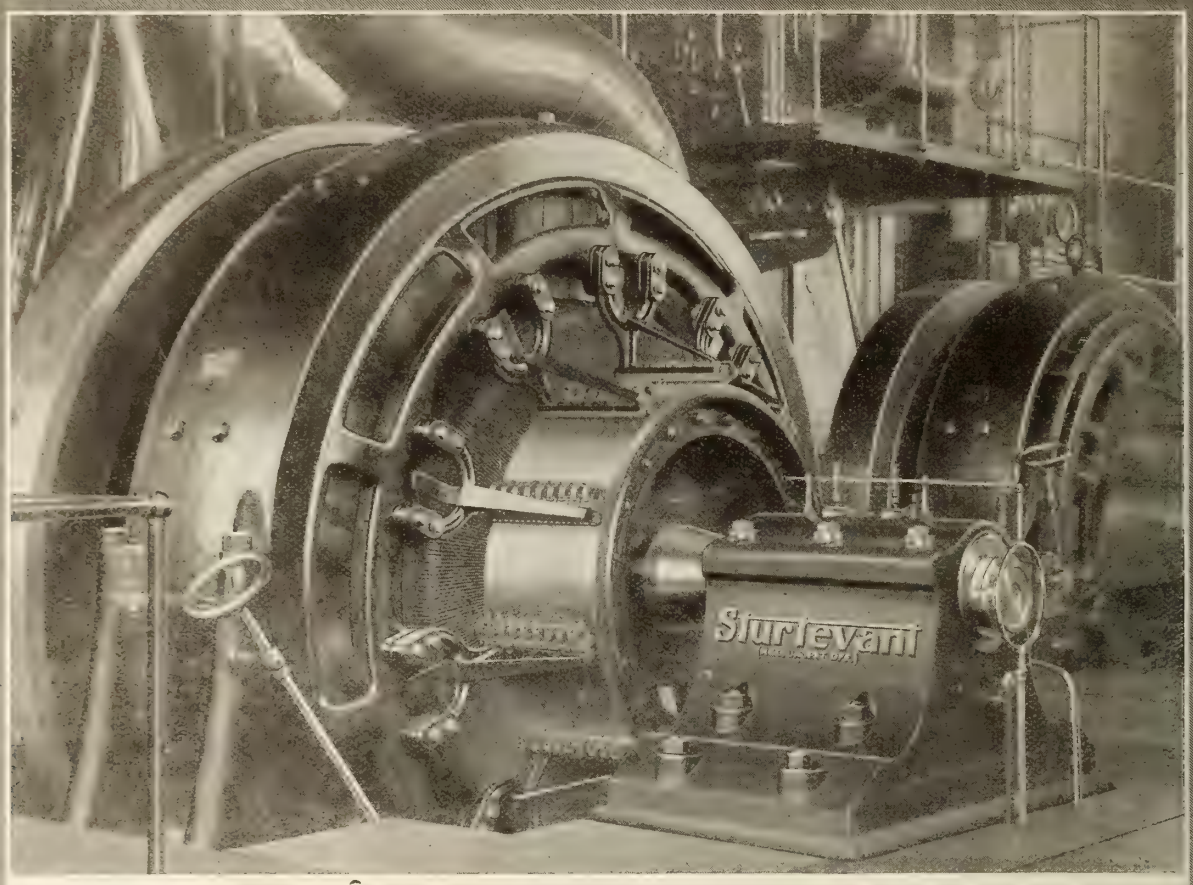
Boilers

Water tube, return tubular, improved Scotch marine and portable.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office:
Phone Westmount 6800

Toronto Office:
20 Victoria Street



Type C Form, 450 KW, 160 R.P.M., 250 Volt Generator

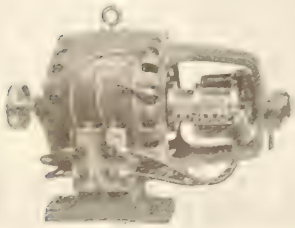
Sturtevant

(Trade Mark)

HEAVY DUTY MOTORS

with guaranteed overload capacity!

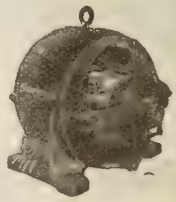
Through thirty years of constant effort Sturtevant direct-current electric motors and generators have been developed to an enviable degree of refinement and excellence. They range in size from the fractional horse-power motor to the generators of 600 KW capacity. All types are of simple, compact, and efficient design, and intended for constant full-load operation with guaranteed overload capacity. The skilled workmanship and selected materials employed in the rugged construction are assurance of enduring reliability and power economy. They can be used with equal efficiency for group, as well as individual drives, such as fans, air compressors, pumps, machine tools, etc. Made to standard voltages, although special speeds and powers have also been developed. Built open, semi-enclosed, or fully enclosed, as conditions require. All standard types are kept constantly in stock and can be shipped immediately. Write for our new Catalog No. 264U.



B. F. STURTEVANT CO.
OF CANADA, LIMITED

Head Office and Works
Galt, Ont.

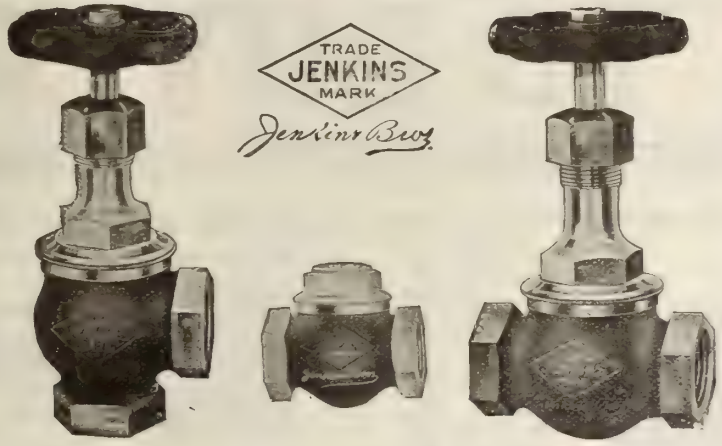
Sales Offices
Toronto, Montreal



Builders of Direct-Current Motors and Generators for all purposes

Sturtevant
PUTS AIR TO WORK

Jenkins Bros. Valves



They Stay Right

When the power house superintendent makes an inspection of the pipe lines he tests the valve bearing the Jenkins Bros. Diamond trade mark with a smile of confidence. He knows from experience, that above all things it can be depended upon to STAY TIGHT. Only valves of highly scientific design and quality construction can be depended upon to stay tight under severe conditions – Jenkins Bros. Valves are made of first-class material by workmen who know Valve requirements.

Furnished in brass or iron body, in globe, angle, cross, check, Y or blow-off, hose whistle and other patterns.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

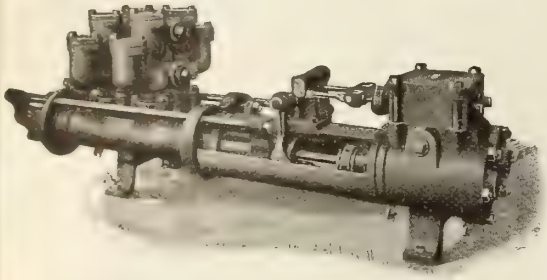
Head Office and Works:
103 St. Remi Street
Montreal, Canada

Agencies in all the
Principal Countries
of the World

European Branch:
6 Great Queen St., Kingsway
London, W.C. 2, England

Catalogue No. 8 free on request

HINTS TO BUYERS

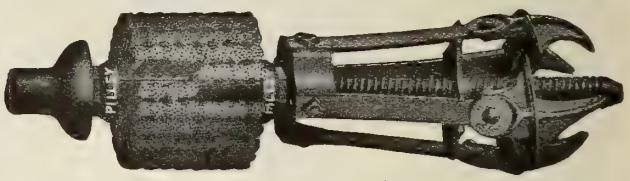


PUMPS that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

GEORGE T. LADD COMPANY
Farmers Bank Building
PITTSBURGH - - PENN., U.S.A.

LANCO BALATA BELTING
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST TORONTO
SCANDINAVIA BELTING

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO
Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.
MAKERS OF THE "LITTLE GIANT" TURBINE
Put Your Water Wheel Proposition Up To Us

DEPARTMENT OF LABOUR

Ontario Government

Minister:
Hon. W. R. Rollo.

Deputy Minister:
W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a STATIONARY steam plant of 50 B.H.P. or over, in the Province of Ontario, must hold a Stationary Engineer's certificate from the Board of Stationary & Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers.

After January 1st, 1920, the Certificate issued by the Board will be of four grades, viz., First, Second, Third, and Fourth. Application forms for graded certificates will be mailed upon request after the above-mentioned date. The certificates now issued by the Board will be graded into Third and Second-Class upon renewal, same being classified from the information contained in the renewal application which will be sent to each certificate holder.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse-power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1st, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request. The B.H.P. and other information contained in these forms is to be used for statistical purposes. A Registration Certificate will be issued to each applicant. All applications, or requests for same, should be mailed to the Chairman.

W. C. MCGHIE, CHAIRMAN OF BOARD

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., c. 61.

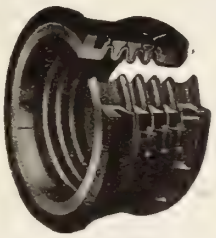
Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, Parliament Buildings, Toronto.

D. M. MEDCALF, CHIEF INSPECTOR OF STEAM BOILERS

BADGER
SELF-EQUALIZING EXPANSION JOINTS

Corrugations on Joints 6 inches and over are 2¼ inches deep



On Joints under 6 inches the corrugations are 1⅛ inches in depth

Perfect Stress Distribution under all Pressures and no cracking or jamming or Pipe Distortion whatsoever

Write us today for our new book of complete information

E. B. Badger & Sons Co.

67 Pitts Street, Boston

Canadian Agents: Fraser & Chalmers of Canada, Ltd.
Beaver Hall Hill, Montreal, Can.

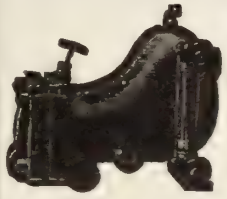
CRANE FLANGED FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST PATRICK ST

MONTREAL

BRANCHES: Vancouver, Calgary, Winnipeg, Toronto.



McDANIEL IMPROVED STEAM TRAP

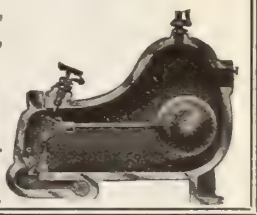
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

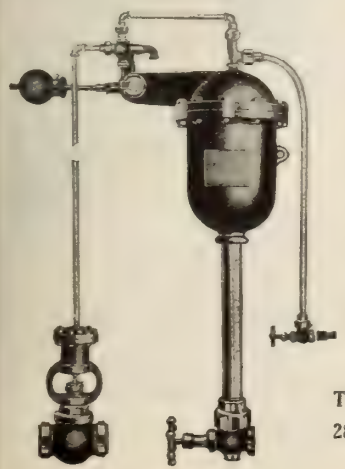
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street. PHILADELPHIA, Pa.



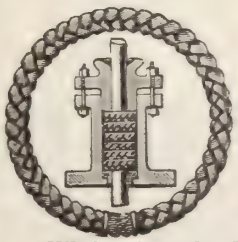
ACT NOW!

You will be safe-guarded against boiler explosion due to low water, if you use VIGILANT REGULATORS. They cannot fail to operate and keep the water level where it will enable the boiler to produce the dryest steam at the highest economy figures.

The slow uniform feeding of these regulators means fuel economy because the feed water is then heated uniformly to a higher degree.

Our instructive catalog will tell you more about the reason why the Vigilant will accomplish all that we claim for it, and more. Write.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsbnrgh, Penna.
Also Manufacturers of the Fulton Pump Governor



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

Mason Steam Specialties

Mason Reducing Valve

ASSURE YOU RELIABILITY OF SERVICE

The practical knowledge of experts who are continuously coming into contact with difficult engineering problems should be of considerable assistance to you. Let us demonstrate the "Mason Service" on your next problem.

THE MASON LINE

Mason Reducing Valves (Genuine)
Mason Pump Governors
Mason Pressure Controllers
Bundy Steam Traps for every service
Coppus Turbine-driven Blowers
Sims Hot Water Generators
Sims Storage Heaters
Sims Open Feed Water Heaters
Bundy Oil Separators
Ashton Gauges and Safety Valves
Everlasting Blow-off Valves
Babbitt Sprocket Rims
Stratton Steam Separators
Reilly Multi-coil Feed Water Heaters
Reilly Evaporators and Distillers
Reilly Multi-screen Feed Water Filters

Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.

The Mason Regulator & Engineering Co., Limited
Successors to H. L. Peiler & Co.
Montreal Office and Factory
135-153 Dagenais St.
Toronto Representative:
The Arthur S. Leitch Co., 1002 Kent Building

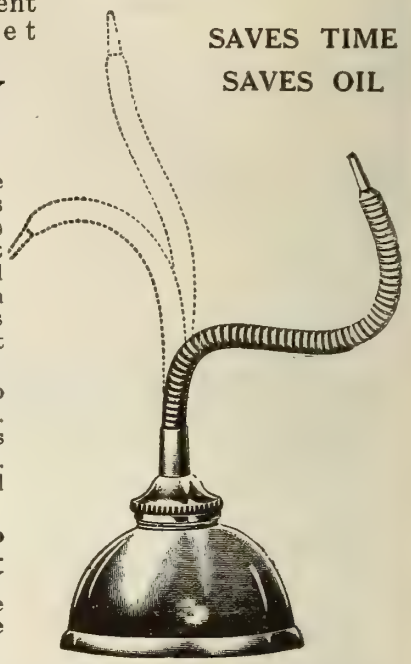
"SAFETY FIRST"

Bend the Spout
to suit position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL

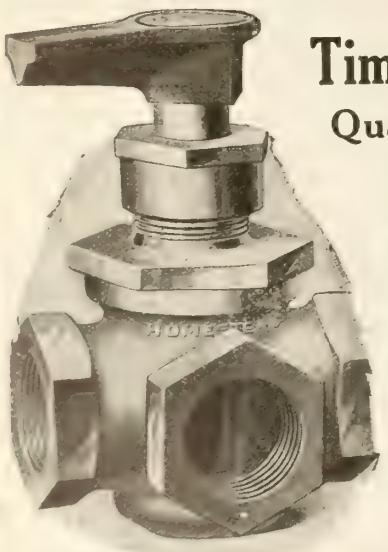


Note the flexible spout. It enables you to oil all places —many places that previously could only be reached with force pump cans with specially bent spouts.

Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO



Time Savers!
Quarter Turn Valves

Free unobstructed pipe area offers practically no resistance to the flow in Homestead Quarter-Turn Valves — there is no PRESSURE DROP. Seatless Construction eliminates usual scoring and Wear under pressure, insuring maintained tightness for long periods of operation.

HOMESTEAD
Quarter-Turn Valves

Let us explain its several other cost-cutting features. Write now.

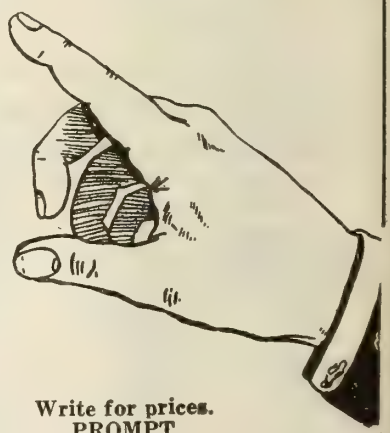
Homestead Valve Mfg. Company
Homestead, Pa.

Structural Steel and Steel Plate Work

of every Description

Penstocks
Thimbles
Draft Tubes
Wheel Cases
Steel Gates
Racks
Gate Steelwork
Power House

MacKinnon Steel Co. Limited



Write for prices.
PROMPT DELIVERIES

Sherbrooke, Que.
Montreal Office:
404 New Birks Building

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
W. R. Sexton Boiler Setting Co., Toronto.

BOILER HOUSE ACCESSORIES
W. R. Sexton Boiler Setting Co., Toronto.

BOILER SETTINGS
W. R. Sexton Boiler Setting Co., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach., & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd. Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS
Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton. Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.

ELEVATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Sturtevant Co., B. F., Toronto. Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS
MacLean Publishing Co., Toronto.

EXHAUSTERS
Green's Economiser, Ltd., Toronto.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED
Beveridge Paper Co., Montreal, Que.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons. Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

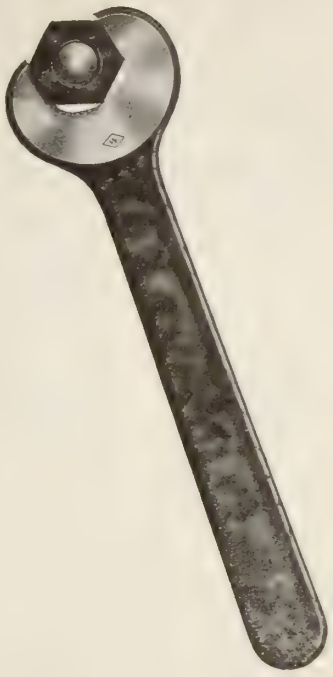
FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

—for every purpose



WILLIAMS' Superior Drop-Forged Wrenches are made in nearly one thousand sizes with openings from 3/16 to 7⅝ inches (4.8 to 194 mm.)—"a Wrench for every purpose." And every one is the product of drop-forgers with nearly half a century's experience behind them. That's why *good mechanics* invariably prefer Williams' Wrenches.

Ask for a Copy of Our New Catalog

J. H. Williams & Co.
"The Wrench People."

78 Richards Street, Brooklyn, N.Y. 78 Vulcan Street, Buffalo, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask.
Agents for Manitoba, Saskatchewan, Alberta and British Columbia

Williams' Drop-Forged Wrenches

What a Canadian Advertiser Says:

The following letter, by no means an exceptional one, accompanied a renewal advertising order received on January 10th, 1920. Such expressions emphasize the fact that our policy of "Efficiency in Power Plant Equipment and Service" is accomplishing splendid results for readers and advertisers.

"Gentlemen:—

"Enclosed please find our contract for space in 'Power House' for the coming year.

"I wish at this time to express my very high opinion of the value of your paper, both from an editorial and advertising standpoint. As a matter of fact, after many years' experience in space-buying, I have reached the conclusion that the value of space in a paper is of value to the advertiser in direct proportion to the value of the editorial matter to the reader. You certainly have a very capable editorial force, and we want to compliment you upon this feature of your paper as well as to express our thorough appreciation and satisfaction with the results secured through our advertisements."

Are You a Reader of "Power House"?

The subscription price is $2.00 per year for 24 books, brimful of choice, up-to-date information.

Are You an Advertiser in "Power House"?

Full information and rates supplied quickly on application. A.B.C. Audit of Circulation.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS, CAST IRON
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

Jos. W. Hays Corp., Michigan City, Ind.

GAS ANALYZERS CO-2

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equip. Co., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

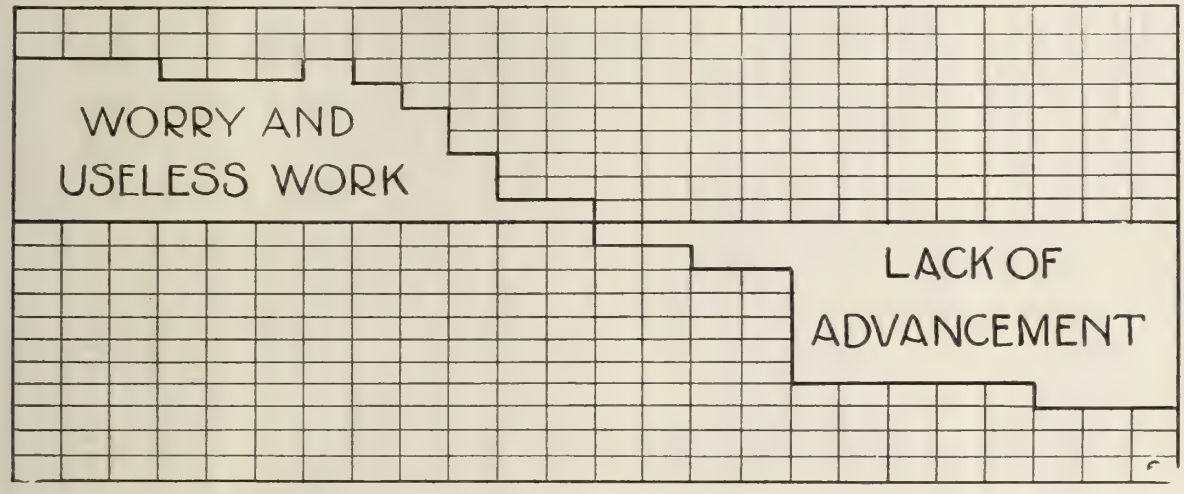
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithaca, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lunkenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
[illegible], Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,, Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
L'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek,

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford.

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, MULTIPORT
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES
Crane Limited, Montreal.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

This Plant, you would like to see

Not because of its giant size, nor its beautiful surroundings, but because of the many evidences you'd see of unusual, exclusive shop methods—of supreme care—of years of experience—of knowledge of our trade. No doubt then where your next Boiler order would go to.

Come on over!

Engineering & Machine Works of Canada, Limited
ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

Showing ease with which Plibrico is laid in place.

PLIBRICO

A High Grade Refractory for Furnace Linings

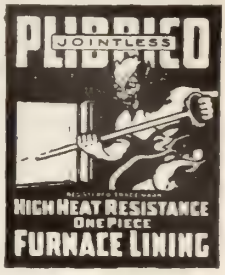
BETTER THAN FIRE BRICK

1. It's Jointless.
2. It's Plastic.
3. It's air and gas tight.
4. It will stand 3100° F.
5. It will save fuel.
6. It can be installed by inexperienced labor.
7. It will outlast fire brick.
8. It can be used in any boiler, furnace or oven.
9. It can be used wherever fire brick is used.
10. It can not be excelled for patching broken and burned out linings.

Any Engineer can see the economy and advantage over Fire Brick

Write for book on furnace building

JOINTLESS FIRE BRICK CO.
1130-1150 Clayton St., Chicago
Beveridge Paper Co., Ltd, Montreal. Shell Bar Boico Supply Co., Ltd. Toronto. Canadian Representatives.



Registered Trade Mark

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. **Glass Tubes and Rod**

S. & C. BISHOP & CO., St. Helens, Lancashire.

Are You Able to Turn Your Spare Hours Into Dollars?

If not—and you are really trying to cash in on the spare moments you have during the day or after working hours—if you have made up your mind to take hold of some proposition and sail right in and actually increase your monthly income without hindering your regular work—surely you will want to know about MACLEAN'S plan for making each spare moment count. And even if you are already making money during your spare time—still you can add to your income with very little additional efforts. For you can have full particulars of MACLEAN'S plan absolutely free. If you will merely drop us a card we will send you the complete details of this plan. It will cost you nothing to find out exactly how others with spare time have materially increased their monthly earnings. For full information or the agency in your locality, write and right now,

Dept. WB

MACLEAN PUBLISHING COMPANY, Limited
143-153 University Ave., Toronto

ECONOMIC Carling BLOWERS SUPERIOR

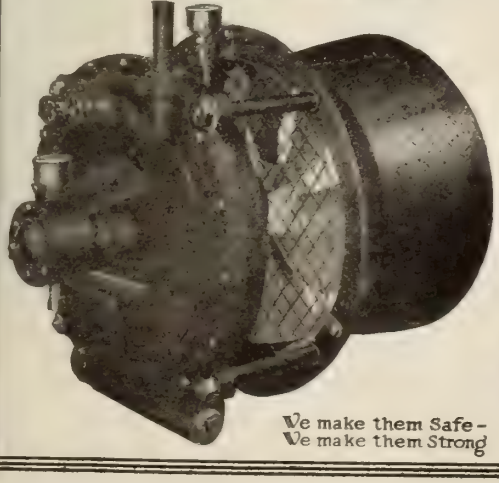
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers **WORCESTER, MASS**
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman
(SOLE MAKER)
9, Westfield Road Birmingham Eng.

Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Hand Frame	No. of Blade for Power Machine			
		Light Machine	Medium Machine	Heavy Machine	Extra Heavy Machine
Light Angles, Channels, Tee Iron, Ornament			262		
Heavy A, Channe, Tee Iro			55		
Light S			5	264	256
Heavy			5-B	2	256-B
Steela, Condu, Brass			2	25	
Solid S, Cold R, Machin			B		B C
Tool Ste, Cast Iron, Brass					
Sheet Metal a, Tubing, Less than 18 gage,	250	258			
Over 18 gage	102	252			

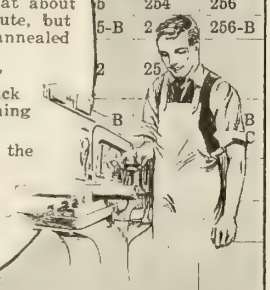
Get the S. P. M. Right

Don't run blades too fast in power machines. You can cut soft steel, if you use compound, at about 100 strokes per minute, but don't try it on unannealed tool steel.

"Haste makes waste" just as much in hack sawing as in anything else.

Send for a copy of the Starrett Catalog No. 21 "CD" and Chart "CD"

42-983.



Numbers above are those given in the Starrett General Catalog and on boxes containing the blades

Get the Starrett Hack Saw Booklet Sent Free

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.

THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS

Tycos TEMPERATURE INSTRUMENTS

INDICATING RECORDING CONTROLLING

Recording and Index Thermometers
Angle and Straight Stem Thermometers
Electric Contact Thermometers
Temperature, Pressure and Time Regulators
Mercury Column Vacuum, Pressure and U Gauges
***Tycos* Base Metal, Rare Metal and Radiation Pyrometers**
Hygrometers, Hydrometers
Mineral Oil Testing Instruments
Thermometers of all kinds for industrial and household use.

If to-day's mail carries your request for *Tycos* catalogs and other literature you will be a day nearer the solution of your temperature problems.

Taylor Instrument Companies
ROCHESTER, N.Y.

THERE'S A *Tycos* OR *Taylor* THERMOMETER FOR EVERY PURPOSE

INDEX TO ADVERTISERS

A
Allway Oiler Mfg. Co. 46
Audel Co., Theo. 40

B
Badger & Sons Co., E. B. 45
Bishop & Co., S. & C. 55

C
Can. Assoc. Stationary Engrs. 51
Can. Fairbanks-Morse Co. 39
Can. Graton & Knight Co. 8
Carling Turbine Blower Co. 55
Chaplin-Fulton Mfg. Co. 45
Crane, Ltd. 45
Coppus Engr. & Equip. Co. ..... Front Cover

D
Darling Bros. 44
Dart Union Co. 3
Detroit Stoker Co. 1
Dept. of Labor 45
D'Este Co., Julian 9
Dominion Belting Co. 12
Durabla Mfg. Co. 4

E
Electric Welding Co., The 44
Engineering & Mach. Works of Canada, Ltd. 54

F
Federal Engineering Co. 44
Foyle Co., W. & G. 40

G
Garth Co. 45
Gates Refractories, Ltd. 2
Gilman, Frank 55
Goldie & McCullough Co. 16
Goodyear Tire & Rubber Co. 6
Graton & Knight Mfg. Co. 8
Green's Economizer, Limited 4

H
Hays School of Combustion 13
Hints to Buyers 44
Homestead Valve Mfg. Co. 46
Hoyt Metal Co. 2

I
Imperial Oil Co. 11

J
Jeffrey Mfg. Co. 9
Jenkins Bros. 43
Jones Underfeed Stoker Co. 12
Jointless Fire Brick Co. 55

L
Ladd Co., The Geo. T. 44
Laurie & Lamb 45
Leonard & Sons, E. 3
Lunkenheimer Co. 7

M
MacKinnon Steel Co. 46
Mason Regulator & Engr. Co. 46
McLaren Ltd., D. K. 15
Morrison Brass Mfg. Co., Jas. ..... Outside back cover
Murphy Iron Works 7

N
Norwalk Iron Works 5
Northern Electric Co. ..Inside back cover

P
Peacock Bros. 37
Pilley Packing & Flue Brush Mfg. Co. 44
Philip & Sons, E. J. 4
Pyro Products Co. ....Inside back cover

R
Refrigeration Dept. 10
Royles, Ltd. 14
Robb Engineering Works 41

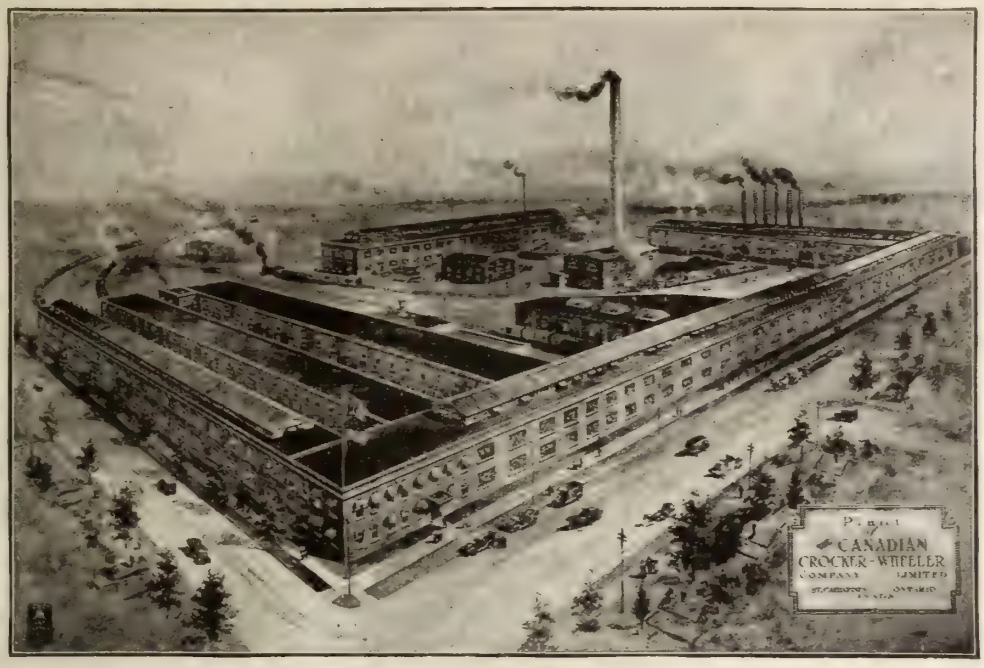
S
Sarco Co., Inc. 37
Sexton Boiler Setting Co. 41
Shell-Bar Boico Supply, Ltd..... 5
Smart-Turner Mach. Co. 44
Standard Mach. & Supplies, Ltd... 14
Starrett Co., L. S. 56
Sterling Engine Co. 9
Steel Mill Packing Co. 9
Sturtevant Co., B. F. 42

T
Taylor Instrument Co. 56
Tagliabue Co., C. J. 8

V
Victoria Foundry Co. 44
Valve Engineering Co. 8

W
Watson & McDaniel Co. 45
Wilson Mfg. Co., J. C. 44
Williams Co., J. H. 49

Y
York Mfg. Co. 10



Where Canadian Crocker-Wheeler apparatus is made

The modern design and excellent construction of Canadian Crocker-Wheeler apparatus is well known and has been still further improved in recent development work. The following apparatus is now all made by the Canadian Crocker-Wheeler Company at their St. Catharines plant.

Service Transformers	A. C. Generators
Power Transformers	D. C. Generators
Induction Motors	D. C. Motors.

We are distributors of this apparatus, which can be obtained from any of our branch houses, standard equipment being carried in stock.

Northern Electric Company
LIMITED

Montreal **Quebec** **Toronto** **Winnipeg** **Edmonton**
Halifax **Ottawa** **London** **Regina** **Calgary** **Vancouver**

MORRISON'S

Quality

The Guarantee TRADE MARK J.M.T. REGISTERED *of Quality*

Boiler Mountings

STEAM goods and specialties that meet every requirement of the engine and boiler room, stamped with the Morrison Hall Mark of quality and reliability.

EVERY article factory tested and guaranteed.

Engine Supplies

Steam Specialties

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 3. Publication Office, Toronto—February 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Sketch above represents the fire box of a water tube boiler lined with PYRO-PUTTY.

PYRO-PUTTY TRADE MARK REG. U.S. PAT. OFF.

FIRE BRICK IN PUTTY FORM

will minimize your boiler furnace troubles and expense—*and save you fuel*

Pyro Putty is far more durable than standard fire bricks for making new furnace linings, because it is not weakened by a multiplicity of fire clay joints.

PYRO-PUTTY is put up in 700-lb. barrels in a stiff, moist, pliable, "ready to use" condition.

PYRO-PUTTY will prove economical for repairing worn fire brick furnace linings, because repairs can be made quickly by unskilled labor.

May we send further information and prices?

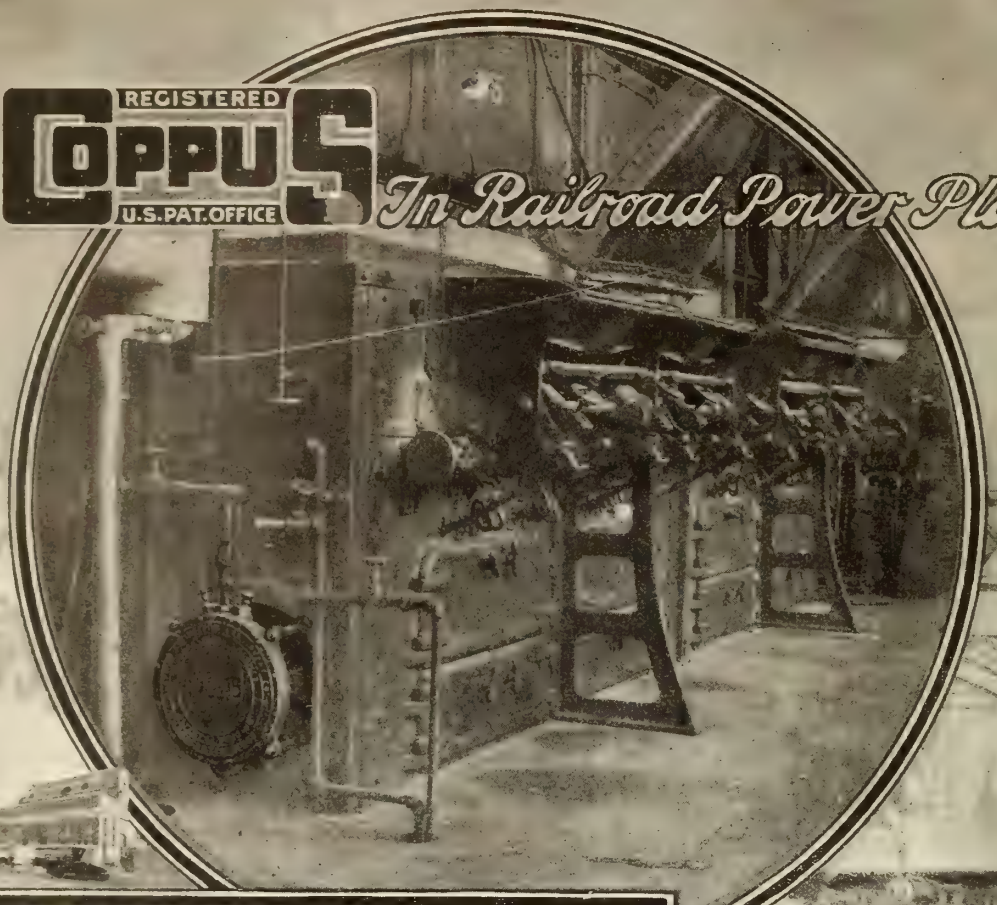
"A few barrels of Pyro-Putty should be part of the emergency equipment of every steam power plant."

PYRO PRODUCTS COMPANY

P.O. Box 685, Toronto, Ontario

REGISTERED COPPUS U.S.PAT.OFFICE

In Railroad Power Plants



Railroads are sticklers for efficiency. Equipment approved by them must produce results — save money — earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers **pay.**

Every one of this big battery of blowers—one of which is shown above—has cut coal costs—reduced labor charges—and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peek loads quickly—and burn cheap fuel. COPPUS Blowers **pay a profit** to the Central Railroad of New Jersey. **They can do as much for you.** Why not put them on the job? Catalog H-23 will show you how

"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

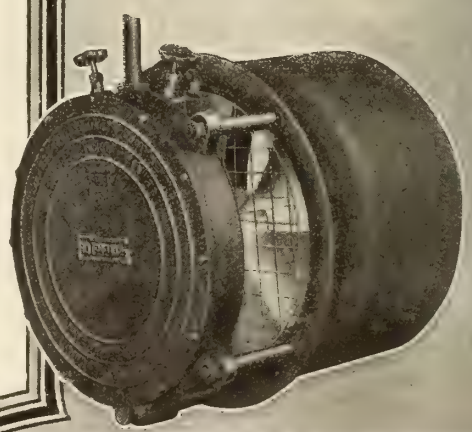
Mfgs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street

Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street

Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta



COPPUS TURBO BLOWER

POWER HOUSE, February 5, 1920, Vol. XIII., No. 3. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription rate in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

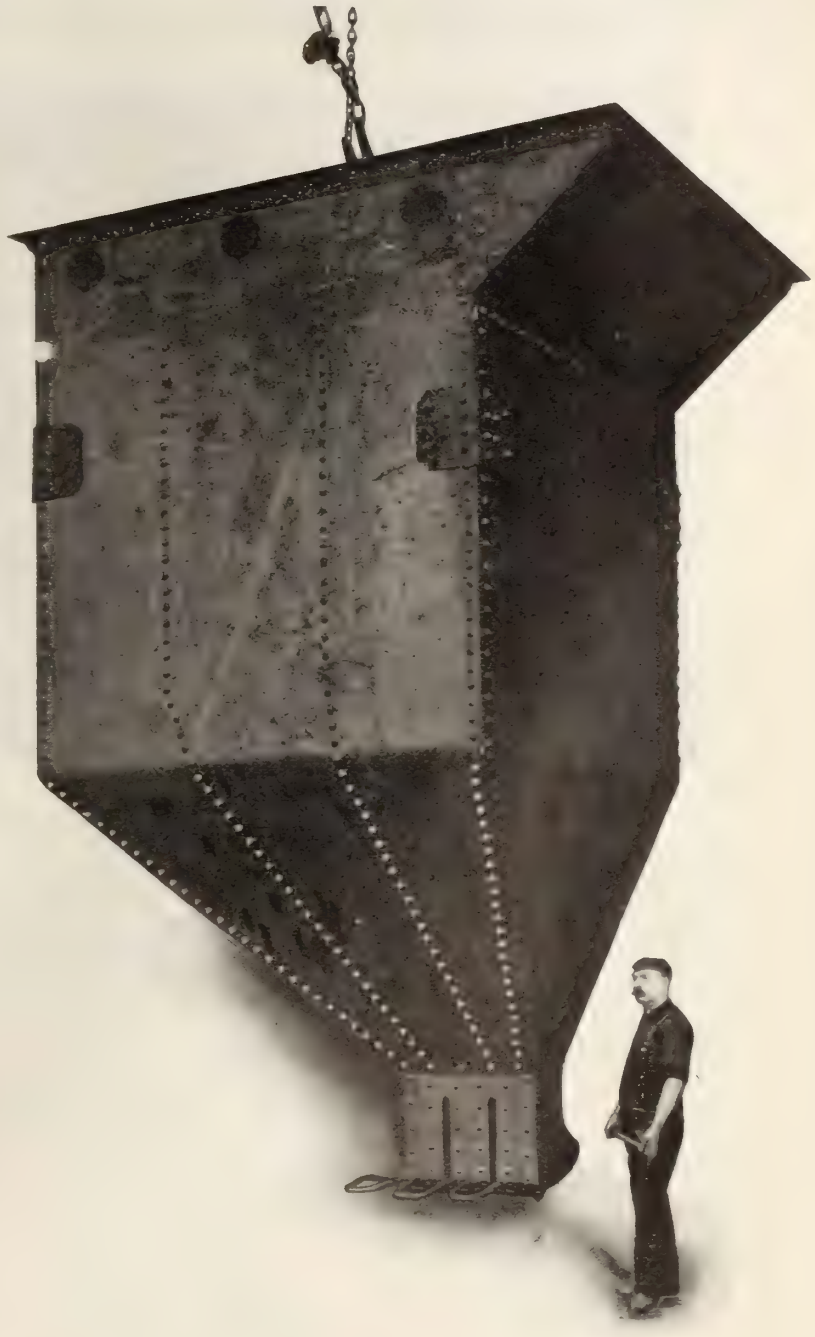
STEEL TANKS AND BINS

We have made a success of building steel plate work by specializing in it.

The new additions and improvements to our boiler shops have placed us in a better position than ever before to do this work right.

Our facilities in every department have materially increased. We have the equipment and the experience to turn out this special work as it should be.

If you are confronted with any problem on this work, send it in and let our Engineers give you the value of their experience.



We design and build:

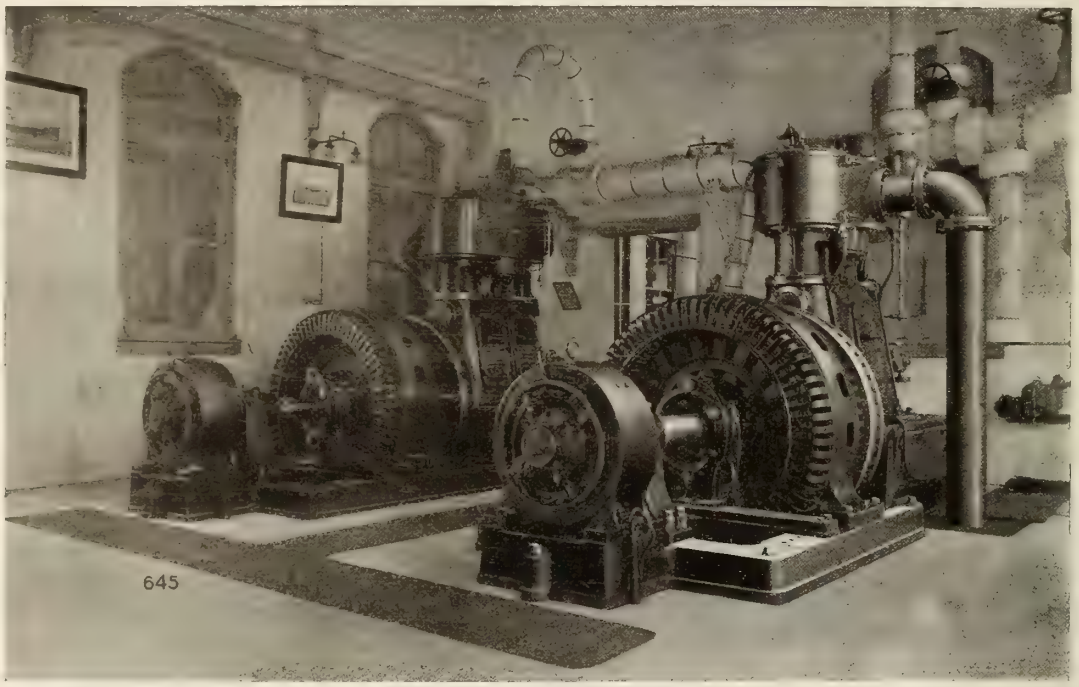
CONVEYORS
SMOKE BREECHINGS
STEEL STACKS
SPARK ARRESTORS
STEEL BUCKETS
ELEVATORS
RIVETED TANKS
STEEL TANKS
STORAGE BINS
COOKERS AND DIGESTORS
STEEL GAS MAINS
REFUSE BURNERS
WELDED TANKS
SETTLING TANKS

Waterous

BRANTFORD, ONTARIO, CANADA

Belliss & Morcom, Ltd.

Engines and Air Compressors



Bellis Engines at Verdun, P. Q., Waterworks.

We are prepared to supply and instal Steam, Gas, Diesel Oil Engines, Steam and Exhaust Turbines. We have Engine Generator Sets ready for delivery.

Send Us Your Enquiries For

Steam Engines
Gas Engines
Oil Engines
Diesel Engines
Steam Turbines
Air Compressors
Condensing Plants
Centrifugal Pumps
Boiler Feed Pumps
Water Wheels
Water Meters
Hydraulic Presses
Hydraulic Pumps
Hydraulic Accumulators
Pressure Filters
Gravity Filters
Water Softening Plants
Refuse Destructors
Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected

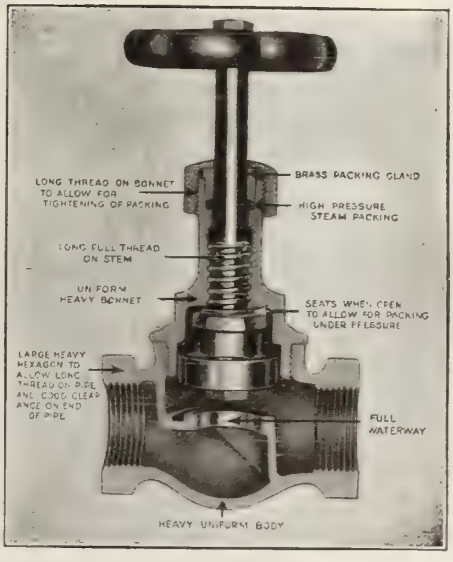
LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

"The Valve O'Nine Points"

There are nine outstanding features of the "EMCO" Composition Disc Valve—plainly shown in the accompanying illustration—which in themselves are sufficient reasons why this valve is superior to any other.


LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
BRASS PACKING GLAND
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREAD OF PIPE AND GOOD CLEARANCE ON END OF PIPE
FULL WATERWAY
HEAVY UNIFORM BODY

Cross Section
"Emco" A840 Composition
Disc Valve

Combined with these

there is superiority of strength, durability and workmanship which is the outstanding quality of every "EMCO" product.

Registered in the following Provinces as follows:—

Globe Valve A840	
British Columbia - -	No. 2590
Alberta - - - -	No. 1102
Saskatchewan - - -	No. 2365
Ontario - - - -	No. 1755

The design is approved and registered in the Provinces of the Dominion by inspectors of steam boilers for a pressure of 175 pounds.

Made of the best bronze metal, each valve is subjected to a thorough hydraulic test before it leaves the factory.

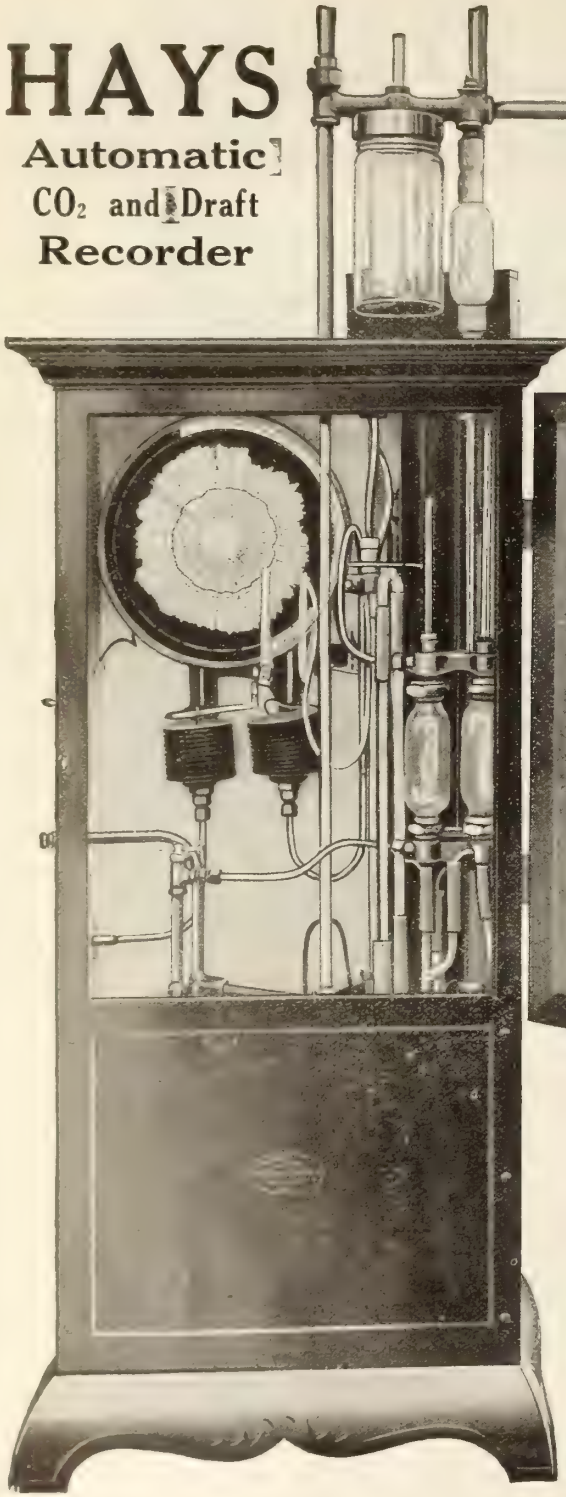
We can make prompt deliveries. Write for prices, etc.

Empire Manufacturing Co., Limited

London and Toronto, Canada

HAYS
Automatic CO_2 and Draft Recorder

Reduces Fuel Expenses 25%



The Hays Automatic CO_2 and Draft Recorder gives a constant gas analysis and a continual record of draft conditions. The slightest error in firing can be detected and corrected. The CO_2 Recorder will spur your firemen to greater efforts and thereby save money for you.

Install a Hays Automatic CO_2 and Draft Recorder and you will automatically bring to your plant the *Economy* of sustained efficiency. The Hays Draft Gauge is the fireman's best friend; it helps him produce maximum steam pressure with minimum amount of coal—Fuel Expenses are reduced 25%.

With the Hays Automatic CO_2 and Draft Recorder the ordinary fireman may become an expert flue gas analyst and reach the standard of efficiency in the combustion of fuel without the knowledge of what the atomic weight of carbon may be, or why one atom of carbon unites with two of oxygen to form the gas CO_2.

Any man who can read a thermometer, who is able to give the temperature of the boiler room, is qualified to bring any boiler furnace to the highest standard of efficiency with the Hays Automatic CO_2 and Draft Recorder.

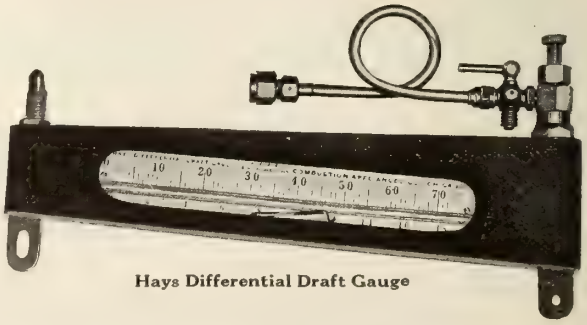
We manufacture Draft Gauges for all makes of furnaces.

Write for complete literature covering our full line of combustion efficiency appliances.

The Jos. W. Hays Corporation
Michigan City, Indiana, U.S.A.

General Representatives for Canada:
Stephen H. Payne, 30 Church St., New York

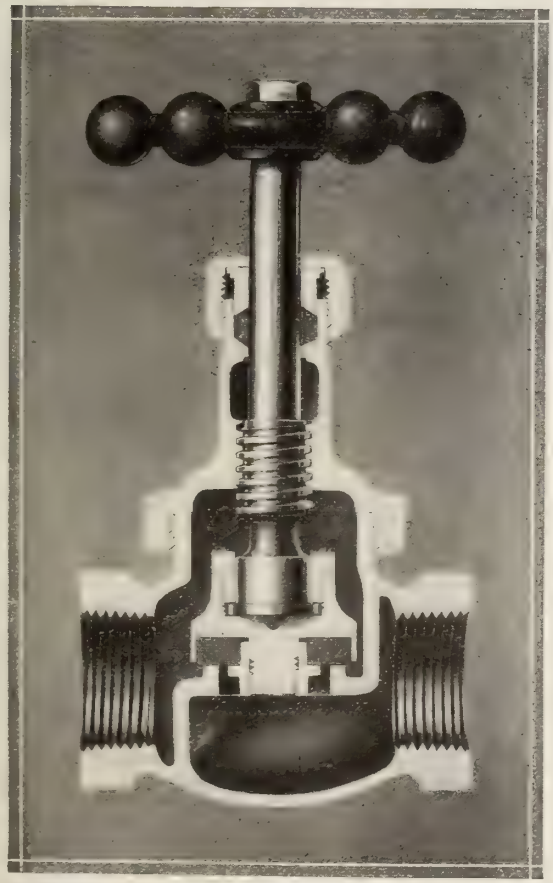
REPRESENTATIVES IN CANADA:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto
Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal
Wm. Goold, 701 Merchants Bank Bldg., Winnipeg



Hays Differential Draft Gauge

TRADE
PENBERTHY
MARK.

BE SURE THIS NAME is on the Valve you buy



SECTIONAL VIEW OF PENBERTHY COMPODISK VALVE
Registered and Approved for 175-lbs. Steam Pressure

Then you get "The valve with the outside bonnet construction."

The first progressive improvement made in brass valve construction in generations.

Think of the advantages! Valve always accessible.

No straining or stripping of threads when assembling or taking apart.

Impossible to spread or enlarge body of valve when screwing down bonnet to place.

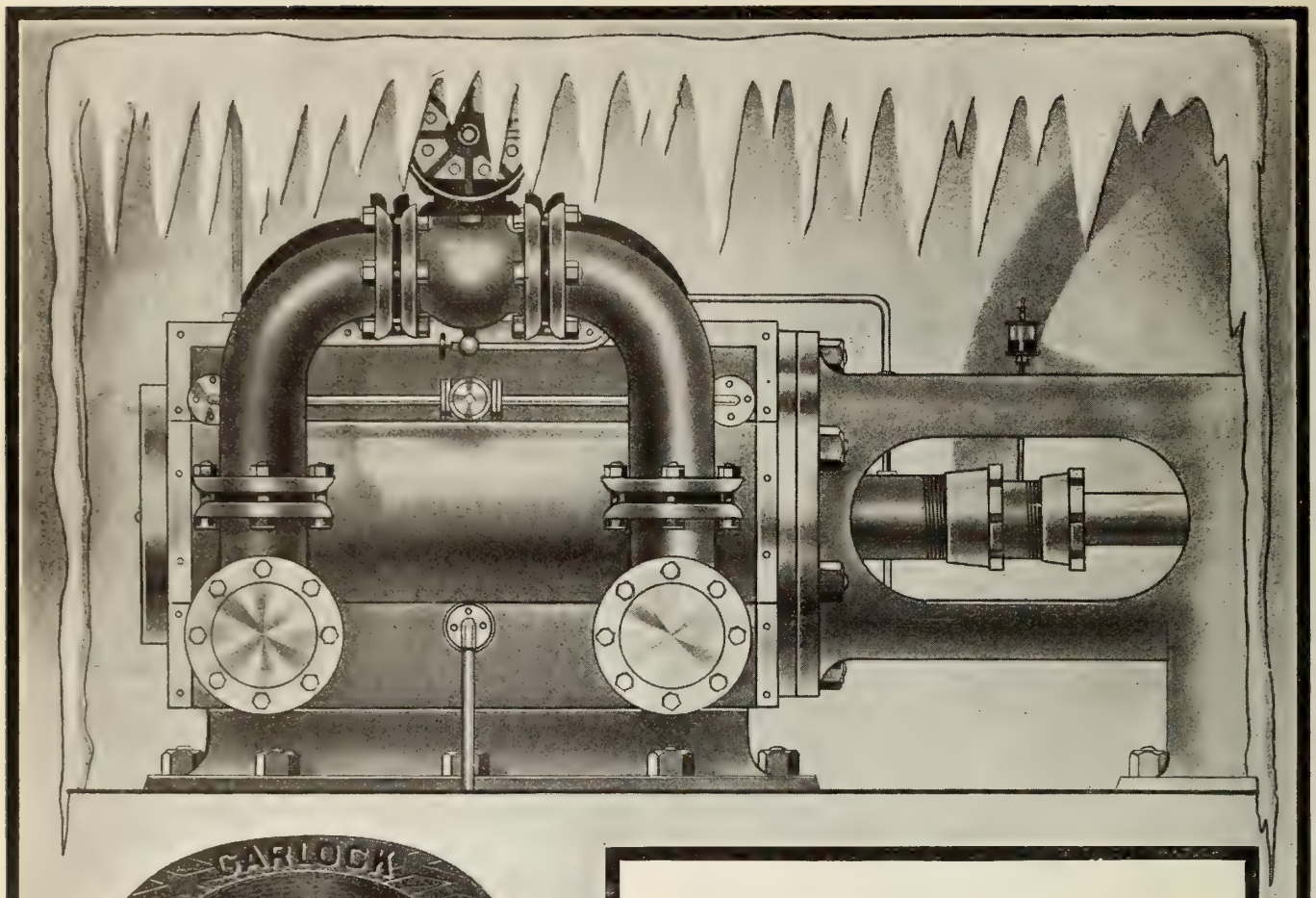
No corrosion of threads, for they are on the outside, away from the action of steam and water.

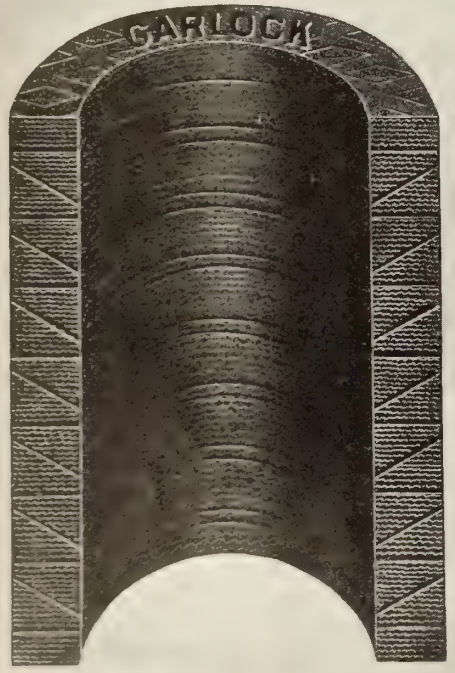
Are You Responsible
For the Efficiency of Your Power Plant?

THEN SPECIFY "PENBERTHY" VALVES
THE BEST BY EVERY TEST

STOCKED BY LEADING JOBBERS AND MILL SUPPLY HOUSES IN CANADA

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA





Refrigerating Engineers

and owners of ice plants do not care to experiment with Ammonia Packing during their busy season. Conditions of temperature and lubrication demand a scientifically made, high-grade packing, for this service. Before repacking your compressor stuffing boxes this Spring write to our nearest branch for catalog illustrating and describing several styles and combinations of

Garlock Ammonia Packings

or send us a statement of your conditions and requirements and benefit by our many years' experience in this field.

The Garlock Packing Company - Hamilton, Ont.

S: Montreal, Quebec - - 409 Shaughnessy Building
Toronto, Ontario - - 404 Continental Life Building
Winnipeg, Manitoba - - - - Galt Building
Calgary, Alberta - - - 211 Eighth Avenue West

Bert Collins

How to measure the cost of a gasket

WHY should the cost of a gasket be measured by the actual cost of the piece of sheet packing from which it can be cut? If a gasket blows out, its cost will certainly be many times the difference between the price of a poor packing and that of good packing at a few cents more per pound.

Do you realize that a 4 in. flange can be **properly** gasketed at an **additional** expense not exceeding 2 cents even if the proper sheet packing costs 20 cents per pound more than the ordinary kind? You would not be willing to have a gasket blow out for 2 cents or many times 2 cents.

Even where a small difference in price per gasket might amount to a considerable total, remember this—the risk of blow-outs increases directly as the number of gaskets.

Service Sheet, from which gaskets are cut, is the result of the elimination of weaknesses in sheet packing. Service Sheet may cost more per pound—and even more per gasket than some other asbestos fibre sheet packing—but its factor of safety is figured so high that the possibility of a blow-out is, as nearly as possible, eliminated. There's a better way of figuring the cost of a gasket, rather than by the cost per pound of the sheet from which it is cut.

CANADIAN JOHNS-MANVILLE CO. LIMITED

Montreal Toronto Vancouver Winnipeg
Hamilton London Ottawa

JOHNS MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos

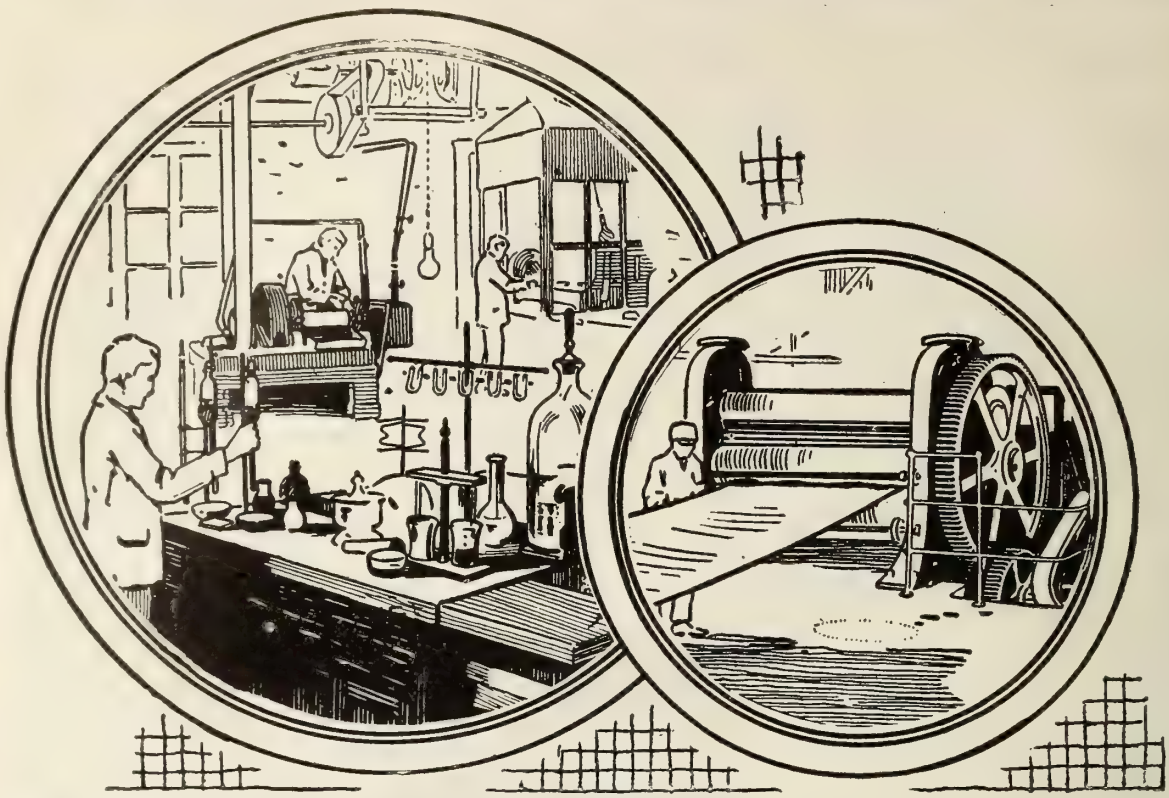
and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE

POWER PLANT MATERIALS



The Quality Standard That Produces "Plus Service" Belting

The only sure way to get satisfactory service is to buy products of known worth.

In Dominion Rubber System Belting, the worth is known because every ounce of material—each individual operation and each finished belt must test up to the highest quality standard ever made for belting.

From the time the materials come into our factory until the belt is running on your pulleys, there is no chance of your getting anything but "plus service" belting.

This is the result of over fifty years of belt making experience and research by the oldest, largest and most completely equipped rubber organization in Canada.

The rubber that goes into Dominion Friction Surfacing Belting is not a mere waterproofing substance—our chemists have given it a far greater value by making it into a friction compound that prevents practically all power wastage on the pulleys.

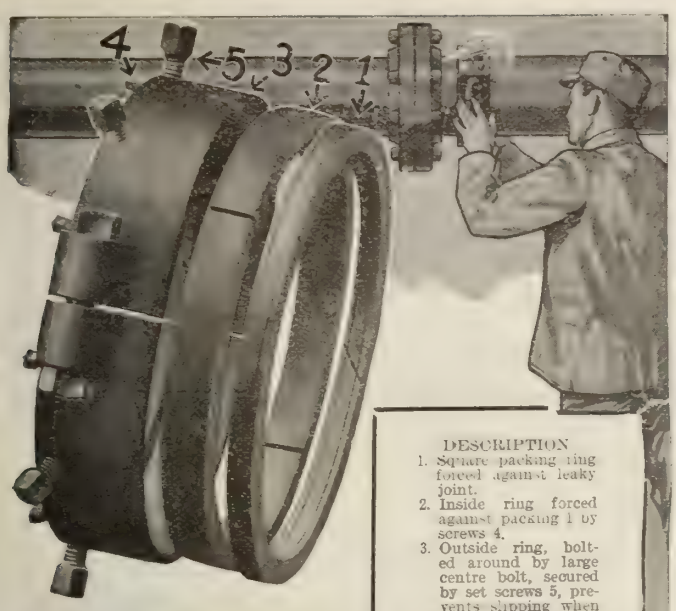
"Plus service" includes the free technical advice of our belting engineers who are ready to help you with your transmission and conveying problems without placing you under obligation to us.

A phone call, wire or letter to our nearest branch places all of our facilities at your disposal.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Service Branches:

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.



DESCRIPTION

1. Square packing ring forced against leaky joint.
2. Inside ring forced against packing 1 by screws 4.
3. Outside ring, bolted around by large centre bolt, secured by set screws 5, prevents slipping when adjusting screws 4.

Keep one on hand for emergencies

You never can tell when a joint in some important pipe line will spring a leak, causing danger, loss of power and perhaps a shut-down of the plant. But these troubles can be averted by having on hand some Yarway (formerly the Simplex) Pipe-Joint Clamps ready to meet the emergency when it arrives.

Why take a chance? Provide yourself at the earliest moment with sizes to fit each line. It's the cheapest insurance you can buy.

Thousands in use.

You can try one for 30 days subject to return. Write to-day.

Learn the good points of other Yarway Products

Yarway Seatless Blow Off Valve (formerly the Simplex).
Yarway Lea V-Notch Meter.
Yarway Boiler Skimmer.
Yarway Hydraulic Valve (Caskey Patents).
Yarway Adjustable Spray Heads (C. C. Thomas Patents).
Yarway Starting and Pressure unloader (Richards Patents).

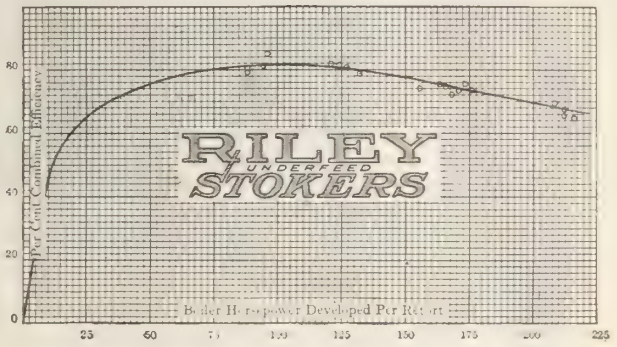
Yarnall-Waring Company

7604-20 Queen Street
Chestnut Hill Philadelphia, Pa.

A. McLellan, 103 St. Francis Xavier St., Montreal.
James Robertson Company, Montreal.
Gorman, Clancey & Grindley, Ltd., Calgary. Alberta.
Cunningham Hardware Company, New Westminister, B.C.

YARWAY PIPE-JOINT CLAMP
Formerly the SIMPLEX

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

The first year after installing Riley Stokers, the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

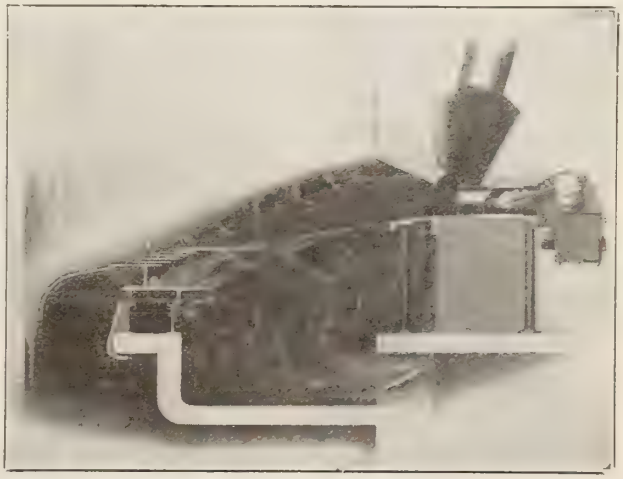
Catalog HR-2 sent on request.

For information on Murphy Automatic Furnaces for small boilers, see Oct. 20 advertisement or send for Murphy Furnace Catalog H M-2,

Sanford Riley Stoker Co.

WORCESTER, MASS.

British Licensee: Erith's Engineering Co., Ltd., London. French Licensee: Erith Leroy & Cie., Paris, France.



LINDE

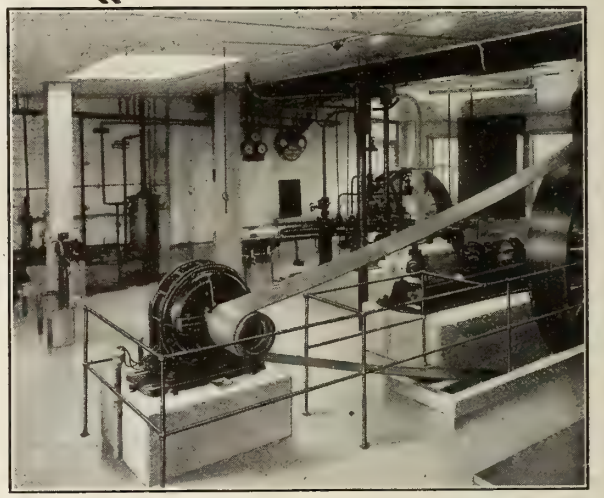
Sets the Standard for

ICE-MAKING MACHINERY

FOR EVERY PURPOSE

Economical - Efficient

100 ton Linde Refrigerating Plant in Operation.



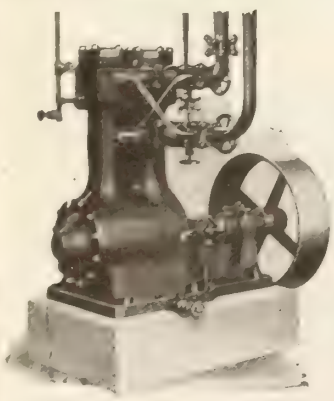
Is your refrigerating system thoroughly efficient? If not it will pay you to install LINDE equipment. We can meet all requirements. Our new vertical enclosed type machines are suitable for plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other refrigerating equipment on the market.

By adopting Linde equipment in the place of old and insanitary methods you increase your profits. Write to-day for information.

Makers of Quality Machinery in Canada Since 1896

The Linde Canadian Refrigeration Co., Limited
37 ST. PETER STREET, MONTREAL, QUE.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants Equipped With

FRICK Refrigerating Equipment

are much more sanitary than the use of harvested ice—and more convenient.

Get in touch with our Canadian representative and secure from him such information as you desire.

Frick Refrigerating Plants are made to suit every practical condition.

Write for Catalogs

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Tighter Joints and Lower Installation Cost

In addition to its high heat-insulating efficiency, its demonstrated durability and its fire-retarding properties, Nonpareil Corkboard also offers definite advantages from the standpoint of economical installation.

Every carpenter knows that in the erection of a building, the use of well-cut lumber saves both time and labor. And the same thing is true of corkboard. Sheets which vary in size and whose edges and ends are not square, are harder to install than those of uniform dimensions.

The ends, sides and edges of each sheet of Nonpareil Corkboard are trimmed by accurate machinery. As a result, all are exactly alike—uniformity of size is assured. This one feature provides two important things: Low cost of installation and joints that are tight.

Even though Nonpareil Corkboard is a little higher in price than some competing materials, a comparison of qualities will show clearly the reason for the difference.

If you want to know about ALL of the advantages of Nonpareil Corkboard, read the 152-page illustrated book, "Nonpareil Corkboard Insulation." Just write and tell us that you would like to have a copy and we will send one free of charge.

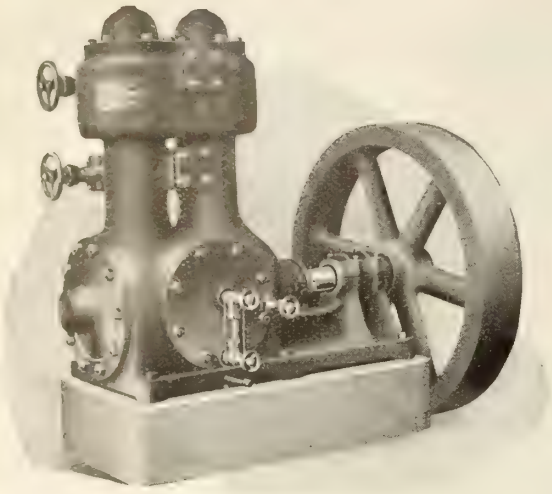
Armstrong Cork & Insulation Company

504 McGill Building
Montreal, Que. Canada

Nonpareil Corkboard Insulation

For Cold Storage Rooms

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

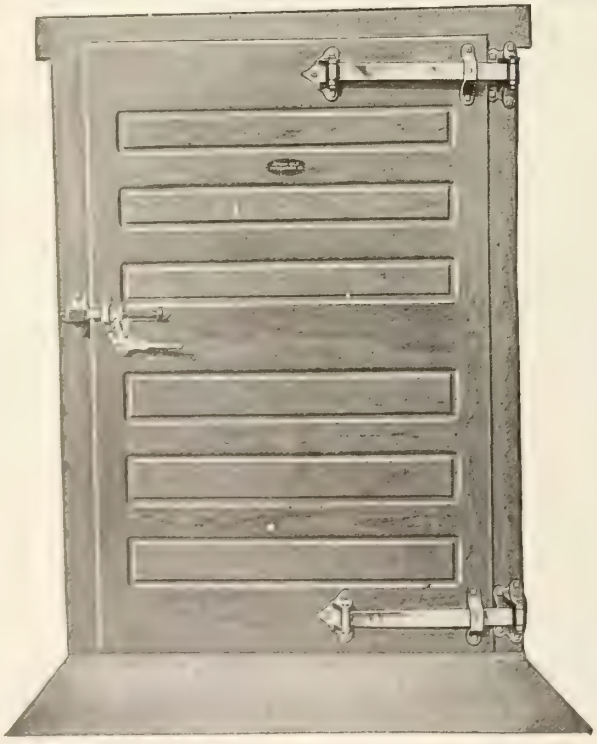
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Repentatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant,** as we find **them substantially made** and the **insulation perfect.** We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our **plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

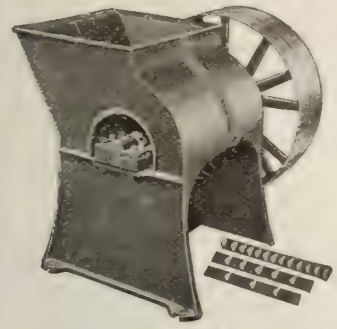
"**The doors supplied by you,** in use at both plants, **have been in every way satisfactory,** and we think **the Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co.

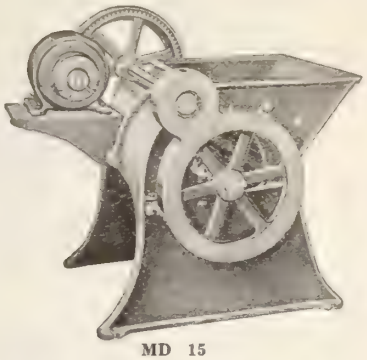
HAGERSTOWN, MD., U.S.A.



No. 13

Endorsed Everywhere by Users of Crushed Ice

BECAUSE—
1—Prepares ice in a jiffy.
2—Saves all the hard labor.
3—Saves ice because work is done without scattering.
4—Gives you uniformly crushed ice—fine or coarse as required.
5—Releases the time of employees for other work.
6—Saves you money by building a better business and reducing your upkeep cost to the minimum.



MD 15

A LITTLE GIANT ICE BREAKER

A 90

is a necessity to every user of crushed ice. It is not an ordinary ice breaker. Carefully developed to meet individual needs. Nineteen different sizes and styles. Uniformly fine or coarse ice as desired. The patented features—DIAMOND POINT DOUBLE CUTTING PICKS AND TWO-PIECE CONSTRUCTION—insure the effectiveness and longer life of the LITTLE GIANT.

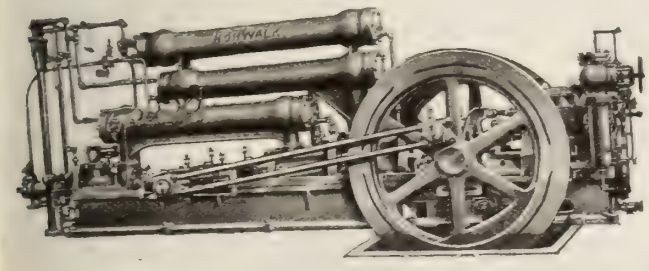
Send for our interesting Special Catalog. It's FREE and contains much of value to you.

B. L. SCHMIDT CO., DAVENPORT, IOWA, U.S.A.

No. 90

NORWALK
AIR & GAS · COMPRESSORS

Before you buy a Compressor investigate the Norwalk



24-inch large four-stage single steam cylinder-driven air compressor.

All requirements in any branch of air or gas compressing service are met with maximum efficiency by Norwalk Compressors—their reliability, simplicity and economy having been demonstrated to the satisfaction of users everywhere.

When you contemplate the purchase of a compressor, do yourself the justice of learning the distinctive Norwalk advantages.

Write for bulletins on Air, Oxygen, Hydrogen, Acetylene or Carbonic Acid Gas.
Let our engineers work with you on any special compressing problem. Their counsel, based upon forty years of high-quality compressor building, is yours for the asking.

THE NORWALK IRON WORKS CO.
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

GOODYEAR
MADE IN CANADA

EXTRA POWER BELTING

Pulling the Peak Load

Nearly every industry has some belt-drives with variable loads.

Nearly every industry has had belt trouble when the peak came on these drives.

One of the best things Goodyear Extra Power Belting does is to take care of peak loads without trouble.

How it has solved one peak load problem is told in a letter to us from the Chisholm Milling Company (reprinted here).

The very qualities which give Goodyear Extra Power its great advantage where loads vary, make it a better belt for all-round use.

The *pulley-gripping friction surface* pulls over the stiff places and prevents power waste through slippage.

The *great strength of the fabric plies* which are welded into one by much fine rubber, gives very long life.

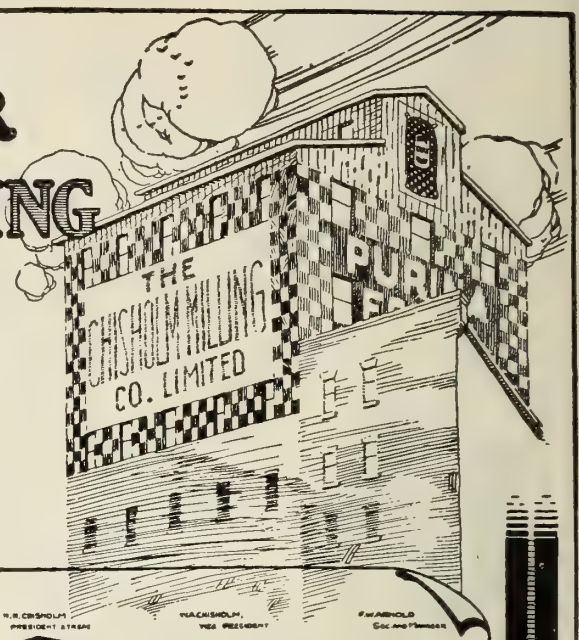
Practically *all the stretch is taken out* of Goodyear Extra Power before you buy it—saving costly shut-downs to tighten belts.

The fine rubber, *which seals the seam*, prevents ply separation.

Over 1000 Canadian industrials have found Extra Power Belting an economical proposition—in price, in length of service, in efficiency of service. Some of them have solved problems exactly similar to yours. Let a Goodyear-trained belting man tell you about it. No obligation. Just phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver, Victoria. Service stocks in smaller cities.



W. R. CHISHOLM, PRESIDENT & GEN'L MANAGER — W. A. CHISHOLM, VICE PRESIDENT — F. W. ARNOLD, SEC. AND TREASURER

The Chisholm Milling Co.
MILLERS AND DEALERS IN
CEREALS, GRAIN AND FEED
JARVIS STREET & ESPLANADE
TORONTO

The Goodyear Tire & Rubber Co. of Canada, Ltd., Toronto, Ont. — Nov. 15th, 1919

Gentlemen:—

About five years ago we bought our first Goodyear Extra Power Belting. To-day half our belts are Goodyear Extra Power, and as fast as old belts wear out we are replacing them with Extra Power. The performance of the first belt has brought about this change.

We were having trouble with our corn degerminator. Every now and then the machine would stick. Although we were using the highest priced belts we could buy, they continually burnt through when the sudden load of a sticking degerminator came. One expensive belt went in two days. The next one lasted but little longer. Then we tried a Goodyear Extra Power Belt. IT gave us 18 months' service. When the degerminator stuck, Extra Power just seemed to buckle down to the job and pulled right through the peak load. It wasn't long before we decided to use Extra Power Belts on all our equipment.

Now we have installed them on grinding mills, corn mills, shaft drives, etc.

We figure that we save a great deal in price, save power, and get surer service.

Yours very truly,
The Chisholm Milling Co., Limited

W. Flegg

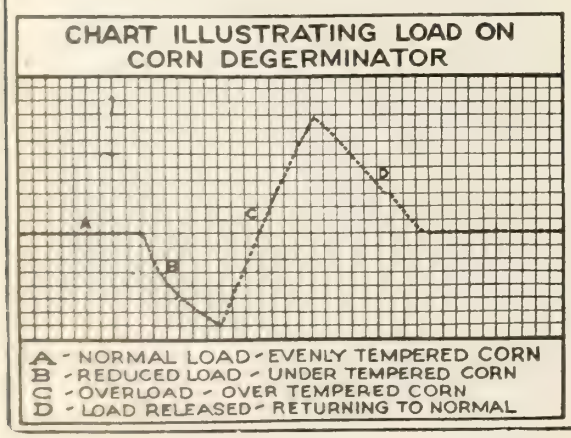
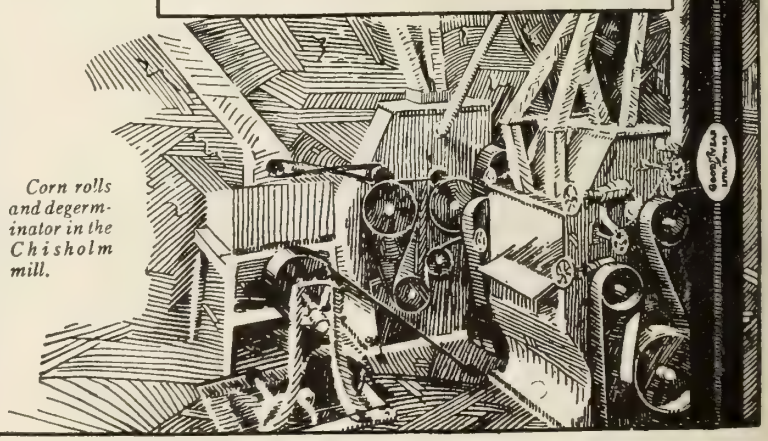


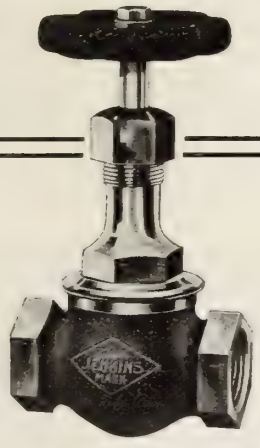
CHART ILLUSTRATING LOAD ON CORN DEGERMINATOR
A
B
C
D
A - NORMAL LOAD - EVENLY TEMPERED CORN
B - REDUCED LOAD - UNDER TEMPERED CORN
C - OVERLOAD - OVER TEMPERED CORN
D - LOAD RELEASED - RETURNING TO NORMAL



Corn rolls and degerminator in the Chisholm mill.

Jenkins Valves

Jenkins Valves bear the Jenkins "Diamond Mark"--a valve without it, isn't a "Jenkins."



Jenkins Valves wear longer and cost less for upkeep.

Knowing valve requirements and meeting them with a valve strong and heavy enough to stand the severest strain possible makes Jenkins valves DEPENDABLE.

They hold absolutely tight under steam, water, air or gas pressure, for remarkably long periods of service without attention, reducing upkeep costs to a minimum.

The design is heavier than the usual commercial standard pattern of other makes, enabling us to guarantee them for 175-lb. steam or 250-lb. water-working pressure. All are fitted with renewable Jenkins discs made of a softer composition than the metal, and which will seat perfectly tight in spite of inequalities or rough spots in the metal surfaces.

Jenkins' Valves are furnished in brass or iron body, in Globe, Angle, Cross, Check, Y or Blow-off, Hose, Whistle and other patterns.

An unfailing combination is Jenkins Discs in Jenkins Valves. Your supply man can serve you—but to make sure of the genuine—look for and demand the Jenkins "Diamond Mark." It is your guarantee of securing the ***genuine*** *article.*

Catalogue No. 8 free upon request

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi Street, Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway, London, W.C.2, England

TRADE JENKINS MARK Jenkins Bros

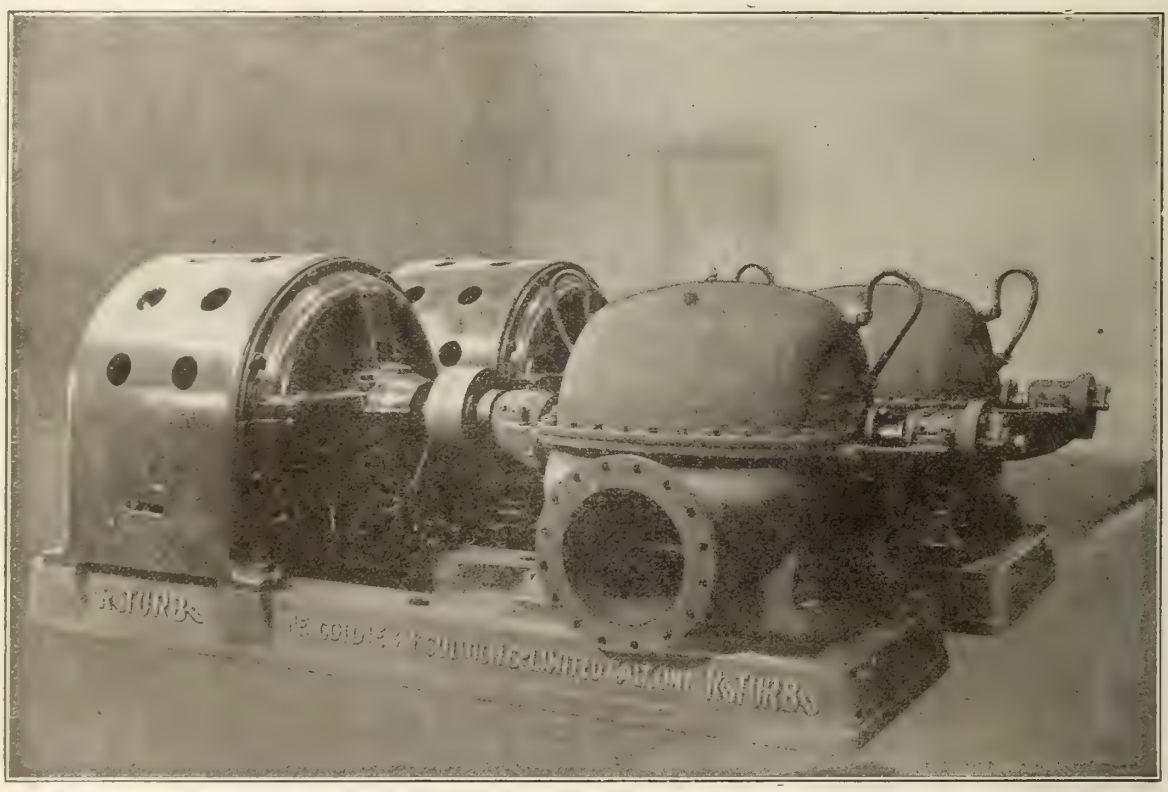
For 54 years Genuine Jenkins Valves have rendered faithful service in over 103 industries.

Every genuine Jenkins Valve bears the diamond trademark—the seal of an iron-clad guarantee.

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed by us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Bank of Hamilton Bld'g.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig 400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 | Canada, $2.00 per year; U.S. $2.50 per year. | Published Semi-monthly

A Water Dynamometer Which Simplifies Testing

Accurate Data Are Obtained Through the Use of Froude Water Dynamometer. Its Sensitiveness and Accuracy Lending Themselves to the Most Refined Tests

THE accompanying illustrations show the use of the Froude water dynamometer as developed at Worchester, England. One of these water brakes was utilized for testing a 950 h.p. Diesel engine at Turin, Italy, and much larger engines than the above have been tested without difficulty.

This water dynamometer was originally designed by the late Mr. William Froude for use in his experiments on the propulsion of ships. An earlier form of hydraulic brake took the shape of an ordinary centrifugal pump, the resistance to rotation being regulated by a valve placed in the outlet pipe. The apparatus was rather cumbersome in comparison with the power which could be absorbed, particularly at low speeds, and the range and method of regulation were not very satisfactory.

To meet these difficulties, Mr. Froude invented a new form of rotor and casing, which gave a greatly increased resistance for brake shaft. Each face of the rotor is formed with a semi-elliptical annular channel divided into a number of compartments by means of oblique vanes. The corresponding faces of the casing are also formed with similar channels divided in the same way.

The channels on the rotor and casing thus form two complete annular channels of elliptical cross section, each channel being divided as stated above into compartments by means of the oblique vanes. When in action the water in each annular channel is rotated continuously by the centrifugal force imparted to it by the rotor, and passes from one compartment into the next, and so on. An extremely high speed of rotation of the water is obtained, and the power put into the dynamometer is by this means converted into heat which passes away in the water leaving the machine. The motion of the water causes the rotor to re-act on the casing, which tends to turn on the friction rollers.

This is prevented by means of an extension arm working between stops, at the end of which are the balance weights by which the actual power put into the dynamometer is measured. The friction rollers supporting the casing are mounted on ball bearings and the machine is thus very sensitively balanced and great accuracy is assured. It will be understood that the friction of the dynamometer shaft in its bearings and packing glands re-acts on the casing and is measured at the end of the arm so that no error is introduced on this account.

It is of interest to note that there are many types of water dynamometers used, one form being suitable for absorbing power when running in one direction of rotation only. At the same time this machine can be run in the reverse direction for any length of time without any ill-effect (provided it is filled with water). The brake is fitted with two couplings and may therefore be used for testing engines running in either direction by coupling up alternate ends of the

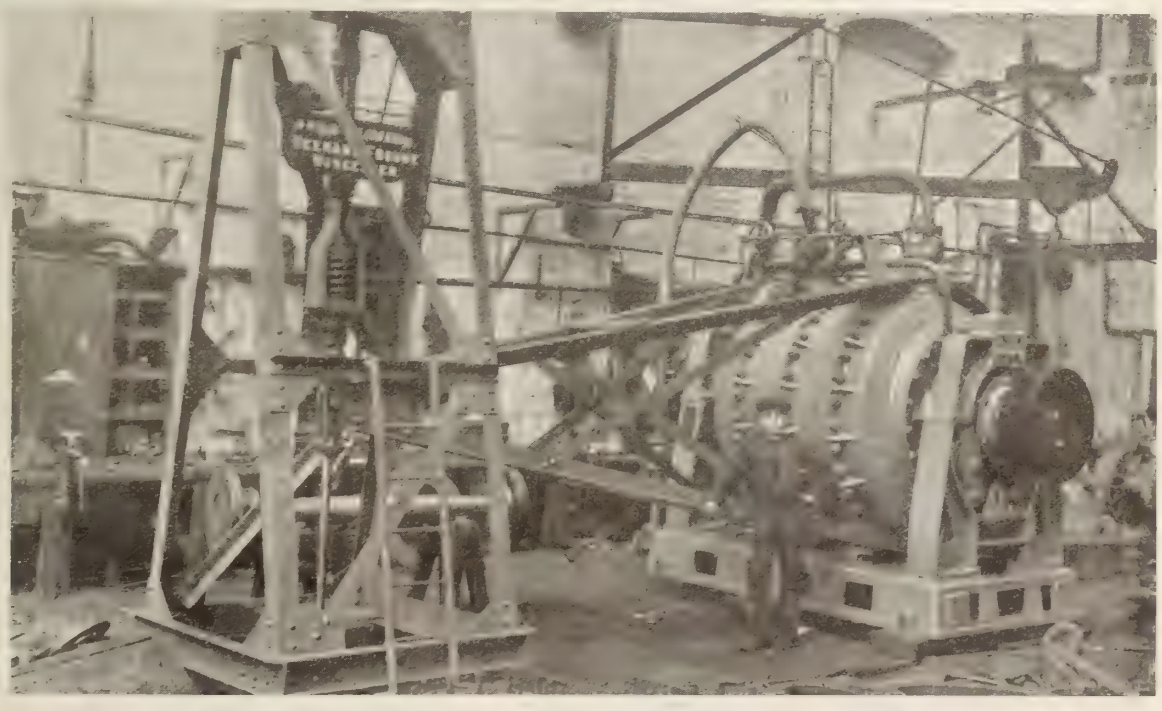


FIG. 1—FROUDE HIGH-POWER DYNAMOMETER SHOWING GENERAL ARRANGEMENT OF ASSEMBLY.

brake shaft. In the same way the machine may, if necessary, be used for testing reversible engines by turning the body of the brake round in order to make a test in the reverse direction.

These water brakes are divided into two classes, high duty and low duty machines. Generally the high duty and low duty brakes of corresponding sizes are of the same overall dimensions. The difference lies almost entirely in the different materials used in their construction. For example: A high-duty brake has a steel rotor and steel casing, whereas a low-duty brake has a steel rotor and a casing of special quality of cast iron. In addition to these brakes, there are reversible machines provided, i.e., brakes which may be used to absorb power in both directions of rotation at one coupling up.

The water dynamometer can usually be accommodated in an ordinary test house without any difficulty. In some cases a special pit is made in which internal combustion engines are tested. This machine, instead of carrying cast iron weights at the end of the arm, is arranged to pull downwards on to a special weighing machine. This weighing machine may swivel round the end of the dynamometer arm so that the overall space taken up is actually very small.

In general, for testing steam or internal combustion engines running at moderate speeds, a solid coupling is used and provision is made on these brakes so that after the coupling on the machine has been approximately lined up with the coupling of the engine to be tested by arranging suitable foundation the final lining up may be easily and accurately made. For this purpose the rollers or bearings carrying the brake body are adjustable in both horizontal and vertical directions. This is found to be a great convenience. Some use flexible couplings even for the larger sizes of brakes. In this case a coupling having rubber, gutta percha, or raw hide bushes fixed round the coupling bolts is often used. For testing high-speed internal-combustion engines it is always advisable to fit a flexible coupling.

As to water supply for the water dynamometer, it is pointed out that provision should be made for an ample supply of water to the brake. Usually a pressure of from 15 to 20 lbs. per square inch is sufficient, and for slow speed work a pressure of 10 lbs. per square inch is often enough. For very high speed work it is sometimes necessary to allow a greater pressure. The minimum consumption of water amounts to about two gallons per B.H.P. per hour, but the makers recommend that allowance should be made for three gallons per hour for each B.H.P. to be absorbed. Water may leave the brake at any temperature up to 150 deg. to 170 deg. Fahr., or 65 deg. to 75 deg. Cent.

As to the regulation of the load, these brakes are designed to automatically maintain a constant torque. The power absorbed by these machines depends to a great extent on the quantity of water in the brake. When the position of the inlet valve is fixed the load is regulated by an automatic outlet valve which may be relied upon to give an absolutely constant torque in spite of variations in the pressure of supply. In the case of smaller machines intended for testing petrol engines the brakes are always full of water, and the power absorbed is regulated by a system of sluices. These sluices consist of two discs of metal which are interposed between the rotor and the casing so as to regulate the amount of working surface which is in action.

It may be of interest to note the details of the calculation of the horsepower. These brakes are arranged so that the horsepower may be very easily calculated by noting the weight at the end of the arm and the speed of the engine. Machines may be arranged to give the results either in the British unit of 33,000 feet lbs. of work per minute, or in the metrical unit of 75 kilogrammemetres per second. In either case the length of the dynamometer arm is arranged so that by the aid of the simple constant "K" the horsepower can be calculated from the following formula:

$$\text{H.P.} = \frac{W \times N}{K}$$

Where

W = Load at end of dynamometer arm.
N = Revolutions per minute.
K = Constant.

For example: In the case of a machine built to British standards, having an arm 5 ft. 3 1/40 in. long—K = 1,000. For a metrical machine having an arm 1,432.4 mm. long—K = 500.

Regarding the reversible dynamometers, it may be stated that although the above dynamometers may be used for testing engines running in both directions of rotation by alternately coupling each end of the dynamometer shaft, it is sometimes necessary to test reversible engines in both directions of rotation at the same coupling up, and there have been built a number of brakes for this purpose. There are two types of reversible dynamometers. The single rotor reversing brake has one rotor; the vanes on one side being inclined in an opposite direction to the vanes on the other side, so that one face of the rotor is working when the brake is running in the forward direction, and the other face is working when the brake is running in the astern direction.

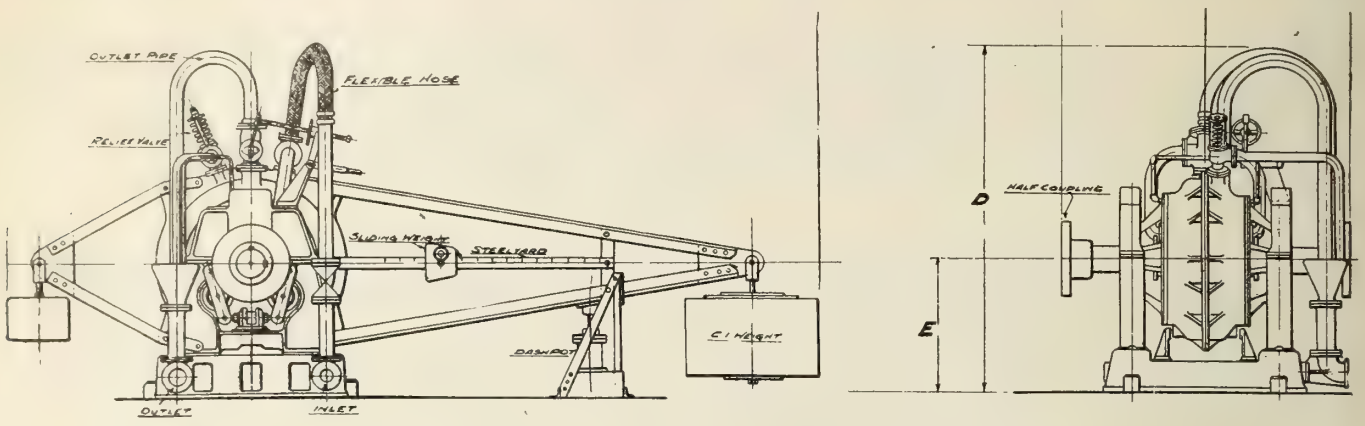


FIG. 2—WATER DYNAMOMETER.

The single rotor reversing brakes have a ball thrust bearing on an extension of the brake shaft to deal with any hydraulic thrust which is set up. The measuring apparatus on this reversible brake is somewhat different to the apparatus fixed on the non-reversible machines. A stand, built up of steel sections, carries a suspended weighing machine from which hangs a heavy cast iron weight. The arm of the dynamometer is arranged so that the reading on the weighing machine is increased or decreased according to the direction of running, and the effective torque is thereby measured.

The double rotor reversible brakes are for powers not within the capacity of the single rotor machine, and for speeds which make it inadvisable to use a thrust bearing. These brakes are fitted with two separate rotors, and of course such a machine is more expensive to build than the single rotor brake. One rotor is used for working in the forward direction, and the other for working in the astern direction. This type of brake has been largely used at the works of Messrs. Fried. Krupp, Kiel Gaarden. In neither of these reversible brakes is an automatic valve fitted to the outlet, and it is necessary to provide water for the brake at a steady pressure.

As to the application of the water brake for testing petrol engines, it is claimed that this brake provides the cheapest and most reliable method of

obtaining absolutely accurate knowledge of the output of a motor at various speeds. The water used for the braking action carries away with it all the heat generated by the dissipation of power. There is therefore no question of trouble due to heating up or seizing of the brake. These brakes are often used for endurane tests, and run as long as four weeks continuously night and day.

For gasoline engine testing the machine can with advantage be made portable. In many test shops the engines are mounted for testing side by side in a series of cradles. A very convenient arrangement for utilizing the Froude dynamometer is to lay a light track alongside these cradles on which the trolley carrying the brake may run. The brake can be run from one engine to another and coupled up by means of a flexible coupling. The power absorbed is registered on a spring balance. By means of a simple chart hung in a prominent position in the test house, the horsepower corresponding to the readings can be read off instantly. Within the space of a few minutes the engine can be tested at half a dozen different speeds with absolute and perfect accuracy. As soon as an engine has been tested the brake can quickly be uncoupled and pushed along on its rails to the next engine; this gives a speedy method of subjecting each motor to a short test, and is very convenient in large works where a number of motors are passing through the testing shop continuously.

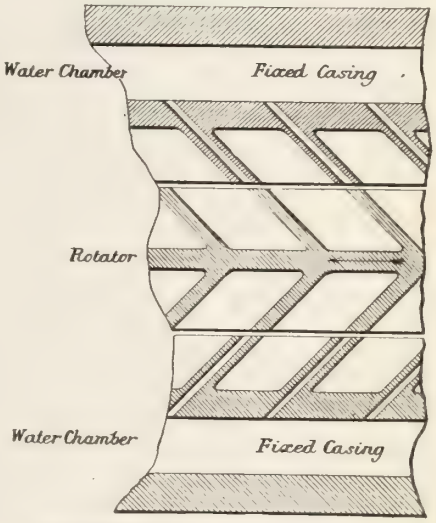
The application of the machine as a simple brake is of interest for use in cases where it is desired to absorb but not to measure the power. Amongst other applications may be mentioned brakes for use in connection with aerial ropeways, raising and lowering gear in mines, and on board ship in connection with the laying of marine cables. As the heat generated by the absorption of power is continually carried away by the water passed through the machine, the brake may be relied upon to run for any length of time without trouble. The machines built for this purpose are arranged so that the resistance varies as the square of the speed. The result is that when the machine has been set to give a certain resistance at a certain speed, any tendency for the brake to over-run is counteracted by the rapid increase in the torque caused by a slight increase in the speed. The result is that the brakes provide steady running in spite of variations in the load.

It is maintained that all absorption dynamometers must, of course, absorb the power to be measured and convert it, either into heat by means of friction, or into electrical energy. When the power is converted into heat, solid or fluid friction may be used. Absorption brakes are divided into those which utilize solid friction, fluid friction, or electrical energy. The solid friction brakes are represented by those of the Prony brake type, which utilize ropes, steel bands, or wooden blocks applied to a fly-wheel, to create the necessary resistance. They are very limited in power even when water cooled, on account of the difficulty of getting rid of the heat with sufficient rapidity to prevent the brake becoming overheated.

The solid friction brakes have been used up to as much as 100 horsepower and even more, but become very cumbersome when the power to be absorbed exceeds 30 to 40 horsepower, especially when the speed is low. Such brakes often impose a strain on the bearings of the engine under test by reason of the loads which the engine shaft is called upon to carry. There have been known cases where the bearings of petrol engines have had to be completely renewed after running tests with a brake of the Prony type. The wear of these brakes is rapid, and it is difficult to maintain the resistance constant for any length of time without very careful attention. The resistance is also apt to be very jerky, and the brakes require very careful watching to prevent accident due to seizing. Another point: It is necessary to remove all the load before the engine can be started up from rest, and this is very inconvenient when it is desired to stop and re-start the engine frequently.

Electrical brakes are important absorption brakes, but it is held that the results obtained by electrical measurement are always open to argument on account of the efficiency factor of the dynamo. The correctness of the ammeter and the voltmeter also enters into consideration. The resistance cannot be maintained absolutely constant over a long run on account of the variations in the current produced, due to the change of temperature of the dynamo, and also on account of difficulty in maintaining the resistance in the external circuit constant.

It is pointed out for small powers, the dynamo is sometimes mounted bodily on bearings, and the torque between the armature and the field coils measured by means of an extended arm and spring balance. But this method of application is limited to comparatively small powers. Here again there is trouble in maintaining the load constant. The range of speed and power which can be obtained from a dynamo is rather limited. Also for high speed work the momentum of the rotating parts of the dynamo is considerable.



ARRANGEMENT OF WATER PASSAGES.

As proof of the scientific accuracy of these brakes, it may be mentioned that Professor Osborne Reynolds of the Victoria University used a brake of this type to investigate the correct value of the mechanical equivalent of heat in foot pounds, and the figure now used, viz., 778, was established by this test.

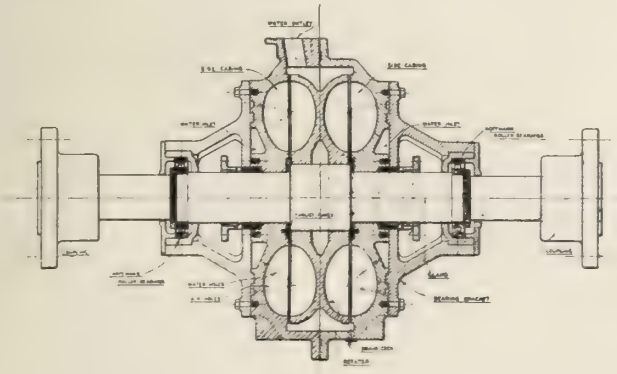


FIG. 3—SECTIONAL ELEVATION.

RAPID ROAD CONSTRUCTION

A new type of road repair equipment has been produced by a leading British firm. It consists of an electric battery-driven truck, on which is mounted a compressed air plant operated by an electric motor. Current can be supplied to the motor either from a storage battery or from the street electric mains. An air received and a special water-cooling arrangement are supplied, so that no separate water supply is necessary. The frame carrying the motor, compressor, receiver, and water tank can be raised on four jacks, and the electric truck can be used for other purposes, while the equipment is at work. Special types of pneumatic tools are supplied for breaking up road foundations and for tamping, the speed of operation being far in excess of anything possible with manual labor.

The Chemical Treatment of Boiler Feed Water

The Author in the "Stevens Indicator" Gives a Report on This Subject Which is Well Worth Reading. The Various Methods in Common Use Are Outlined and a Description of the Manner in Which They Work is Given

By E. ECHIKSON

ONE of the most important elements in the generation of power by the steam engine is the water from which the steam is made. The vast amount of energy consumed throughout the world entails the use of millions of gallons of water, and it is not surprising therefore that the quality of this most important substance should be a subject of extensive investigation. The user of power does not, however, always recognize the vital importance of the matter and as a result suffers a loss which seriously detracts from the efficiency and economy of plant operation. The presence of a few grains of solid matter in the feed water, invisible even to the naked eye, does not appear to him a controlling factor in the successful operation of a boiler, but, when he is made aware of the effects of these impurities, he cannot but recognize that the apparent molehill is really a mountain. This matter of feed water purification is consequently one of intense practical interest, and a reasonable knowledge of the subject, coupled with action upon that knowledge, will very possibly place a big item on the right side of the balance sheet.

Due to the continuous boiling and concentration which goes on in a boiler, there result four distinct boiler troubles. The first, and probably the most important, is the formation of scales. Particles of solid matter are dissolved in all natural waters, and when subjected to heat they are thrown out of solution and precipitated as scale. Such a deposit has a heat resistance twenty or thirty times as great as iron, and though it might form an excellent heat insulator for the outside of a pipe, it is very decidedly out of place on the inside of a boiler. The resulting loss of economy and capacity is, however, of secondary importance compared to the danger of overheating. Because of the presence of the scale the water cannot reach and cool the tubes. The latter may become red hot, and in their weakened state, explode.

Next in importance to scaling is corrosion, which arises from the use of water containing acids, strong acid salts, fatty oils, or organic matters. Distilled water or condensed steam also has a distinct tendency to dissolve iron, and when used, must be diluted with some raw water. The probable effects of corrosion are evident.

The nature of the impurities in the feed may be such as to cause foaming, the filling up of the steam space with unbroken bubbles of steam, or priming, which occurs when the steam carries water with it. The two usually occur together and manifest themselves by the rising and bubbling of the water in the gauge glass.

II. Sources of Water

The characteristics of a water are determined largely by the source from which it is drawn, and it is convenient therefore to distinguish the following three broad classes of supply.

(1) *Rain Water*—This water is very soft, but due to the fact that it contains dirt from the air and from factory roofs and that it is difficult to collect in sufficient quantity, it is practically unavailable as a boiler feed water.

(2) *Surface Water*—This water is taken from lakes, streams and artificial reservoirs which are fed by the slopes of hills. It is sometimes slightly acid, but is never hard, because it has not penetrated below the surface and so dissolved any lime or magnesium salts.

(3) *Ground Water* may be obtained from springs and wells. It is usually clear in appearance, but is hard, due to the taking in solution of mineral salts from the earth through which it has passed. The nature of the impurities in such water depends, of course, upon the composition of the strata from which it is drawn, the hardest waters usually coming from beds of gypsum and magnesian limestone.

III. Scale Prevention by the Three "General Processes"

It is evident from the above that every water will require individual treatment, and that a process which is suitable for the purification of one supply may be useless when applied to another. An analysis of the water by a competent chemist is absolutely essential to the success of a softening plant, and upon his report must be based the choice of a proper chemical reagent.

The three general chemical processes in use for water softening are:

(1) *The Lime (Clark) Process.*

(2) *The Soda Process.*

(3) *The Combined Lime and Soda Process.*

The Lime Process is used where the water contains bicarbonate of calcium and magnesium. It consists in the addition of calcium hydroxide, usually in the form of limewater. This limewater combines with carbon dioxide, which may exist in the free state in the water, or combined in the above mentioned bicarbonates, forming insoluble normal calcium or magnesium carbonates. The soluble bicarbonates, having lost a part of their carbon dioxide, are converted to the insoluble normal carbonates and precipitated according to the following reactions:

$$CaH_2(CO_3)_2 + Ca(OH)_2 = 2\ CaCO_3 + 2\ H_2O$$

$$MgH_2(CO_3)_2 + Ca(OH)_2 = MgCO_3 + CaCO_3 + 2H_2O$$

If any ferrous bicarbonate ($FeH_2(CO_3)_2$) is present, it will be acted upon in the same manner as the bicarbonate of magnesium. It is believed that with an excess of limewater the magnesium salt is changed to magnesium hydroxide ($Mg(OH)_2$). As this salt is also insoluble the effect is the same as in the case of the simpler action, but it allows a little latitude in the quantity of reagent to be used.

The Clark process does not affect calcium sulphate in any way. The limewater does, however, react with magnesium sulphate:

$$MgSO + Ca(OH)_2 = Mg(OH)_2 + CaSO_4$$

From this reaction it is seen that, although the magnesium is precipitated as the insoluble hydroxide, an equivalent amount of calcium sulphate is introduced, and inasmuch as this compound is in many ways more objectionable than magnesium sulphate the water is deteriorated rather than improved. The lime process is, therefore, only applicable to waters which contain bicarbonates as their chief impurity and in which amount of sulphates is small.

The Soda Process is adapted to the removal of objectionable sulphates. It is carried out by the addition of either carbonate or hydroxide of soda. When sodium carbonate is added to water containing the sulphates of calcium and magnesium, it combines with them to form the insoluble normal carbonates, leaving inert sodium sulphate as shown by the following reactions:

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

$$MgSO_4 + Na_2CO_3 = MgCO_2 + Na_2SO_4$$

This action takes place very slowly, and unless the water is preheated, which as a rule it is not, large settling tanks are necessary. Moreover, the presence of free carbon dioxide in the water interferes with the formation of the insoluble normal carbonates:

$$CaSO_4 + Na_2CO_3 + CO_2 + H_2O = CaH_2(CO_3)_2 + Na_2SO_4$$

The bicarbonate may be reduced to the carbonate by heating.

Caustic soda acts more quickly than carbonate of soda, and, though the results are better when the water is preheated, the speed of the reaction is usually sufficient to produce fair results. If the water to be treated contains no free carbon dioxide or bicarbonates, the caustic soda will react directly with the magnesium salts to form insoluble mag-

nesium hydroxide. It will not, however, precipitate the lime salts, because calcium hydroxide is freely soluble. If, on the other hand, the water does not contain free CO_2 the soda is believed to combine with this gas to form sodium carbonate, and the reaction outlined in the previous paragraph then takes place, Collet, however, believes that sodium hydroxide reacts with calcium sulphate and forms the soluble calcium hydroxide. This calcium hydroxide then reacts with CO_2 to form insoluble calcium carbonate:

$$CaSO_4+2NaOH=Ca(OH)_2+Na_2SO_4$$
$$Ca(OH)_2+Na_2SO_4+CO_2=$$
$$CaCO_3+H_2O+Na_2SO_4$$

If the carbon dioxide necessary to complete the above reaction is drawn from bicarbonates, the softening power of the soda is doubled:

$$CaH_2(CO_3)_2+CaSO_4+2NaOH=$$
$$2\ CaCO_3+Na_2SO_4+2\ H_2O$$

If, however, there is an excess of carbonic acid available, all of the bicarbonates will not be decomposed, and some method must be used capable of purifying a water containing fairly large quantities of both sulphates and bicarbonates. The combined lime and soda process is employed in such cases.

This *Combined Process* consists simply in adding enough soda to decompose the sulphates and sufficient lime to absorb the excess carbon dioxide:

$$CaH_2(CO_3)_2+CO_2+CaSO_4+Ca(OH)_2$$
$$+2NaOH=3CaCO_3+Na_2SO_4+3H_2O$$
$$2CaH_2(CO_3)_2+CaSO_4+Ca(OH)_2+$$
$$2NaOH=4CaCO_3+Na_2SO_4+4H_2O$$
$$CaH_2(CO_3)_2+CO_2+MgSO_4+$$
$$2Ca(OH)_2+2NaOH=3CaCO_3+$$
$$Mg(OH)_2+Na_2SO_4+4H_2O$$

The chlorides and nitrates of lime and magnesia act like their sulphates and may be removed in the same way. By varying the proportion of the lime-water and the caustic soda, almost any water containing mineral impurities may be deprived of its scale forming ability.

IV. Corrosion

In the foregoing paragraphs I have discussed briefly the action and removal of impurities which are essentially scale-forming materials. There are, in addition, found in water substances which are just as objectionable and as difficult to remove, namely, corrosive agents. As mentioned above, they may consist of materials which yield organic acids when acted upon by hot water, mineral acids, and certain metallic salts like magnesium chloride. When corrosion is due to the presence of organic matter (and oils), the best remedy is mechanical filtration, and this is a problem for the mechanical engineer rather than the chemist. Mineral acids rarely occur in any considerable quantities in natural waters, but, when they do, the effect of such re-agents as lime, when used in softening, is to neutralize them. Magnesium chloride is usually removed by the soda process, although lime is also effective:

$$MgCl_2+Ca(OH)_2=CaCl_2+Mg(OH)_2$$

The hydroxide of magnesia is precipitated and the calcium chloride remains in solution. Provided there is no magnesium sulphate present, this calcium chloride is harmless.

The corroding action of magnesium chloride presents, however, a more interesting case than the comparatively simple matter of its removal. There are two distinct theories as to the operation of this troublesome salt in eating away the iron of a boiler. The more usual one assumes that magnesium chloride is decomposed at high temperatures and gives off chlorine. The magnesium unites with the oxygen of the water and forms insoluble MgO which is precipitated. The chlorine combines with hydrogen and forms hydrochloric acid, which immediately begins to corrode the iron. This view of the matter is attacked by Ost on the ground that, when water containing magnesium chloride is distilled, even at high temperatures, there is no evidence that magnesium chloride decomposes. On the other hand, experiments showed that when hot water strikes the iron surface of a clean boiler a black crust of ferrous hydroxide ($Fe(OH)_2$) is formed. Ost, therefore, concludes that with hot water iron forms ferrous hydroxide and that the magnesium chloride then reacts with the iron hydroxide as shown:

$$MgCl_2+Fe(OH)_2=FeCl_2+Mg(OH)_2$$

The sulphate of magnesium would act in the same way.

If any calcium carbonate is present, it combines with the iron chloride and forms ferrous carbonate and calcium chloride. Calcium chloride then reacts with magnesium sulphate, thus reproducing the original amount of magnesium chloride and giving in addition the objectionable calcium sulphate. It is this series of actions which explains why a very small amount of magnesium chloride can do a large amount of mischief, while at the same time it remains unaltered in quantity. It should be noticed, however, that the presence of magnesium sulphate is essential to the carrying of this cycle of changes.

The next boiler trouble to claim our attention is foaming and, associated with it, priming. The causes are given by Carney as

1. Sodium Salts.
2. Mud or Suspended Matter.
3. Organic Matter.

There is no practical way of removing sodium salts, but mud and organic matter can be removed by filtration. A chemical process is, however, sometimes applied to the extraction of suspended matter. Commercial aluminum sulphate ($Al_2(SO_4)_3.18H_2O$), or Alum, ($Al_2(SO_4)_3.K_2SO_4.24\ H_2O$), is added to the water to be clarified. The sulphate radical displaces the carbonate radical of any calcium or magnesium salts dissolved in the water, forming calcium sulphate which is precipitated. The alumina is precipitated as flocculent and sticky aluminum hydroxide which envelops the particles of foreign matter and mechanically removes them. It is evident that this reaction can take place only when alkalies are present to combine with the sulphate radical. If carbonates of lime and magnesium are not naturally present in the water, the addition of caustic soda or sodium carbonate will cause the precipitation of the alumina.

VI. Water Softening Plants

In carrying out the above methods of correction of boiler troubles by chemically treating the feed water, the addition of the chemicals in an effective manner is a matter of no small moment. Irregular treatment, such as would be obtained by non-automatic feeding of boiler compounds, is not nearly as efficient as the use of the well-known water softening installations. Of these there are many different kinds, but in general principle they may be divided into a few groups, typified by the products of several well-known manufacturers. I shall, therefore, in concluding this paper, briefly describe the construction and mode of operation of the Kennicott, Scaife and We-Fu-Go water softening plants.

In the Kennicott system the hard water first enters a raw water chamber which is placed above a box containing a water wheel. The water falls on the wheel, and, in so doing, generates the power necessary for stirring up the chemicals. These are placed in an adjoining mixing tank containing a paddle wheel stirrer. A part of the raw water flows into a dividing box, which separates the stream into two parts, one of which is thrown back into the main hard water stream, and the other of which is directed into the regulating tank. As the level of the water rises, the regulating tank float also rises and in so doing lowers the mouth of the lift pipe into the reagent tank and allows the chemicals to flow out. As the amount of water fed to the regulating tank depends on the head of the main hard water stream, it is evident that the proportion of chemicals to water is automatically kept constant. From the reagent tank the chemicals flow to the top of the reaction cone, where they meet the hard water. This reaction cone is merely an inverted funnel-shaped affair placed inside of a cylindrical tank. Around the neck of the funnel and occupying the annular space between the funnel and the tank is a layer of filtering material. When the water has passed down the inside of the cone and up around the outside, the action of the chemicals, which is continuously taking place, has succeeded in precipitating the foreign matter. It remains only for the overflow through the filter to complete the softening action by removing all suspended particles. The water is then ready to be fed to the boilers.

In the Scaife system the feed water first passes through a heater where it

attains a temperature of about 200° F. Due to the driving off of carbon dioxide, the carbonate of lime and magnesium are precipitated and are deposited in removal pans inside the heater. The water is pumped from the heater into a large precipitation tank where the necessary chemicals are added by small pumps. The chemical tank from which these pumps draw their supply is of sufficient size to hold all the material necessary for a ten or twelve hour run, and the apparatus therefore needs practically no attention except the addition of the reagents once a day. In the precipitating tank the acids in the water are neutralized and the removal of scale-forming materials is completed. As a final precaution the softened water is filtered before being sent to the boilers in order to eliminate any possible suspended matter. This apparatus has the desirable characteristic of being continuous in operation and, at the same time, accomplishing its purpose without retarding the outward flow of the feed water.

The We-Fu-Go apparatus represents what is known as an intermitent type of softener. In this system the water supply first is run into the settling or treating tanks where it is agitated in contact with the softening reagents by means of a two-armed paddle at the bottom of each tank. The water next flows by gravity to the filters, which remove all particles of solid matter which have not settled in the treating tanks. From the filters the water is pumped to a clear water storage reservoir and thence through an open heater to the boilers.

In preparing this report the following references have been consulted:

Steam, Babcock and Wilcox.

Engineering Chemistry, Benson.

The Use of Boiler Compounds, Booth.

Boiler Water Purification, Booth.

Water Softening, Booth.

Boiler Waters, Christie.

Water Softening and Purification, Collet.

Industrial Uses of Water, De La Coux.

Steam Power Plant Engineering, Gebhardt.

Mechanical Engineers' Pocket Book, Kent.

General Outlines of Non-Metallic Chemistry, Pond.

EXPERIMENT STATIONS OF THE BUREAU OF MINES

In connection with the work of the United States Bureau of Mines, Department of the Interior, the bureau is now conducting eleven mining experiment stations, located in various mining centres of the country, and bending their energies toward the special mining problems that are local to their part of the country. So great has been the demand for knowledge concerning the character of the work undertaken at these various mining stations and its general relation to the mining industry, the bureau has issued a bulletin describing the work of the stations.

Dr. Van H. Manning, director of the bureau, sketches the work of the different stations as follows:

"The station at Columbus, Ohio, situated at a lay-working centre, is employed mostly on ceramic problems. In this country there are about 4,000 firms manufacturing clay products, including brick, tile, sewer pipe, conduits, hollow blocks, architectural terra cotta, porcelain, earthenware, china and art pottery. The amount invested in these industries is approximately $375,000,000, and the value of the products exceeds $208,000,000 annually.

"The station at Bartlesville, Okla., is investigating problems that arise in the proper utilization of oil and gas resources, such as elimination of waste of oil and natural gas, improvements in drilling and casing wells, prevention of water troubles at wells, and of waste in storing and refining petroleum, and the recovery of gasoline from natural gas.

"What the Bureau of Mines has done for the great coal-mining industry, chiefly through investigations at the experiment station at Pittsburgh, Pa., has been published in numerous reports issued by the bureau. Some of the more important accomplishments have been the development and introduction of permissible explosives for use in gaseous mines, the training of thousands of coal miners in mine-rescue and first-aid work, and the conducting of combustion investigations, aimed at increased efficiency in the burning of coal and the effective utilization of our vast deposits of lignite and low-grade coal.

"How vast are the deposits of low-grade ores being made available through the experiment stations is shown by the work assigned to the station at Minneapolis, Minn. The primary purpose of this station is to devise methods of utilizing low-grade iron ores. It has been estimated that the reserves of low-grade magnetic iron ores in the State of Minnesota alone amounts to some forty billion tons, but until recently these ores have been untouched because no process of treating them profitably has been devised. Even now only one company is attempting to utilize them. The Minneapolis station has already demonstrated that one process for utilizing the great deposits of manganiferous iron ore on the Cuyuna Range is metallurgically possible.

"Work such as this not only stimulates mineral production and helps to make available tremendous resources that are now unused, but it increases the total wealth of the nation and ultimately benefits every citizen.

"The mining industry is so related to commerce and manufacture that the importance of publishing the results of technical investigations of mining problems is becoming more and more evident. The miner and the mine operator are integral parts of the industrial system of the country, and each needs to keep in close touch with what the Government is doing through the mining experiment stations of the Bureau of Mines.

"In the West vast quantities of low-grade complex ores will become available as soon as commercially feasible processes are devised. Many of the problems involved, which are being attacked at the Golden (Col.) station, the Salt Lake City (Utah) station, the Seattle (Wash.) station, the Tucson (Ariz.) station, and the Berkeley (Cl.) station, are of such a nature that the small operator cannot afford to attack them, and the large operator finds them outside his field. Yet the solution of any one of them may add greatly to the available resources of the country and may result in establishing a new industry that will build up the district in which it is situated. Already these stations, although young, have witnessed such results.

"To-day, through the efforts of men at the Golden station, there is an American radium industry. Formerly the low-grade radium-bearing ore was wasted, the best of the ore was bought by foreign concerns at ruinously low prices, and the radium was shipped back to this country at excessively high prices.

"The Salt Lake City station has devised novel methods of treating certain low-grade and complex ores of lead and zinc. These methods show a large saving of metal over methods hitherto employed, and have made available ores that other methods could not treat profitably.

"The Seattle station is busy with the beneficiation of the low-grade ores of the Northwest, and the mining and utilization of the coals of the Pacific States; the Tucson station is working on the beneficiation of low-grade copper ores; and the Berkeley station has shown how losses may be reduced at quicksilver plants, and how methods at those plants can be improved.

"In the conduct of these investigations the bureau seeks and is obtaining the co-operation of the mine operators. At more than a dozen mills in the West engineers from the stations are working directly with the mill men on various problems, and the results they already have obtained more than warrant the existence of the stations. Success in solving one problem may easily be worth millions to the country. Mining men are using these stations more and more freely as they realize that the Government maintains these stations to help them, and that the difficulties of the operators, both large and small, will receive sympathetic consideration and such aid as the stations can give."

Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

Some Information Regarding Hydraulics

The Subject of Hydraulics From Both a Theoretical and Practical Standpoint is Described, Particular Stress Being Laid on the Application of This Knowledge to Fire Service

By DONALD A. HAMPSON, Associate Member A.S.M.E.

MOST men can trace their interest in the active work of fire departments back to boyhood days and the delirious joy of going to a fire with all the thrilling and noisy accompaniment. Men in the mechanical field are naturally interested in modern apparatus, its performances, and advances in the protection of life and property. In smaller cities with their volunteer fire departments and in private plants which maintain some sort of a department or other means of protection of their own, the engineering features such as the selection of new apparatus, repairs, hydraulic problems, etc., demand the assistance of someone with special training—and that someone is usually selected because of machine shop, engine room, drafting or surveying experience. With a good working knowledge of hydraulics to guide them,

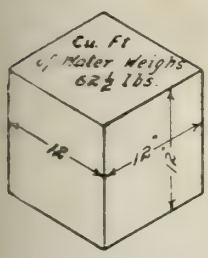


FIG. 1.

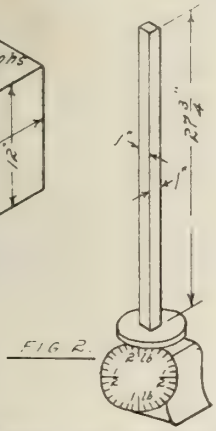


FIG. 1—ILLUSTRATING THE WEIGHT OF WATER.

FIG. 2—SHOWING COLUMN OF WATER THAT GIVES 1 LB. PRESSURE PER SQUARE INCH.

men of the machine trades are particularly well fitted to assist in this work—often at the same time gaining an unusual opportunity to appear in public life, where their business habits of getting quick, definite results in an economical manner make a unique showing alongside of the average municipal proceedings.

The Water Supply

Back of the fire department there must be a water supply. Viewed from several angles, the supply is of vital importance to all residents of a community. Except in new communities, a means of water supply has been provided, it serving for domestic, fire, and industrial uses. Many plants have their own water supply, either to assure better and quicker results in conjunction with city service or, in the case of isolated plants, to provide the only means of fire protection that is available. Whether public or private, an adequate or a seemingly too adequate supply is a measure of economy, figured in terms of insurance premiums, if in no other. Incidentally, it may be stated that the fire loss of the world in times of peace is approximately two hundred and fifty million dollars per year!

There are three common sources of water supply, i.e., the gravity system which delivers water from a reservoir on a higher elevation; standpipes which furnish a substitute for the higher elevation and into which the water must be pumped, and some arrangement of cisterns or wells from which the water is pumped into the mains. This latter system is in very limited use—the constant expense of pumping and the restricted quantity of water available making such a system of value only in special cases, though for industrial fire purposes where a positive source of power is to be had, pumps are recommended.

Villages that are not in a position to instal a gravity system, either from geographical or financial reasons, find the standpipe admirably adapted to their needs; pumps of some sort are required to keep the supply full, but it is often possible to arrange the installation in connection with some other work, thereby decreasing the maintenance expense. Standpipes are tanks, generally of metal, set upon a solid foundation on the highest elevation near at hand. Before the general introduction of elevated tanks, standpipes were often used for factory protection.

But the most widely adopted and satisfactory water supply is the reservoir, fed by rainfall alone or in conjunction with springs and streams. Its location is selected from a number of possible sites in which elevation, watershed, distance from the community it is to serve, cost of reservoir and pipe lines, and further expansion of the system are the factors weighed in making the selection. Maintenance is but a small item if the work is well done in the beginning, and it might be added that such a water system will not only pay dividends, but it will have the distinction of being the one self-supporting department in the community. A well-laid-out system will provide an abundance of water at all times, and this at a pressure that is not so high as to cause serious leaks in the piping and yet is ample for all needs.

The Part of Gravity

Gravity plays the leading part in the great drama of water. The reservoir, or gravity system depends upon this phenomenon for its action. Nearly all hydraulic calculations contain the factor of gravity or one that is deduced from it or is a substitution. The force with which the stream of water issues from the faucet is due to gravity and is the same in amount as if the water had fallen from directly overhead the same height instead of having come through long lines of pipe—there is, however, some loss in coming through pipes and around bends.

Hydraulic measurements are not made by weight but by pressure, though as just stated the weight (gravity) is the basis of pressure. In Fig. 1 we see the familiar cubic foot of water that weighs 62½ lbs. Weights of all other substances are taken from this as unity—steel, for instance, having a "specific gravity" of about 8 and weighing about 500 lbs. for a cubic foot. If we could shape water into a rod 1 in. square and have that rod 27¾ in. high, its weight upon the scales, Fig. 2, would be 1 lb.; this is an important point—it should be memorized because the length ex-

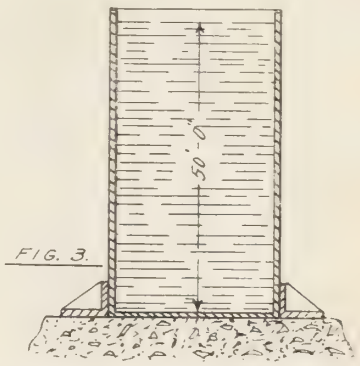


FIG. 3—TYPICAL STAND PIPE. THIS DEPTH OF WATER PRODUCES A WEIGHT AND PRESSURE OF 22 LBS. ON EVERY SQUARE INCH OF THE BOTTOM.

pressed as 2.3 feet is a frequently used factor in conversion. Our standpipe, Fig. 3, has 50 ft. of water in it—therefore the pressure on the bottom is 50 ÷ 2.3 = 22 lbs. per sq. in.

That water has weight every fireman can testify, but he seldom knows how much weight. A length of filled hose is heavier than most persons would guess; a one foot section of 2½ in. hose weighs 1½ lbs., and the water it holds, 2 lbs., making a total of 3½ lbs. as seen at Fig. 6—this is 175 lbs. for a 50 ft. length of hose without fittings! Water can be compressed but a fraction of one per cent. This property makes it invaluable in hydraulic machinery where thousands of tons pressure must be maintained. Water pressure is distributed equally in all directions as may be seen by reference to Fig. 4, where the piston in the left hand cylinder compresses the water, distributing the pres-

sure equally in all directions against the walls, as contrasted to the right hand piston which bears on a block of wood which transmits the same pressure directly and solely to the bottom.

The vertical height determines the pressure at the point of issuance. This height is called the "pressure head" or just "head"—it does not matter whether the points are directly over one another or miles distant, the vertical height

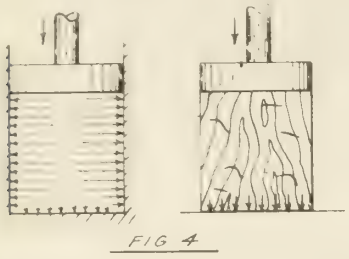


FIG. 4—AT LEFT WE SEE THAT WATER PRESSURE IS TRANSMITTED EQUALLY IN ALL DIRECTIONS. AT RIGHT WE NOTE THAT PRESSURE ON A BLOCK OF WOOD OR METAL IS NOT EQUAL.

remaining the same, the outlet pressure will remain the same, barring certain losses in the flow. Fig. 5 illustrates this point by an actual case from one city. Two hydrants were selected, one but an eighth of a mile from the reservoir and the other two miles away, but both having the same elevation, i.e., 150 feet below the surface of the water. Both hydrants are on the same 24 in. main, and according to the law of "head," both should show the same pressure, which they did without about one per cent.

Filters as a part of the municipal water system cut off some of the pressure—that because they are situated below the level of the reservoirs about ten to twenty feet and the water going into the mains partakes of a head based on the elevation of the filters. This means a loss of five to ten pounds pressure in the mains which may cut down the effective pressure for fire or high sections served so that pressure filters have to be installed, these being filters which have the pressure put back (so to speak) by pumps.

Besides weight and pressure, the factors of friction, velocity, and discharge figure largely in hydraulics. It is often said that water seeks its own level and rough calculations (?) are made upon such action. Water does seek its level but it never reaches it in any but a closed system, i.e., one where there are no discharges and where the water has time to adjust itself—the level is not reached until motion has ceased. The factors mentioned at the beginning of this paragraph are responsible for failure to reach the level in an open system.

The Hydraulic Grade Line

The height to which water will rise in a flowing system is shown by what is called the "hydraulic grade line," an imaginary line drawn from the surface of the supply to the last point of discharge; if at any point along the main, a tube were erected, the water would rise to that line—also if any part of the main rises above the line or some part of the city is above it, water will not flow there unless pumped or siphoned. Knowledge of the principle of the hydraulic grade line is of interest to firemen in noting the greater pressure at some locations than others. Fig. 7 shows an easily constructed model to illustrate and prove the principle; it will be seen that the water rises to the line; but if the outlets were plugged, the water from the tubes would spurt as high as the level in the tank.

The fireman must take the water at the hydrant as it is. The path from the main to the nozzle is usually shown as by Fig. 8, and the relative areas and capacities as shown at Fig. 9. The 4 in. pipe leading into the hydrant looks much too large for the 1 in. nozzle which the fireman uses—and it would be if the rate of flow were the same in each, which it is not, a nozzle being a device to increase the speed of delivery and thus needing a large feed pipe.

The fireman works with movable equipment—pumps, hose, and nozzles. Special formulae have been worked out for use in this connection because the standard formulae of hydraulics do not fit these special conditions. In big pipes, water flows along easily—the water in the 24 in. main at Fig. 5 loses but 1 lb. pressure in two miles of travel and it discharges over 16,000 gals. per min. (constrast this with a 3 in. pipe laid over the same stretch which would discharge only 20 gals. per min. to see the efficiency of large pipes). A familiar formula for discharge is:

$$\text{Gals. per min.} = \sqrt{\frac{D^5 \times H}{L}}$$

D in inches, H in feet, and L in yards.

Water is restricted in its flow by a number of factors such as—the resistance it offers to entering the pipe at the reservoir, friction in running through the pipe due to rough interior and confinement, bends in the pipe, branches leading off, and changes in the size of the pipe.

Friction

Friction is the big item of loss both in pipes and hose. Iron pipes are subject to a disease called tuberculation, a raising up of lumps on the interior, hastened and aggravated by an imperfect protecting coating at the time of manufacture. Tuberculation not only decreases the effective area but it makes this roughness which is the cause of so much friction. There is friction of liquids just as there is friction of solids and just as a weight is more easily shoved over a glass surface than an unplaned board, so water moves more easily through smooth vessels.

Fire hose is lined with rubber to make the interior smooth, as well as to make it waterproof. The friction of water moving inside good rubber lined hose is fully one-third less than through iron pipe of the same inside diameter. But when the lining gets worn, the friction may rise 50 per cent., showing that to get the required discharge worn hose must be replaced. This friction on the interior has been termed "skin friction."

The usual way of stating friction is to speak of it as so much loss of pressure in lbs. per sq. in. or as the pressure lost in 100 ft. of hose or pipe. In passing through a hydrant there is a loss of pressure of from 2 to 3 lbs.; and in connection with this it might be added that that is less than the friction loss in a hundred feet of good hose carrying only 150 gals. per min., showing that it is false economy to space hydrants too far apart.

Friction varies:

(1) Increases directly with an increase in length of pipe or hose.

(2) Increases directly as the inside diameter gets smaller.

(3) Increases as the square of the velocity.

(4) Increases with the flow.

Rule 4 is not commonly stated because it follows from rule 3, but it has been added here to emphasize the point, for firemen are apt to expect greater discharge than is actually realized by trying to increase velocity. As velocity is simply rate of speed, naturally more water will pass through with increased velocity, but a proportionate increase is retarded because the friction increases so rapidly. Table 1 gives the friction loss in 2½ in. hose for several rates of flow; considering eight or ten lengths of hose with a given flow and with twice that flow, we see that very little pressure can survive by the time the water reaches the nozzle.

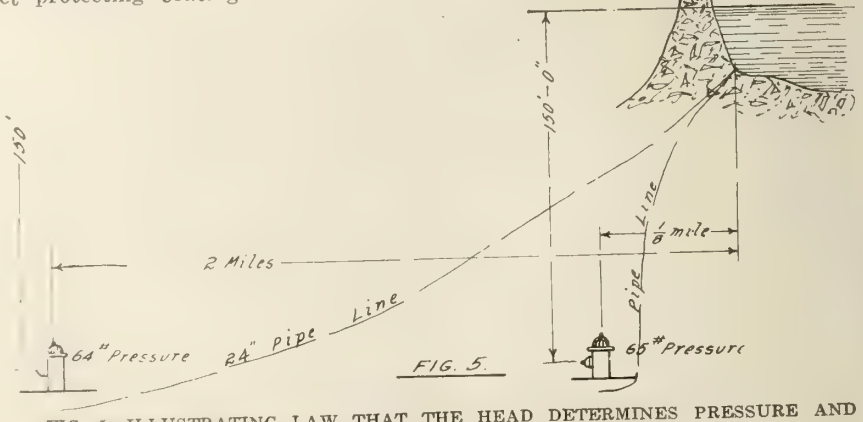


FIG. 5 ILLUSTRATING LAW THAT THE HEAD DETERMINES PRESSURE AND DISTANCE HAS VERY LITTLE EFFECT.

At the fire, the fireman has little time for hydraulic calculations. He is concerned with water where he wants it, when he wants it, and with the most speed, and to attain his ends he must practise applied hydraulics, either knowingly or not. The Siamese is a device to get the same amount of water to a

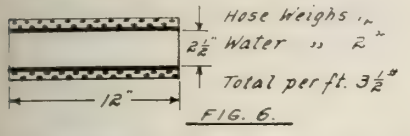


FIG. 6—SECTION OF FIRE HOSE AND ITS WORKING WEIGHT.

given point without such a great friction loss as obtains with a single line, that means more water because the velocity will not have been reduced to such a great extent. A study of the right hand column of table 1 shows at once the gain resulting from the Siamese—not to know the value of the Siamese may mean defeat at a big fire or when water is limited.

Returning now to the four rules of friction we find other chances for their practical application. Rule 1 shows why long hose lines should be avoided—thus, if there is a loss of 5 lbs. pressure in one length of hose, there will be a loss of 50 lbs. in ten lengths, which may absorb the entire pressure from the hydrant. Long lines of hose have no excuse for their existence, in most cases, except to furnish work for firemen.

Rule 2 does not affect the fireman because the size of hose and water mains have been fixed long before he arrives. Two and one-half inch hose has become standard except for the high pressure service in big cities, where 3 in. hose is used. For information it will be stated that the friction loss in 3 in. hose is less than half that in 2½ in. hose.

Rule 3 shows that if the water is forced through faster, the friction increases at an alarming rate. As previously stated in connection with flow, increasing the velocity is not always a good policy for a point is reached where the friction actually holds the water back and no gain is realized.

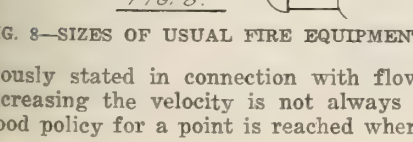


FIG. 8—SIZES OF USUAL FIRE EQUIPMENT.

Our knowledge of friction, then, tells us that more water is obtained for fire use—by keeping the lines short, by having only hose with smooth lining, and by limiting the velocity to, say, that corresponding to a nozzle pressure of 70 lbs.

Velocity

Velocity, as a rate of movement, may be expressed as feet per sec. for water, or in the case of a train, as miles per hour. There are two sources of velocity of the fire stream—"head" and pumps, which create an artificial head. Then we have nozzles which are a device to increase velocity.

Either by reason of the heat or of inaccessibility, it is seldom possible for a fireman to get within anywhere from ten to a hundred feet of the blaze—his stream of water must bridge this space and to do that effectively it must have some force to carry there. An effective fire stream is one that will pass through a ten inch circle at the point of consideration, that has not broken up into spray at that point. The effectiveness of a stream depends upon its velocity and its discharge. If a fireman pointed the open end of a length of hose toward a fire, the hose would discharge just as much water as if it had a nozzle attached, but the water would never reach the fire, it would fall but a few feet from the open butt. The reason for this and for the use of nozzles will be made clearer by a little elementary hydraulics.

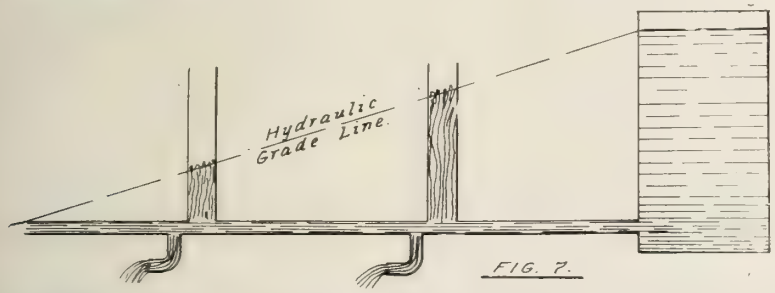


FIG. 7—MODEL USED BY AUTHOR TO SHOW THAT WATER DOES NOT RISE TO ITS LEVEL WHEN DISCHARGING. PIPES ERECTED AT ANY POINT WILL FILL ONLY TO HYDRAULIC GRADE LINE.

The common formula for a velocity is $V=\sqrt{2gh}$ where V is in ft. per sec. and h is the head in feet, while g is of course 32.16 (gravity). The principal use for this formula is in finding the velocity at a nozzle when the pressure is known, altering the formula to terms of lbs. per sq. in., as $V=\sqrt{4.6gp}$. As an example a nozzle pressure of 70 lbs. gives a velocity of $\sqrt{4.6\times32\times70}=101$ ft. per sec., which is at the rate of 70 miles per hour. A 40 lb. nozzle pressure equals 51 miles per hour, showing that a fire stream travels at a high rate. The velocity from a pipe line is affected by conditions previously named, one formula for this being

$$2.3\sqrt{\frac{h\times d}{.02\times1}}$$

Based on this formula, the pipe line of Fig. 5 should show a theoretical velocity of 98 ft. per sec., but actual tests showed it to be only 86 ft. per sec. during the day time.

FLOW IN GALLONS PER MINUTE.	1 – 2½" LINE	2 – 2½" LINES SIAMESED.
150	5·9	1·8
200	10·1	2·8
250		
300	21·2	5·9
400	36·2	10·1
500		

TABLE 1.

Nozzles convert volume into speed, just as the narrow ravine forces the brook to travel faster than when flowing through the wide meadow channel—the flow is practically the same in either case. The shape of the nozzle has much to do with keeping up the volume; thus in Fig. 10 if a hole is cut in the side of the standpipe as at A, the flow will be less than three-fourths what it would if a nozzle were applied as at B. The loss at A has been termed the "contracted vein." The velocity at the point of issuance is the same as it would be if the water had fallen a height equal to the head.

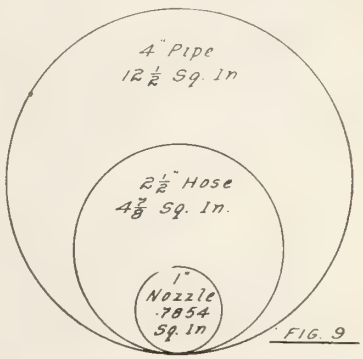


FIG. 9—ACTUAL SIZES, SHOWING ALSO RELATIVE CARRYING CAPACITY AT THE SAME VELOCITY.

As the velocity is the "get there" of the fire stream, anything that decreases it should be avoided as much as possible. Velocity is reduced by sharp bends, roughness inside the line, fittings, and changes in size. To what survives, we owe the activity of our fire streams. The range of a stream of water discharging horizontally is illustrated by Fig. 11, and calculated by the formula $R=\sqrt{4hy}$. In fire work, the streams are seldom horizontal and there is seldom any means of knowing the head, therefore, the range—or "reach"—as it is called is found from the pressure at the nozzle, and the latter determined by a gauge applied to the stream close to the point of issuance. Nozzle pressures and fire distances vary so much that tables have been prepared showing the maximum reach on an effective stream at many

NOZZLE PRESSURE.	20	25	30	40	45	50	55	60	65	70	80	90
V.	35	43	51	64	69	73	76	79	82	85	89	92
H.	37	42	47	55	58	61	64	67	70	72	76	80

TABLE 2.

different pressures, of which the Table 2 is an abbreviation. What are called "horizontal" and "vertical" distances in the table are shown by Fig. 12. The figures of Mr. John R. Freeman, determined nearly thirty years ago, have been the recognized standard for fire streams—he fastened his hose to heavy planks for his experiments and directed them at the angles of Fig. 12.

It will be noticed from the table that

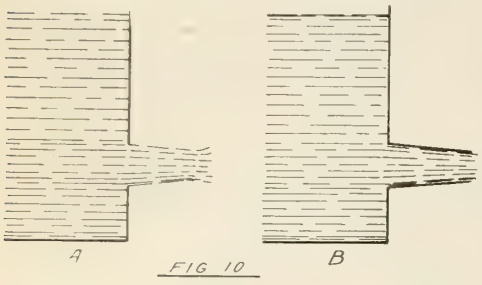


FIG. 10.

the increase in nozzle pressure is not accompanied by a proportionate increase in reach—this shows us the folly of trying to get more water, and that further, by increasing the pressure—somewhere around 50 lbs. at the nozzle is the most efficient stream. It will be also noticed that the vertical reach is greater than the horizontal. Table 2 is the reach with a 1 inch nozzle, the reach with other sizes up to 1½ inches do not vary 2 per cent. from this, showing that size of nozzle has nothing to do with reach.

Discharge

The discharge from a pipe is found from the formula to be Q=gals. per min.=.04d²×vel. Greater velocity means greater discharge both from a pipe and a nozzle. To obtain the discharge from a nozzle when the pressure is known, the formula is $D=29.7d^2\sqrt{p}$. As an example a 1 inch nozzle at 60 lbs. gives 216 gals. per min. This formula is near enough for practical results, but differs from actual discharges calibrated and compiled into tables—the tables give 229 gals. for the conditions named in the last sentence—the use of co-efficients brings the computed discharge up to the tables, but as it is difficult to remember these for all conditions, $D=30d^2\sqrt{p}$ is sufficiently accurate for field work. Due to the contraction named and shown by Fig. 10, an opening of the sort at A or the flow from a hose end—open butt—is materially reduced from that if some form of nozzle is provided, the open butt showing a discharge of only 70 per cent.

It is often desirable to know the discharge, but the nozzle pressure is not known though the pressure at the hydrant or the pump is. The discharge through lines of hose depends upon their layout—long lines of hose, hose carried up ladders, and sharp bends cutting down the discharge very much; in such cases the pressure at the hydrant or at the pump, if one is being used, does not indicate the ratio of discharge—it indicates certain operating conditions which build up the pressure at that point. This pressure may be used to find the discharge by the use of a formula in which N.P. is the nozzle pressure, E.P. is the pump or hydrant pressure, L the number of 50 ft. lengths of hose, and K a constant from the table 3.

$$\text{Then N.P.} = \frac{\text{E.P.}}{1.1+KL}.$$

An example is 2 lines of 2½ inch hose Siamesed into a 1½ inch nozzle with the pump showing 140 lbs. The N.P. then will be

$$\frac{140}{1.1+135\times 2} = 104 \text{ lbs.}$$

Knowing the nozzle pressure and the size bore, the discharge can always be found by the formula previously given, for our example $D=30\times 1\frac{1}{2}^2\sqrt{104}=$ 681 gals. per min.

The constant K has to be selected according to the number and size of lines and the bore of the nozzle. Only values for 2½ inch hose have been given in this table. Sometimes the nozzle pressure is known and the hydrant pressure is not and it is desired to form an idea of the latter; in such a case the discharge formula is translated into E.P.=N.P.×1.1.+KL.

It takes pressure to get water through long lines of hose with their friction and up ladders with the loss of head and weight of water and through small nozzles converting to velocity. A few localities have sufficient pressure for any fire demands, but most cities do not and the water in the mains has from 20 lbs. to 60 lbs. pressure. Pumps of the stream or motor-driven variety must then be employed for fire departments and power pumps for industrials. Pumps increase pressure—they are usually capable of increasing it beyond what hose will stand for long.

As has been said, the gauge on a pumping engine is indicative of the work the machine is doing—not of the amount of water the firemen are getting. That should be firmly fixed in mind. Enthusiasm in volunteer departments turns often to getting a high pressure at the machine instead of water on the fire. A couple of good, effective streams on the fire are better than a dozen poor ones. The same enthusiasm frequently leads to the laying of so many lines that none delivers an effective stream. The writer has seen first-class pumpers virtually useless because placed where the supply had already been tapped by many hand lines of hose—the pumper could get but little water, and this it was distributing through long lines to fearless men who couldn't reach above the first floor. Very likely the taxpayers of that community would be asked to enlarge the water supply, when the whole trouble is lack of knowledge of hydraulics by those in charge.

NOZZLE SIZE.	1 – 2½" LINE.	2 – 2½" LINES SIAMESED	3 – 2½" LINES.
1"	.105	.025	
1⅛"	.167	.043	
1¼"	.248	.066	.028
1½"	.505	.135	.061
1¾"	.907	.242	.115
2"	1.55	.413	.190

TABLE 3.

Lines which are carried up ladders or through water towers or standpipes do not discharge the amounts of the formulas given unless first the engine pressure is decreased by an amount which is the height of rise multiplied by .434. The gain in carrying a line up a ladder or in a building is that of obtaining a better point for play of the stream—there is no gain of velocity or discharge.

Where there is a pumper, it is of interest to know its capacity as compared to the delivery of the main from the reservoir or as compared with some stream that may flow through the town and which might be called upon to supply water for a serious fire. Very few streams of size that have not had their flow measured at some time or other—suppose that it was found to be 31,000 gallons per minute—that would equal the rated capacity of thirty-one pumpers of standard 1,000 gallon capacity; or,

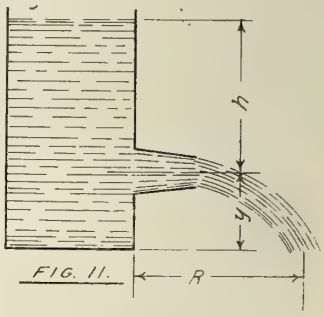


FIG. 11.

considering the main in Fig. 5, that will deliver about 10,000 gallons per minute, which equals the delivery of ten machines of the assumed capacity.

The selection of the best kind of pump is a matter of local conditions. A pump for stationary fire service may be of the gear type, centrifugal, or piston pump, the triplex pump of the latter type being highly in favor with the underwriters. The matter of drive for the pump has much to do with the type selected; for instance, the centrifugal pump makes a good outfit in combination with either an electric motor or a steam turbine for the drive is direct connected, and such a set is compact and efficient.

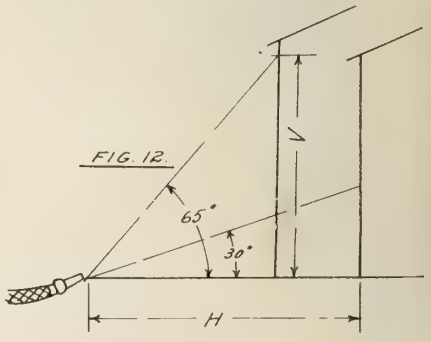


FIG. 12.

For use of the fire department, the modern trend is almost wholly toward motorizing. The steamer which has served so faithfully in the past has been outclassed by the gasoline pumper, which by this time is thoroughly reliable, and which has far greater capacity and speed than the steamer of the same weight. Only in Northern localities is there raised an objection to motor apparatus—that of inability to negotiate snow of depth. However, at time of the heaviest snow falls it is impossible for horses to draw any but light loads, and for a team to pull a heavy steamer is practically the same. During the severe blizzard of 1915, one third-class city was so tied up that not a vehicle of any sort moved for three days, except a seven-ton motor-driven pumper, newly purchased, which the driver in his enthusiasm took from the house against orders and successfully made a round of the town.

There are the usual three types, gear, centrifugal, and piston, to select from in the purchase of a motor pump. The gear pump is used by the most manufacturers, and is well and favorably known. Its objections may be summed up as pulsations of the stream and of the hose (not serious), wear of the gear teeth, and trouble with foreign matter if drafting from open water. The centrifugal pump has all the good qualities of stationary centrifugals; the centrifugal is a velocity pump, the pressure it delivers increases with the square of the velocity of the impellers. As there are no close-fitting parts it does not deliver a positive amount of water at all times, and it will not pump at pressures much over 200 pounds per sq. in.; having no fitting parts, it cannot create a vacuum, and when drafting, has to be primed. Its efficiency is the lowest of all the pumps, 65 to 70 per cent. on the average, but its freedom from trouble and ever ready qualities make it desirable for fire service. Stationary pumps of this type are used for the high-pressure systems in all the big cities.

The piston pump, gasoline driven, has proven quite successful, one make (Ahrens-Fox) having performed a feat never attainable with the steam-driven piston pump, i.e., that of pumping water to the top of the Woolworth Building in New York.

DAYLIGHT FROM ELECTRICITY

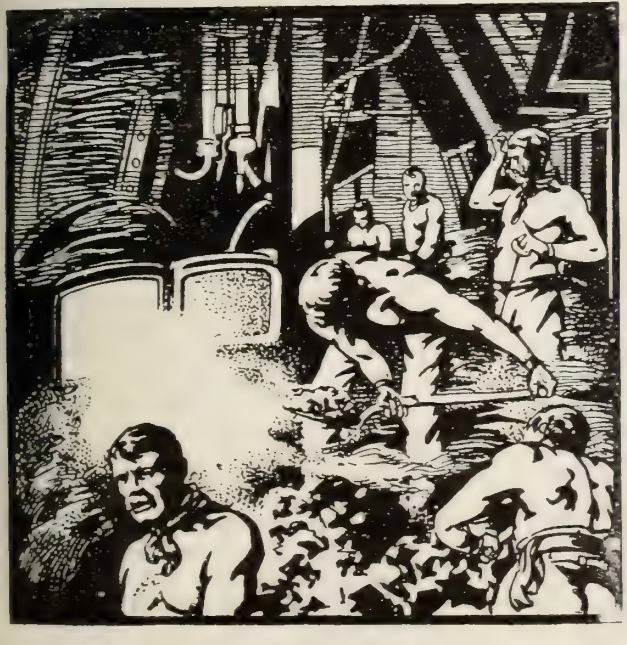
Various attempts have been made within recent years to obtain an artificial light which is near enough in tone to ordinary daylight to enable colors to be matched within accuracy. In most of these attempts screens were used to filter the light of electric lamps. Recently, however, a much more promising solution was solved by a British artist, Mr. Sheringham, in conjunction with Dr. Martin of the optical section of the Imperial College of Science, London, and Major Klein, an officer engaged on camouflage work. The device is remarkably simple. All the light from a half-watt (or gas-filled) electric lamp is thrown on to screen overhead, painted with apparently aimless splashes of various pigments. All the light obtained is that reflected from this screen and the pigments are arranged to absorb certain portions of the electric light so as to make the reflected light a close imitation of daylight. Electric light (from gas-filled lamps), is rather richer in red and yellow rays than daylight, and the pigments correct this excess. This mode of lighting has already been adopted with conspicuous success in a London picture gallery.

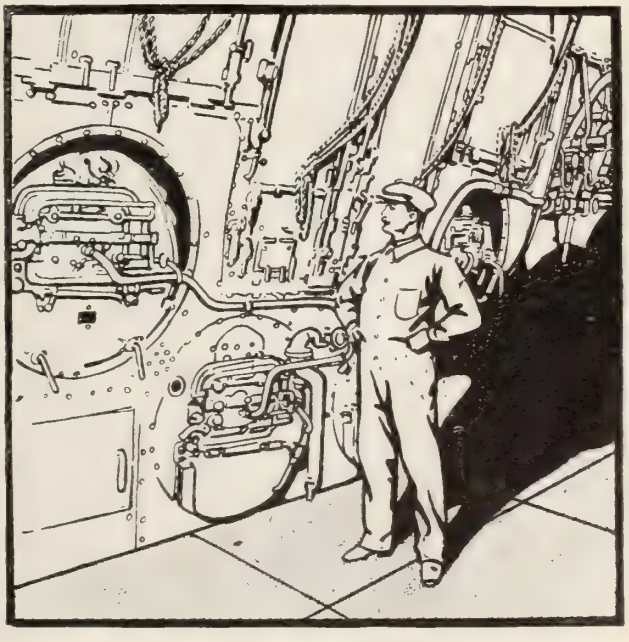
COVERING IRON WITH IRON

During the war many worn parts of aircraft machinery and motor vehicles used by the British forces were rapidly repaired in a remarkable way. The metal worn away was replaced by depositing a film of iron by means of electricity. This process was applied in the case of ball bearings and other parts, where even a minute amount of wear was so serious that scrapping would be necessary. It was also used with good results in saving from the scrap heap any parts of machinery which had accidentally been made a few thousandths of an inch too small. The problem of electrically depositing iron is a very difficult one, but the methods developed by British engineers were most successful. By means of heat treatment the deposited film becomes so closely welded to the metal that microscopic examination can detect no dividing line. Much of the research work in this matter was carried on at Sheffield University.

A BRITISH ELECTRIC "SCOOTER"

A very attractive development of the motor scooter has been made in Great Britain. Realizing the advantages of simplicity in the mechanism of this humble type of vehicle, a British firm has produced an electrically-driven model. A small storage battery is placed between the wheels and drives an electric motor of ½ horse power geared to the back wheel. Speeds up to 12 miles per hour are obtainable on level roads, and one charge of the battery will cover from 25 to 40 miles. The control is by means of a small switch actuated by rotating one of the handles. A seat is provided, and there is a road foot-rest on each side of the battery. Owing to its moderate speed, the electric scooter is intended merely as a convenient town or village runabout for occasional use, as by ladies on shopping or visiting expeditions. The final cost is expected to work out at aobut £30, and the running costs are very low, while maintenance expenses will, owing to the absence of an engine and other complicated mechanism, work out at a very modest figure.





COAL VS. OIL FIRING ON BOARD SHIP—A CONTRAST FROM THE "STEAMSHIP."

The Use of Superheated Steam and Superheaters

The Use of Superheated Steam Results in Very Material Economies in Power Plant Operation. This Article Deals With the Subject in a Comprehensive Way From Both Operating and Economic Standpoints

By ROBERT JUNE, Mechanical Engineer

THE possibilities of effecting economies in the power plant through the use of superheated steam are worthy of careful consideration in these days of high fuel and labor costs. In this connection, the fact should be recognized, at the outset, that the use of superheated steam is not necessarily confined to new plants especially designed for such operation, but that in many cases it can be successfully adapted to old plants without incurring excessive expenditures. In our discussion, it will be well to examine the effects of superheating, factors governing advisability of using superheat, temperature to which steam is to be raised, superheater construction, materials for use with superheated steam, and some details of operating practice.

Effects of Superheating

By superheating, we mean the practice of raising the temperature of steam, immediately after its generation in the boiler, to a point considerably above the saturation point, without greatly increasing its pressure. When utilized in the steam engine, superheated steam possesses the following advantages:

1. The more heat supplied per unit of volume of steam to the engine, the more work can be obtained from the engine, and the increase of pressure having a practical limit, this extra heat is to be obtained by superheating the steam. A moderate amount of superheat produces a large increase in volume, the pressure remaining constant and diminishing the weight of steam per stroke for a given amount of work.

2. The diminished density of the steam employed to do the work lessens the back pressure, or, as commonly expressed, improves the vacuum. This also applies to the air and vapor which are carried with the steam, and further expanded by the increased heat, and are consequently contracted to a much less volume when chilled, by striking the cooling surface of the condenser; thus the air pump has less work to do.

3. The prevention of condensation during expansion without the use of steam jackets is the most important advantage to be attached to the use of superheated steam. Steam jackets are wasteful and inefficient when applying heat to the engine. Inefficient, because the contact is only with the steam immediately adjacent to the walls of the cylinder, with probably little effect being derived by the steam in contact with the piston and in the interior of the cylinder out of reach of the radiation from the walls; wasteful, because of the full effect of heating the exhaust steam after it has done its work in the cylinder during the waning stages of expansion and throughout the exhausting stroke. This is particularly true of engines which have a pause at the end of the stroke, which pause always finds the cylinder full of steam which has completed its work in the cylinder and is ready to be exhausted. Ample evidence of the truth of this statement is found in the high ratio of water condensed in the packets of direct-acting pumping engines to the amount of steam used in the cylinders.

4. Elimination of condensed water in piping leading to engine.

5. Reduction of friction, cutting down loss of pressure in ports and passages, and permitting reduction in size of conducting pipes.

Factors Governing Advisability of Using Superheated Steam

The decision to use or not to use superheated steam in any particular plant will depend upon a thorough study of the plant conditions, taking into account fuel cost, engine performance, capacity of plant, steam line losses, cost to install and maintain superheaters, etc.

Engine Performance: As a general proposition, the savings to be effected from the use of superheated steam vary inversely with regard to the efficiency of the prime mover when using superheated steam—being greatest with direct-acting pumps, and smallest with steam turbines. A fair estimate of the average saving which may be effected with moderate superheat, that is, say 100 to 125 degrees F., based on continuous operation of existing plants, is for slow-running full-stroke, throttling engines, including direct-acting pumps, 40 per cent.; simple engines, non-condensing, with medium piston speed, including compound direct-acting pumps, 20 per cent. for compound condensing Corliss engines, 10 per cent.; for triple expansion engines, and turbines, 6 per cent. Of course, higher figures than these have been obtained but these may be taken as a fair average. Table 1, below, gives a fairly accurate range in steam consumption for prime movers, based on saturated steam, 100 degrees, and superheated 200 degrees.

TABLE I.

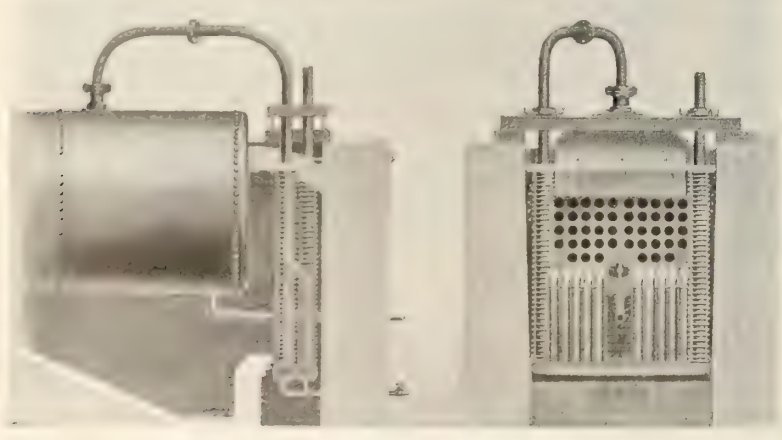
Ranges in Steam Consumption by Prime Movers.

Type Engine	Steam Consumption, lb. per H.P. Hr. Saturated Steam	100° Superheat	200° Superheat
Simple non-condensing ..	29-45	20-38	18-35
Simple non-condensing automatic	26-40	18-34	16-30
Simple non-condensing Corliss	26-35	18-30	.....
Compound non-condensing	19-28	15-25	13-22
Compound condensing ..	12-32	10-20	9-17
Simple duplex steam pumps	120-300	80-160	.....
Turbines non-condensing (kw. hr.)	28-60	24-54	21-48
Turbines condensing (kw. hr.)	12-42	10-38	9-34

Capacity of Plant: Naturally, the capacity of the plant has an important bearing upon the advisability of using superheated steam, inasmuch as the cost of the installation may be out of proportion to the savings to be effected. If the steam consumption is equivalent to about 250 h.p. continuously, however, it would seem desirable to investigate the possibilities of superheated steam.

If the plant is large, the question should, by all means, be taken under advisement. This is particularly true where there is any apparent lack of boiler capacity, as it may develop that the use of superheated steam will necessitate the purchase of additional boilers.

Another point worth remembering, in this connection, is that in the case of old boilers, where the insurance companies may require that, owing to their condi-

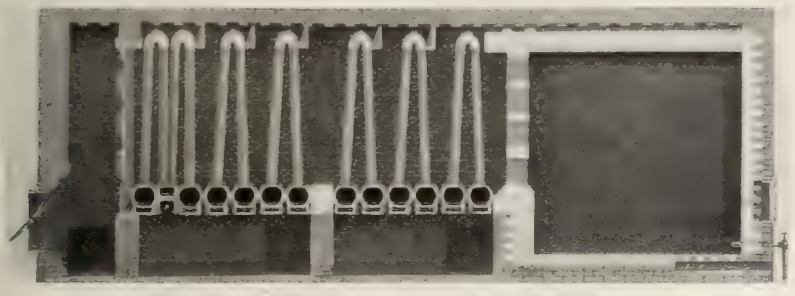


SUPERHEATER ON HORIZONTAL WATER-TUBE BOILER.

tion, they be operated at lower pressures. Under such circumstances, a loss in capacity of the boiler results. This loss may be made up by a change from saturated to superheated steam.

Steam Line Losses: Condensation in long pipe lines is a problem which is faced in many plants. Ninety per cent. of the heat necessary to evaporate water is latent heat and if condensation takes place before the steam is transformed, this latent heat is liberated and the waste and losses, due to condensation may be very large. Under the best conditions, with properly proportioned, well-covered steam pipe, we find a loss of 1/5 to 1/3 of a degree F. of superheat per foot of steam pipe. It seems reasonable to assume that with the ordinary large and indifferently covered steam pipe, that the loss may reach as much as one degree F. for every foot of pipe; consequently, a pipe 100 feet long would probably lose 100 degrees of superheat which is equivalent to five per cent. of moisture in the steam, if we assume that the steam is dry before leaving the boiler.

Superheat is necessary to raise the temperature of the steam to a point where it may all be transmitted to its destination without continuous loss. As superheated steam does not give up its heat as readily as saturated steam, it can be transmitted with smaller total loss. Superheated steam is, therefore, fore, valuable as a means of eliminating the condensation in steam pipes.



INDEPENDENT TYPE OF SUPERHEATER.

Cost of Installing and Maintaining Superheaters

The cost of installing superheaters should be figured to include not only the cost of the equipment, but also the cost of remodeling the steam lines, should this be necessary. Superheated steam will, of course, cause greater expansion and contraction in the steam lines, and it may be necessary to make important changes in these lines before superheated steam can be used.

Insofar as maintenance is concerned, if the superheater is installed in the boiler, it can be regarded as a part of the boiler and there is no reason why this maintenance should be higher than that of the boiler with respect to the comparative cost of the two installations. If pipe lines are not properly arranged, they may be more expensive to maintain, but the remedy for this is proper arrangement to take care of the expansion and contraction. Once this has been secured, there is no reason why piping for superheated steam should cost more than that for saturated steam.

Degree of Superheat: In the United States and Canada, total steam temperatures rarely exceed 600 degrees, while in Europe 600 degrees is a common temperature, and temperatures of 850 degrees are often reached. This does not necessarily mean that steam practice in Europe is in advance of steam practice in America and Canada. In Europe they have had a condition of excessively high fuel costs and low labor costs, whereas we have had the reverse, that is comparatively cheap fuel and very high costs for labor and materials. This means that, insofar as we are concerned, the greatly increased cost of an installation above a total temperature of 600 degrees F., may so far offset the possible savings in fuel that the installation will not be economical.

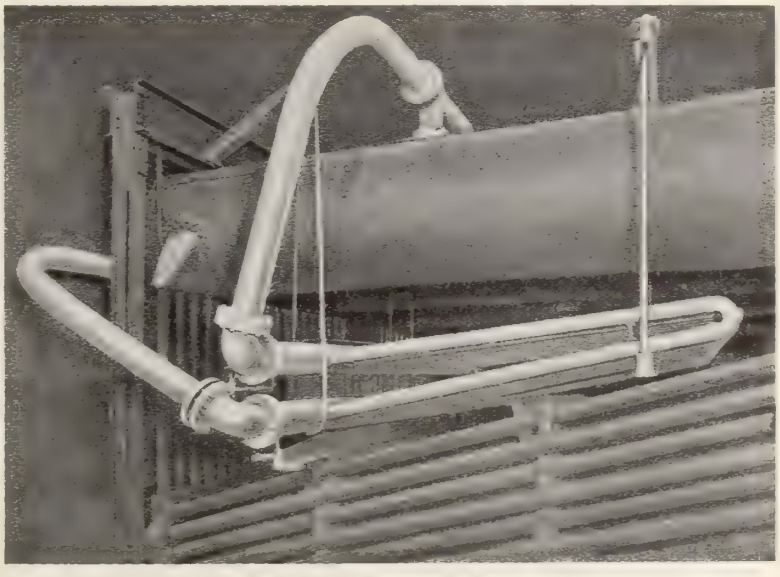
As a general proposition, we may state that for at least ninety-five per cent. of the steam plants in the United States and Canada, 100 degrees of superheated steam is about right, and that only in exceptional cases should superheat exceed 125 degrees.

It should be remembered that high temperatures are apt to interfere with lubrication, and perhaps to cause warping of the valves. With superheat, difficulties of this nature are to be expected. While on this subject of the effect of superheated steam on the valves of an engine, it may be well to run over conditions obtaining in the engine when superheated steam is used. After leaving the superheater and while passing through the steam lines, the heat lost by radiation does not cause condensation, but instead merely causes a loss of a portion of the superheat.

The greatest saving from superheat is obtained in the engine cylinder and results from the elimination of most, if not all, of the loss due to cylinder condensation. The saturated steam losses ordinarily occur in the cylinder, due to condensation caused by the steam coming in contact with the relatively cool cylinder walls. The drop in pressure, caused by this condensation, induces a further flow of steam into the cylinder to fill the space originally occupied by the steam which has been condensed. In the average simple engine cylinder, condensation varies from 20 to 40 per cent., and as water condensation takes up only 1-150 as much space as the steam, we may assume that the same amount of steam will be required to replace that which has been condensed. Even with superheated steam, we do not always obtain dry steam at cut-off, but the important point is that most of the losses caused by cylinder condensation are eliminated. The presence of moisture in steam is apt to result in the use of large amounts of oil for lubricating purposes, and water in the steam tends to wash all water out of the oil. With superheated steam, the walls of the engine cylinder are free from water. A thin film of oil adhering to the surface will give perfect lubrication.

Superheater Construction

Superheaters are of two general types; those placed independently of the boiler, and those built into the boiler and at some point heated by the gases from the boiler furnaces. With water-tube boilers,



SUPERHEATER ON HORIZONTAL RETURN TUBULAR BOILER.

it is usual to place superheaters between the first and second passes, although this arrangement varies with the individual boiler. With fire-tube boilers, the superheater is placed in the combustion chamber at the rear of the boiler.

Since the absorption of the heat depends upon the average differences between the gases and the steam, the required degree of superheat may be obtained from a comparatively small amount of heating surface close to the furnace, or a larger amount at a greater distance.

The requirements of a successful superheater are:

1.—Safety of operation and minimum danger of overheating.

2.—Construction permitting of free expansion.

3.—Arrangement such that it may be cut out without interfering with plant operation.

4.—Provision for keeping surfaces exposed to gases free of soot.

Advantages of the independent superheaters are:

1.—Degree of superheat is not dependent upon boiler performance.

2.—Repairs may be made without reference to the boilers.

Among the disadvantages are:

1.—Requires individual attention.

2.—Requires extra piping.

3.—Requires additional space.

Among the advantages of the superheater placed in the boiler setting:

1.—Lower first cost.

2.—Requires no individual attention.

3.—Takes up no additional space.

Among the disadvantages are:

1.—Subject to boiler conditions and must frequently be watched during the period of cutting in boilers, and superheat is apt to fluctuate with temperatures in the furnace.

A great deal has been written about the advantages and disadvantages of certain types of superheater construction. At the present time there are a number of superheaters on the market which have been brought up to a high state of perfection and there is no need here to enter into a discussion of their relative merits. The commercial superheater companies and large manufacturers of superheaters have competent engineers who specialize in superheater work, and the power plant manager or superintendent contemplating a superheater installation will do well to consult with these specialists.

Materials for Use for Superheater Steam

Where boiler pressures are high and a comparatively high degree of heat is used, it is necessary to pay special attention to the materials and construction of the piping system. The following points are worthy of note in this connection:

Piping: Screw joints are not generally desirable with superheated steam. This makes necessary the use of welded flange, Van Stone, or similar joints. For this work, piping made from open-hearth steel is more desirable than ordinary wrought iron piping, because it can be properly worked since it contains less carbon, and the quality is more uniform.

Fittings: Fittings are now manufactured especially for superheated steam, and for this purpose are entirely satisfactory. A point to be watched is that the fittings as purchased from the manufacturers are specified as being intended for use with superheated steam. Of course, as a matter of good practice, it is well to limit the number of fittings as much as possible by the use of welded joints and bends in the pipe.

Valves: The very best valve obtainable should be used for superheated steam. There is a general impression among the engineers that globe valves and angle valves are more apt to prove steam dry after a period of use than gate valves, although the gate valve has the advantage of causing a much smaller drop in pressure, due to its design permitting a straight flow of steam. A piece of steel six inches long when heated to 500 degrees F. will expand .019 inches. This fact shows the variations in the co-efficient of expansion of the metals of which they are constructed will have an important effect on the performance of a valve setting tight. Valve setting is a point which should be watched.

Metals: Various authorities state that cast iron should not be used at temperatures which they variously state as ranging from 480 to 575 degrees F. Above this temperature, the limit of elasticity in cast iron is reached, with a pressure ranging from 150 to 175 lbs. Under such conditions the material is strained and does not resume its former shape, eventually showing surface cracks which continue to grow until the metal parts. From this, it follows that castings are not suitable for either fittings or valves in superheated steam work. Cast steel is, undoubtedly, the best material for both valves and fittings. This metal is capable of withstanding all temperatures and pressures up to at least 800 degrees F. without showing any appreciable weakness.

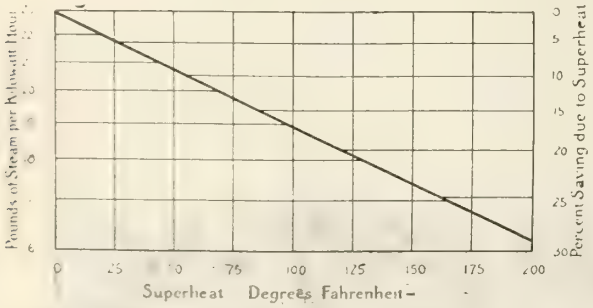
High temperatures have a very pronounced effect upon the breaking strength of brass and bronze, and these materials should not be used with superheated steam as they will soon get out of shape and eventually break.

Gaskets: Copper or bronze gaskets are looked askance upon by many engineers for superheated steam work. Among types which met with favor are corrugated soft Swedish steel gaskets and corrugated or bronze gaskets surrounding asbestos.

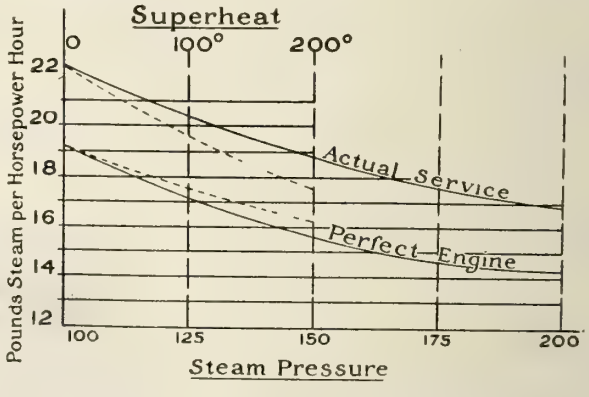
Operating Notes

There are times when, in the ordinary use of a superheater, the circulation of steam will be less than at others. While at such times superheaters may be exposed to the furnace gases at high temperature, such a condition occurs when the load is temporarily arrested or when cutting in the boilers to guard against damage. Under such conditions some superheaters are provided with flooding arrangements by which superheater types are filled with water and this made part of the evaporating surface of the boiler. To do this, it is necessary to open and close certain valves on each boiler, an operation which must be reversed when the critical period is over and the superheaters are to resume their normal practice.

Admitting water to the interior of the superheater induces a formation of scale to the tubes. Moreover, a superheater which has been flooded must be drained before being put back into service. This necessitates, on each boiler, a double operation on the part of the attendant which must be carried out with great care and intelligence, because of the disastrous results to the engine which might follow if the water in the super-



SAVING DUE TO SUPERHEAT-TEST OF HIGH-SPEED TRIPLE EXPANSION ENGINE—BELLIS AND MARCOM LTD., BIRMINGHAM. 100° SUPERHEAT REDUCES STEAM CONSUMPTION PER K.W. HOUR FROM 23 POUNDS TO 18.8 POUNDS—SAVING 17 PER CENT.



EFFECT OF INCREASING SUPERHEAT (DOTTED LINES) FOR PERFECT ENGINE AND ACTUAL SERVICE.

Electric Power Collection From Small Water Power Developments

By C. P. STEINMETZ

In the development of the arts and sciences, and especially in industries which have advanced as rapidly as electrical engineering, we frequently strike barriers which seem to stop further progress in a certain direction and give the impression that the possibilities have been exhausted and the final limit reached in this direction, until some new idea carries us beyond or around the apparently unsurmountable barrier and the beyond shows us a field of development vastly greater even than what had before been considered as the final possibilities. Or more often it is an old idea, which though discarded in the earlier days of development, leads us beyond the barrier which had stopped progress. Thus, when we see development slow down and apparently the limit of progress reached in certain directions, it is advisable to go back to the earlier days and search whether, amongst the ideas then unsuccessfully tried, we may not find some which lead to success under the changed conditions.

A good illustration is given by the history of electric lighting. Metal filaments were tried but found wanting in the earlier days, before the carbon filament, and for a quarter of a century the latter held sway. But after the first few years of rapid advance, progress slowed down and apparently the ultimate limit had been reached at about three watts per mean spherical candlepower. Then the old idea of the metal filament, backed by the twenty years' advance of chemical engineering, carried us around the barrier and more than quadrupled the efficiency of incandescent lighting.

So power generation by the reciprocating steam engine seemed to approach a limit in size and economy of units, until the development of the oldest type of steam engine, the steam turbine, carried us far beyond the possibilities of the reciprocating steam engine.

So the interpole or the commutating pole had been known for many years, but lay dormant until with the change of conditions of commutating machine design it became the means of advance beyond the barriers which were limiting further progress.

But if ever progress was important, and especially engineering progress, beyond the barriers retarding the advance, it is now, in our present period of the world's reconstruction.

But to progress beyond barriers, we first have to see and realize those barriers, and long familiarity with existing methods of doing things tends to standardize our thoughts and leads us to consider as essential and inherent, features which are only incidental and due to the conditions under which the development has taken place, and disables us, when these conditions change, to see beyond the incidental limitations. Standardization is useful and important, and indeed industrial progress would be impossible in the chaos which would result without standardization, but standardization becomes harmful when extending to our thoughts whether and how things can be accomplished. One of the first ways to realize and overcome this limitation is to review the development and ask ourselves why it has taken place in that partcular direction, how far the course of development has been due to temporary conditions and whether with the change of these conditions a different direction of development may lead us beyond the possibilities of our present achievements.

Let us apply this to the development of electrical machinery.

The electric generator and the electric motor are identical. Often the same machine is used as generator or as motor, and where there are differences in construction, they are in details, to accentuate certain characteristics for certain purposes.

Thus in a synchronous machine we may add a squirrel-cage winding in the field pole shoes, when used as a synchronous motor, to give a better starting torque, while we may omit this winding in the generator; but the turbo-alternator when left in circuit, with the steam cut off the turbine, continues to revolve and is just as good a synchronous motor; in a commutating machine we may add a series field when intended as a generator, to give better voltage regulation, and omit it in the use as motor, since the speed regulation of the shunt motor is sufficiently close, etc.

Quarter Century Development

Looking back over the electrical development of the last quarter of a century, we have seen the size of generators and generating stations steadily increase, due to the higher economy of larger generators and generating stations. The maximum size of motors also has steadily increased up to units of many thousand horse-power; but the average size of motors has increased little, if at all, due to the increasing use of individual motors, applied directly to the driven machines.

The average motor is installed with a switch to turn it on, and a fuse to cut it off in case of overload or accident, and then left to itself with practically no attention. In the generator installation, however, we find a very elaborate system of switchboards, instruments, controlling and protective devices, etc., requiring continuous and highly skilled attention. Why is this, if generator and motor are the same type of apparatus? Obviously, it is not due to the use of the machine, in the one case as motor, in the other case as generator, but it is due to the size of the machine. With the huge size of the average generator installation, an elaborate system of control and protection becomes necessary, which is not necessary with the average small motor installation, and indeed, in the installation of very large motors, we find more controlling and protective devices than a switch and a fuse.

Thus, inherently, a generator installation is no more complex than a motor installation. The complexity of the modern generator installation is the neecssary result of its huge size, and a small generator installation could be as simple, limited to switch and fuse as controlling and protective devices, could be left to run itself with occasional ininstallation has steadily increased, while the average size of motor has not, this is not due to the complexity required in the former, but the reverse is the case, the complexity of the generator installation is the result of its huge size.

The difference in the course of development of motor and generator thus must be found in other directions. As an instance, let us consider the application of the electric drive to the cotton mill industry, which is typical of the entire electric motor development.

When the first cotton mill was electrified in 1894, the steam engine was taken out, and a 400-horse-power synchronous motor put into its place, driving by belts and shafts and countershafts the individual machines; that is, the power was generated electrically, but distributed mechanically. But in the new mill of the same plant, a number of 100-horse-power induction motors were installed, each driving a line of shafting to which the individual machines were belted; that is, at least a part of the power distribution was done electrically. I need not say that even this is antiquated and that experience has long proven that the most economical arrangement is to entirely eliminate mechanical power distribution and distribute all the power electrically, up to the individually driven machine. That is, to have individual motors at every machine. This has long become the standard method of electric motor application. This is the reason why the average size of electric motor is small, corresponding to the power required by the individual machine, and large motors are used only where a large unit of mechanical power is required, as at the rolls of a steel mill, or the propeller of the battle cruiser.

But in electric generation we are still in the first stage, that typified by the huge synchronous motor distributing power mechanically through numerous belts, shafts and counter-shafts. We collect the power of a watershed mechanically by elaborate hydraulic works, costing many times more than the most elaborate generating station, and then in a big unit convert the hydraulic—that is, mechanical — power into electric

power in a modern synchronous generating station. Or we burn millions of tons of coal under the steam boilers in our huge steam stations, extract 10 to 14, or possibly 20 per cent. of its energy as electric power, and then pay for the condensing water to throw away the 80-odd remaining per cent. of the heat energy of the fuel, while in numerous other furnaces we burn millions of tons of coal to produce heat, but waste the potential mechanical and electrical energy of this coal.

This is not a condition to make us proud of our industrial efficiency. But it came about naturally, as the result of historical development.

The first electrical development occurred where hydraulic power was available in concentrated form, at waterfalls such as Niagara, etc., that is, cases corresponding in motor development to the rolling mill or the ship's propeller. The synchronous machine is the proper type of generator for such installation, just as the synchronous motor is to-day, and always has been, the preferable type of motor for large units of power unless special conditions prevail and demand the induction motor, such as the need of frequent starting under heavy torque.

The same type of hydro-electric development was extended to conditions where water power was available in less concentrated form, and had to be collected by more extensive hydraulic works, gathering together the power of a watershed, and so the modern hydro-electric generating system was developed as the most perfect known method, within its scope and limits, of utilizing water power — mechanical collection of the water power by hydraulic works, and conversion in a big-unit synchronous generating station.

But the high cost of the hydraulic work makes such development ecenomically feasible only where large amounts of water power are available in fairly concentrated form, and with the increasing development of such power sites, the number of water power capable of development by our present methods is decreasing, while most of the country's potential water powers cannot be developed by our present standard methods of hydro-electric generation, as the cost of the necessary hydraulic development, to collect the water power, is greater than the value of the power which may be collected. The only hope which can be seen for a more complete utilization of our country's hydraulic power, from the abandoned mill sites of New England to the mountain streams of the South and the West, thus lies in applying to the electric generation the same principles which have made the electric motor economically successful; that is, bringing the electric machine to the place of power. That is, just as we place individual motors at every machine where mechanical power is required, and distribute the power to them electrically, so as to place individual electric generators wherever along the water course hydraulic power is available, and collect the power of all these generators electrically.

Small Induction Generator Station

For these relatively small individual generators, required for electric power collection, induction machines would naturally be used just as induction machines are exclusively used for smaller units of motors, however superior the synchronous motor is for larger powers.

Such a small induction generator station then would consist of a standard low voltage induction motor connected to some simple and cheap hydraulic turbine, a few hundred feet of pipe, and a low dam across the creek, to cover the intake of the pipe; a step-up transformer connecting the machine into a medium voltage collecting line, low tension switch and fuse to disconnect in case of accident. Hundreds of such small induction generating stations then would feed into the system over collecting lines, just as hundreds of induction motor installations receive power from it over distribution lines, and a large synchronous main station — steam turbine or hydraulic, or possibly even merely a synchronous motor station — would control the voltage and frequency of the system.

In similar manner, a simple and cheap turbine induction generator plant, interposed between the high pressure steam boiler and the steam heating system which it supplies, would abstract the small percentage of fuel energy which is available in conversion to mechanical and electrical power, and turn it into the electrical distribution system, on whch the induction generator floats, thus collecting electrical energy from numerous small stream stations and eliminating the present wasteful use of coal.

Now this development of electric power collection is coming, as it is the natural economic development of electric generation, just as the individual motor drive was in electrical power distribution. There are already a number of such hydro-electric induction generator installations throughout the country, some in succesful operation for years, and the field thus opened up is very large, larger possibly than all the electrical development which has taken place hitherto, and one of the features of this development is that no new type of apparatus requires to be developed, but the standard induction motor can be used as an induction generator, and has been used successfully for years in some plants.

BEESWAX SAVES MINE PUMPS

The rapidly destructive corrosive effect of acid water in mines is frequently quite astonishing. Pumps have sometimes been rendered absolutely useless in two or three days. Harry Goodman tells in a recent issue of *Coal Age* how a simple, cheap and efficient method of protecting mine pumps from the corrosive action of some particularly bad mine water was recently tried out successfully at Herrin, Ill. After five pumps had been put on the scrap pile one after the other, Elmer Mayor, the top boss, conceived the idea of using beeswax on the parts of the pump exposed to the action off the water. Accordingly, he took apart a new pump, carefully wiped off all grease and dirt from the faces and even from the bolts that clamped the parts together. After carefully heating the clean surfaces he applied the melted beeswax to form an even, thin coating and bolted all the parts together with similarly treated bolts. The pump was then installed and has run without any further attention except the regular oiling. Before the beeswax was tried the pumps lasted from one to three days. The treated pump has been running for several months.

A RECORD IN BRILLIANCE

The most intensely brilliant light in the world is that produced by the flow of electric current between two pencils of carbon. The supremacy of this light —the carbon "arc" lamp, discovered by Humphrey Davy about one hundred years ago—is threatened by a new type of lamp, in which an arc is "struck," as the phase goes, between the minute globules of tungsten in a vacuum bulb similar to that of an ordinary electric lamp. Just before the war British research had produced a lamp of this type with 100 candle power, and the resumption of the investigation after the stress of war has enabled a means to be discovered of producing larger globules, so that lamps of much higher candle-power have been made. At an early date, one with 4,000 candle-power will make its appearance. As the source of light is practically a point, the lamp is very suitable for kinematograph work and for various microscopic and surgical purposes. Being rich in the actinic rays which act on sensitive plates, it has also a wide scope in photography. Its efficiency is very high, though not quite so high as that of the latest types of arc lamps, and its simplicity, its convenience, its long life, and the absence of flickering in the light are likely to make this British invention very popular wherever a concentrated light is required.

A BRITISH SUPER-WINDING ENGINE

An exceptionally powerful winding engine was recently installed in a coal pit in Northumberland, England. It is driven by electricity and is capable of raising 150 tons of coal per hour from a depth of 900 feet. The latest types of electric signalling apparatus have been fitted, along with safety appliances to control the travel of the cage. This large plant, which, in many of its features, is the first of its kind in Northumberland, was designed by the engineer to the coal pit.

Ice skating without ice has been made possible by a New Yorker who has invented skates with a number of rollers set between plates to serve as runners.

Disconnecting Switches and Bus Bar Supports

The Increasing Size of Power Plants Necessitates More Careful Design of Detail Equipment and More Careful Attention to Features Hitherto Neglected. The Following Article Describes One Line of Equipment Manufactured to Meet Exacting Conditions

DELAYS and outages due to short-circuits and switching mistakes have ever been serious, but with increasing sizes in generating units, the significance of better equipment in switches and busbar supports is very apparent to anyone. We now have units of 20,000, 25,000, 30,000 and 35,000 kilowatts, and with 50,000-kilowatt units already designed and being called for by some of the big companies, the bus and switch detail to care for these big units has not progressed with the demand. Consequently, certain large plants have suffered serious losses due to failure of bus supports and their attendant structures and compartments; disconnecting switches have also been opened by shorts and other causes. To provide more reliable and safe devices for these conditions, the engineers have first called for heavier and more rugged bus supports with greater factor of safety, and then called for a locking type of disconnecting switch, followed with a demand that the locks must be positive, and then with further demands that the locks must be foolproof and interferenceproof.

Engineers are to-day demanding better switches with guaranteed minimum millivolt drop under full load, fixed frequency and temperature; such switches can only be manufactured with special care and materials. The use of solid copper forgings has made possible great savings in energy formerly lost through use of poor design and cast copper parts in switch construction. Another waste in energy is found in the various clamp devices that are used on the buses, supporting cables, etc. The elimination of this waste can be obtained by the use of non-magnetic materials in the construction of the clamping member or the supporting device of the conductors.

Phosphor-bronze bolts, when machined from the solid rod, have great strength and are superior to brass or other metals. The porcelain factor is one often neglected by the designing engineer, primarily owing to a multitude of other details seemingly of more importance, It is not generally realized that the entire system is dependent upon the insulating properties and strength of the station porcelain, whether this be on switches or on bus supports. Porcelain manufactured by the wet process has greater strength than that of any other process and is, therefore, used exclusively for all classes of important devices and fittings. Such porcelain can be equipped with well-cushioned mechanical clamps for the proper support of its hardware. The use of cement in any form should be avoided. The design should permit a test with combined high frequency and high potential of, say, four to seven and one-half times greater than the service voltage, and on high-capacity service, due allowance must be made for "spill-over" troubles. This usually requires very heavy and rugged porcelain.

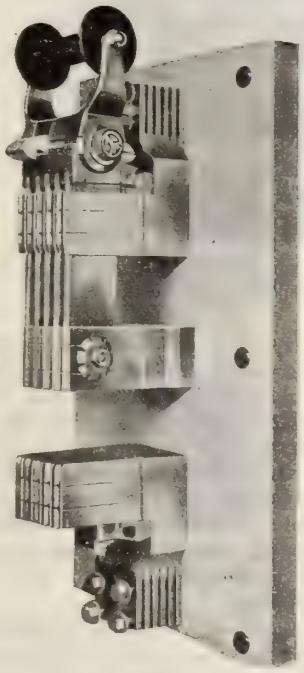


FIG. 1—5,000-AMPERE SWITCH.

The General Devices & Fittings Company, Chicago, Ill., has recently furnished much switch and bus-support equipment for three of the largest power plants in the country, and descriptions and illustrations of a few of these new designs are given here for the first time.

Fig. 1 shows a front view of a back-connected positive-lock type switch with a rating (on the conservative basis of 680 amperes per square inch of cross-sectional area and of 68 amperes per square inch of contact area) of 5,000 amperes and 600 volts, 60 cycles, and 20 degrees Fahrenheit limit temperature rise. These are the only switches ever provided with a positive lock which is thrown in or out with the switch handle. The studs are milled from solid copper forgings and slotted seven inches deep for bus insertions. The studs can also be slotted for flat connections. All contacts are ground to reduce the millivolt drop to the lowest possible point. All hardware, bolts, nuts, spring washers, etc., are of phosphor bronze, turned from solid rod. The clips are of Sigamond spring copper; the blades are extra-hard-drawn pure blading copper; the handle fork and entire lock are of Hertz non-magnetic metal; and the handle itself is of black fibre made from rings turned to size and treated. This

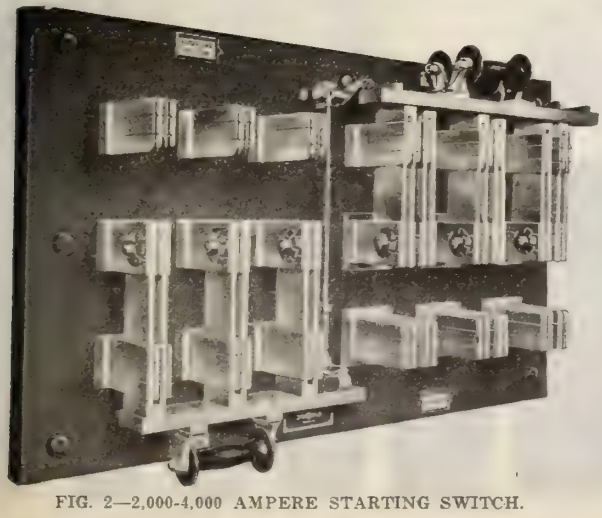


FIG. 2—2,000-4,000 AMPERE STARTING SWITCH.

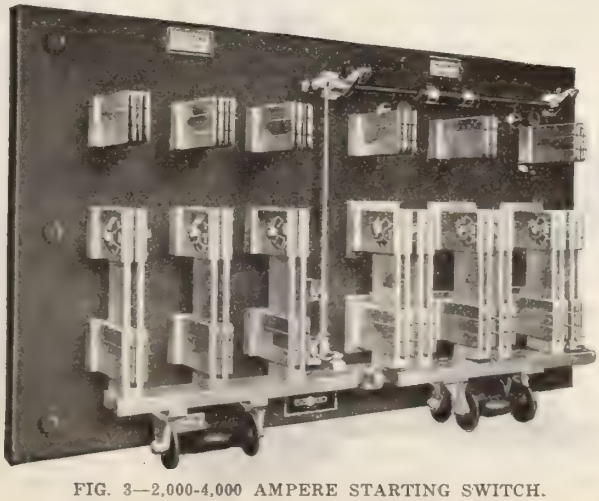


FIG. 3—2,000-4,000 AMPERE STARTING SWITCH.

switch is made in sizes up to 16,000 amperes; above 10,000 amperes all sizes are equipped with double-cushion locks and interferences.

Figs. 2 and 3 illustrate a convertor starting switch of 4,000 ampere capacity at 600 volts. One feature of particular interest on this switch is the interlocking mechanism. This holds the running switch from closing until the starting switch has passed through two starting steps. It also holds the running switch in position clear for starting. The studs and laminated terminals and clip blocks of this switch are of pure copper forged in one piece. Clips are of Sigamond spring copper with ground contact surface. Blades of pure hard-drawn copper machined and brushed finish.

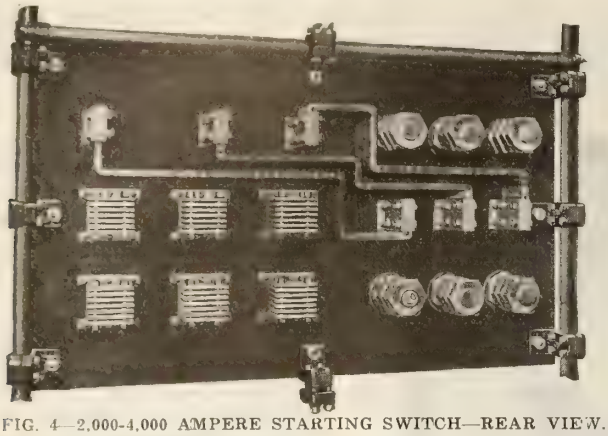


FIG. 4—2,000-4,000 AMPERE STARTING SWITCH—REAR VIEW.

Rear view of this switch is shown in Fig. 4. The switch, complete with its marble mounting, weighs approximately one ton.

Fig. 5 shows a special extra-heavy switch for 2,000 amperes and 15,000 volts, equipped with positive snap lock and vertical terminals for bus insertion. The patent bridge base is an assurance for front-connected switches and horizontal only, if the switches are back-connected.

Fig. 6 shows a special double throw disconnecting switch, for use in conjunction with type H oil switches. The switch is arranged for flat mounting, and the locking arrangement provides for locking the switch either on to the oil switch terminal or on to the alternative connection.

Fig. 7 illustrates a few standard wall bushings for round conductors insulated for 15,000 volts.

A special three-phase bus support for 600-volt service is shown in Fig. 8. All metal, except in the bases, is Hertz non-magnetic metal; the bolts are phosphor bronze, machined from solid rod. These supports are now made in all sizes and voltages and to support up to 19 bars one-fourth inch by ten inches, which, so far as known, is the largest support ever made of this type. Any combination of mounting can be arranged for. This support is also adjustable. Its weight is 320 pounds.

Fig. 9 shows a 66,000-volt special extra-heavy contact-type bus support for holding heavy vertical buses, and arranged to be mounted in and between a 36-inch compartment.

Fig. 10 is a heavy double support for large horizontal bus bar, insulated for 13,200 volts. It is arranged for flat mounting in standard concrete compartments, and provision is made for vertical adjustment of the bar.

Fig. 11 illustrates a line of cable clamp supports for pipe mounting and for use on single, two, three and five-wire runs. Cable clamp support has a malleable iron base, and when used for A.C., the cover is a bronze casting. Both top and bottom sections are extremely heavy design with heavy webbed flanges.

Fig. 12 shows a heavy contact-type bus support for 15,000-volt service. This support is adjustable all round. All porcelain is tested with high frequency at 220 to 280,000 cycles and is also given a combined high-potential, 60-cycle, and high-frequency test of 275,000 cycles before shipping, and this test is with all hardware and equipment in place. All shipments are packed in cartons, each unit being entirely complete.

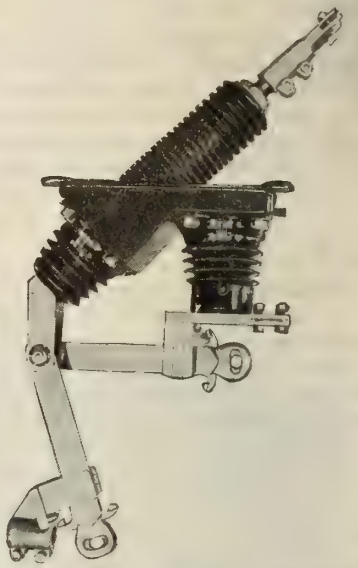


FIG. 6—SPECIAL OIL SWITCH, DISCONNECTING SWITCH.

The General Devices & Fittings Company was the first manufacturer to build switches with a guaranteed millivolt drop, and on both the heavy-capacity and the central-station standards. Copper forgings are used entirely for all switch work and terminals. The porcelain used is said to have no equal for design or strength, and is guaranteed to be wet-process entirely. Corrugated-post types for voltages up to 66,000 volts are stocked. Floor and wall tubes and bushings are also stocked up to 35,000 volts and can be furnished up to 150,000 volts. The

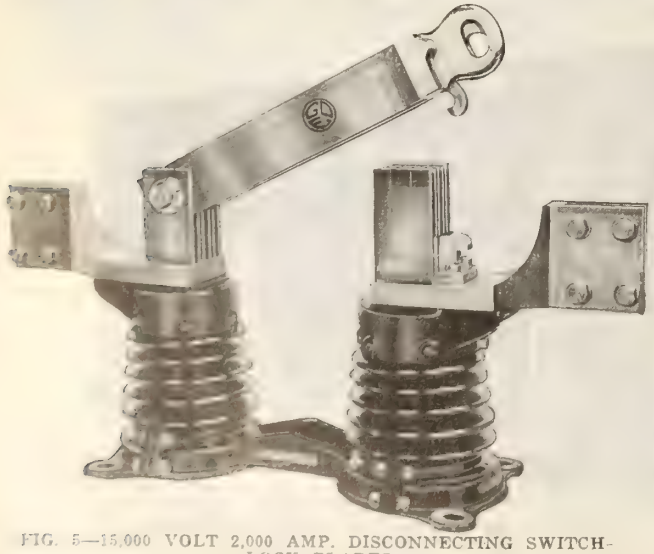


FIG. 5—15,000 VOLT 2,000 AMP. DISCONNECTING SWITCH-LOCK BLADES.

FIG. 7—WALL BUSHINGS. 13,200 VOLT TYPE.

company's exhibit of porcelain is the largest in the country outside of an insulator factory. Its trade-mark "G. D. F." means "Good Designs First", and, taken with its slogan of "Quality and Service", is surely exemplified by the illustrations that are shown with this article.

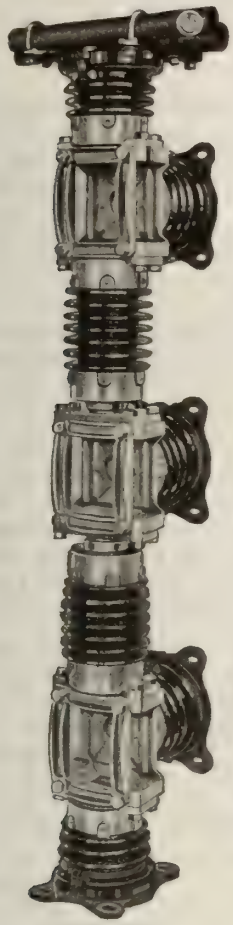


FIG. 8—THREE-PHASE BUS SUPPORT.

One of the interesting features in connection with the manufacturing of this line, is the system of cataloging adopted. It may readily be imagined that the large number of separate devices necessary to take care of modern plant design runs into many thousands, and since many of the parts entering into the complete design of any unit are interchangeable, it is a task of no small difficulty to find a system at once easy to use and accurate. This difficulty has been overcome by the use of a neomonic catalogue, in which each device is given a number formed from the individual part numbers of the different units entering into its construction. This system, together with a designation which defines the type, whether for light, medium or heavy work, serves to identify any one of the many thousands of combinations possible.

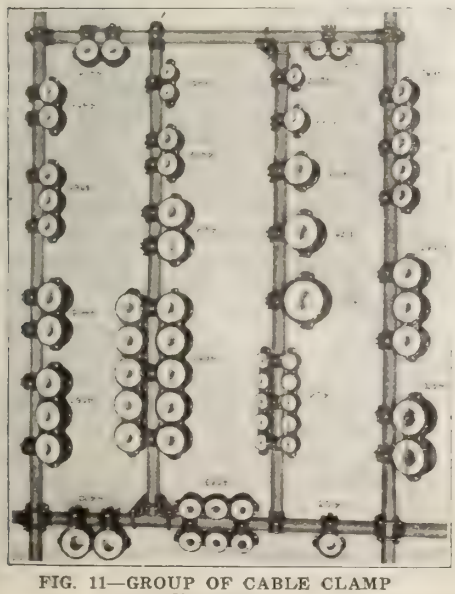


FIG. 11—GROUP OF CABLE CLAMP SUPPORTS.

FIG. 9—6600 VOLT CONTACT TYPE BUS SUPPORT.

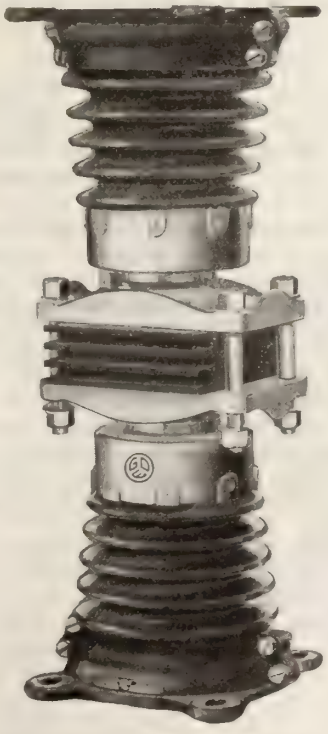


FIG. 10—HEAVY DOUBLE SUPPORT FOR LARGE BUS BAR, 15,000 VOLT.

FIG. 12—HEAVY-CONTACT TYPE BUS SUPPORT FOR 15,000 VOLT SERVICE.

The revival of the project to deepen the St. Lawrence for the passage of ocean vessels is again to the fore, and the possibility has created considerable adverse feeling among New York and American shipping men. The statement of J. S. Duthrie, of the MacDonald Lumber Company, who has been a consistent supporter of the St. Lawrence Canal scheme, emphasizes the advantages of such an undertaking, and says in part: "Ocean vessels will be unloading in the ports even of Lake Superior within ten years. The only thing that will delay it is the fact that the Government has taken over the G.T.R. and tied up the finances of the country for the time being, but that will soon be past. The people of New York see the real facts of the case." S. A. Thompson, the secretary of the Convention of National Rivers and Harbors Congress, expresses the mind of the Eastern section of the States in the following remarks: "Like all the rest of us, the people of New York and the Eastern States want all the business they can get, and because they think, with good reason, that a thirty-foot channel down the St. Lawrence could not only benefit Montreal, but take a great amount of business away from New York, they are violently opposed to the United States Government taking any part in the project."

For several months past the city of Montreal has been experimenting with the use of fuel oil at the Low-Level Pumping Station. Three boilers have been equipped with oil-burning apparatus, but it has been found necessary to revert back to coal firing on two of these, the other remaining as an oil unit, while further tests are being made. So far, the oil method has not proved successful, and the city has assured itself of constant water service by laying in a full supply of coal for winter requirements. A year's supply for this station is in the neighborhood of 56,000 tons.

Laying Out Boiler and Engine Foundations

The Laying Out of the Foundation Has Been Described in Preceding Articles. Mixing and Pouring of the Concrete Are Here Described. Various Features in Which Care Should be Exercised Are Pointed Out

By T. H. FENNER

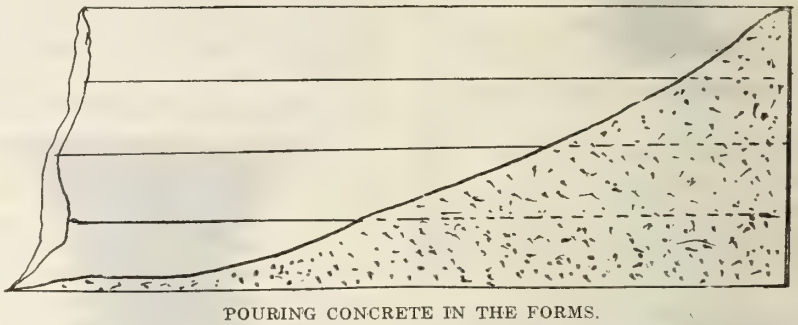
BEFORE mixing and pouring the concrete in making a foundation, take a look round the forms and see that everything is braced and stayed firmly. It is also as well to check up the forms with the foundation plan as a slight mistake can be corrected without much trouble at this stage, whereas after the concrete has set it is an expensive proposition to make alterations.

Arrange for a steady water supply, the best means being a barrel, into which a hose can be led. The barrel can thus be kept always full and the water dipped out with a pail, which is more convenient than using the hose direct. Get the board as near the work as possible to eliminate unnecessary wheeling and save time. Get the men apportioned to their various jobs so that each knows what to do. Obviously at the start of the job the mixing is going to take longer than any other part. Get enough men on the board to handle the stuff expeditiously without being in each other's way. Eight men can work comfortably on an eight foot board, two at each side. To bring the sand and stone to the board will take three men, and it will need three to four men to wheel the mixture to the form and puddle it well after pouring. If there are not enough men available, use smaller batches. With the number mentioned here, a batch would be a barrow load of cement and the sand and stone in the proportion mentioned. Each batch should be thoroughly turned over on the board at least twice, till it is thoroughly mixed. Before pouring the first concrete mix some pure cement and sand and drop it in the bottom of the form to fill up any inequalities in the ground and to provide a bed for the first concrete. In the actual filling of the form it is well to fill the form nearly to the top as the job goes along. This leaves a long slope in the concrete as shown in the sketch, which makes a convenient scarf to join one batch to the next. One of the most important things to be observed in filling concrete forms is to make sure that the concrete will be a homogeneous, water-tight mass when finished. In order to achieve this, every shovelful of concrete should be well puddled as it is poured in the form. By puddling is meant agitating so that there are no empty spaces left between stone and cement. The sure proof of success in this is to see the water rising to the top of the mass, which will occur as the concrete settles closely together. This water is squeezed out, leaving the cement, sand and stone closely and firmly knit together. The larger the stone that is used the more important it is to puddle properly as there is more likelihood of spaces being left between them than with the smaller size. One started, the job should be kept going as fast as it can be done. It may be necessary to rearrange the men as the job goes on, as for instance, taking away a mixer and adding him to the wheeling force. These details are to be adjusted by the man in charge of the job while he is on the job. Hard and fast rules cannot be laid down, and the only object of these articles is to indicate to the man who may be called upon, the methods of going about the job.

When starting to pour concrete after an interval such as a meal hour, or overnight, mix some stiff cement and sand and pour it on the joint. When leaving at night, and before a meal hour, be sure and leave a rough edge to start on again as it is much easier to make a good joint in this way than if the face is smooth. Don't worry about having to make a start after an interval of two or three days even. The cement will knit all right. Concrete remains green for a considerable time, especially if exposed to the weather.

When filling the form do not carry the concrete right to the top, leave about half an inch or one inch for grouting, which is merely filling in with a cement and sand mixture to make a smooth finish. In the places where the feet of the columns are to come this is absolutely necessary. The columns will be placed and levelled up on distance pieces or wedges, and the grouting run in underneath them to make a solid base. This point should always be observed when making foundations for machinery. The top of the foundation should always be left low to allow of the machinery being levelled.

The foregoing has been written assuming that there have been enough men to carry the job right through from start to finish. Of course, if the number of men is limited, the method pointed out in a previous article of carrying on the excavating alternately with the pouring will be the best. This, as already mentioned, economises on cost of forms and labor, and is a very good way of doing the job. However, the pouring will be carried on in the same way, and the same rules applied, whether the job is poured all at once or in relays. Once the form is filled the concrete must be left to harden. It will be about 48 hours before the forms can be removed, or perhaps 72 hours. It is easy to tell by removing a top board if it will be safe to remove the whole thing. If the board comes away easily, leaving the concrete smooth and clean beneath it, the foundation is set sufficiently to allow of the forms being moved. If the board brings away part of the surface of the concrete with it, and is sticky and hard to pry off, leave the form on a while longer. Meanwhile, while the cement is hardening, the ground can be cleared for the bricklaying. The sand left over can be used by the bricklayers. The stone can be moved out to where it may be required later. The steel supporting columns can be brought in, likewise the suspending girders and bolts. Collect all the good wooden blocking 12 inches square, 8 inches and 4 inches that may be needed, and generally utilize the time at your disposal to get everything in readiness for the bringing in and erection of the boiler. Here is where the man has a chance of showing his mechanical foresight and ability. In his mind's eye he must visualize the passage of the boilers from the railroad car or the ground outside, till they are held up on their own suspension brackets ready for the brickwork. It is according to his ability to forecast requirements that the ease and speed of doing the job depends. If ten or twelve men have to stand around a few times a day while some of their number look for blocking, or a jack, or a bolt, or any of the dozen things sometimes wanted in a hurry, the erection will be expensive.. Of course it is not humanly possible to foresee everything, but it is possible to come very near to doing so. The ability to look ahead is a great asset to an erecting engineer. Of course, as in every other line, experience is the great teacher, but every one has to do his first job sometime.



POURING CONCRETE IN THE FORMS.

SOME NOTES ON THE UTILIZATION OF LIGNITE TO THE BEST ADVANTAGE

IN carbonizing the lignite valuable by-products in the form of gas, ammonia, and oils and tar are obtained.

The gas yield is upward of 10,000 cubic feet per ton of lignite. The gas has a heating value of 400 to 450 British thermal units per cubic foot.

A little more than one-half of the gas is necessary to carry on the carbonizing process; the balance can be used as a city gas for cooking, or for lighting if burned in a mantle, for furnace fuel, or for generating power by means of a gas engine. Or, if desired, the entire 10,000 cubic feet can be devoted to these purposes and the carbonizing carried on with lignite producer gas from a fuel gas producer, states a recent publication of the U. S. Bureau of Mines.

If the gas should be used as a town gas, and a higher thermal value than 400 B.t.u. per cubic foot were required, the whole 10,000 cubic feet can be enriched to the desired point. The Director of the Oil Division of the Fuel Administration has proposed that the heating values of carbureted water gas sold for domestic use shall not be over 528 B.t.u. per cubic foot. Or, in a carbonizing oven of the Saskatchewan type, the poorer portion of the gas could be collected separately and only the richer portion, about 7,000 cubic feet, sent into the city mains without enriching. The inferior gas would not be wasted but could be used as bench fuel, supplemented by producer gas. If it were desirable to do the carbonizing exclusively with the oven gas, the richer portion available for distribution in city mains would be reduced to between 3,000 and 4,000 cubic feet per ton of lignite.

The fact that the sulphur content of lignite is small is a good feature. There is an almost entire absence of the corrosive acid resulting from the combination of sulphur with water when the lignite is burned. Should the lignite gas be used as a "stone gas" for heating, cooking and illuminating purposes, there will be almost no sulphuretted hydrogen to be removed by means of hydrated oxide of iron purifiers.

Consider the matter of power: Of the yield of 10,000 cubic feet per ton of lignite carbonized, 6,000 cubic feet are required to carry on the process, leaving a surplus, costing nothing, of 4,000 cubic feet, of 400 British thermal units per cubic foot, or a total of 1,600,000 British thermal units. A good gas engine uses about 10,000 B.t.u. per horsepower-hour. This gives 160 horsepower-hours from the surplus gas from each ton of lignite carbonized. This power is comparable in cost with that derived from natural gas. It is fully as cheap as most hydro-electric power.

This cheap power, of course, is limited by the quantity of lignite carbonized. But the first need of the people in northern climates is domestic fuel, hence the demand for these carbonized lignite briquets is very large. As the population and the demand for power increase, the demand for this carbonized fuel will increase apace. If the demand for power in any lignite field should outrun this supply of surplus gas the amount of power can be readily and cheaply augmented by the use of carbonized lignite in power gas producers.

The by-product should at least pay the cost of carbonizing and briqueting, thus affording a first rank fuel in place of one of lowest rank, at no additional cost.

It is not necessary to dwell upon the benefits that would ensue to these lignite sections by thus placing them in possession of a fuel equal to anthracite and a supply of cheap electrical power.

And these remarks apply to one-third of the coal resources of the nation.

The Ammonia

The ammonia is contained in the gas and gas water. It may be recovered as ammonium sulphate, a valuable fertilizer, as anhydrous ammonia, for refrigeration and other commercial purposes, or it may be treated as the source of other nitrogen products, some of which are of vital importance in the manufacture of explosives. As stated above, this and the Mond process are the cheapest sources of these products, but the amount which can be so recovered is limited to the tonnage of coal carbonized or gasified. The manufacturing practices in this connection have long been standardized.

Oils and Tars

Just what is the most profitable disposition to make of the oil and tar products in this country remains to be determined. This is an industry by itself.

The simple distillation products of this oil can be put to many uses—fuel oil for furnaces and internal combustion engines, creosoting oils for the preservation of timber, waterproofing and preserving oils for leather and cotton and other fabrics, tar paper, roofing pitch, etc.

The pitch makes an excellent binder for the briquets, and will go far toward reducing the cost of this item if more valuable uses are not found for it. The anthracene and creosote oils will, without doubt, find a ready market as wood and leather preservatives.

From the several fractions, upon exhaustive distillation and treatment, are derived hundreds of synthetic products in the way of paraffin, acids, antiseptics, photographic chemicals, aniline dyes, perfumes, drugs, preservatives, etc.

From the light oils come benzol, toluol, aniline dyes, photo-chemicals certain drugs, and many other chemical products. From the carbolic and creosote fractions are derived carbolic acid, creosote, picric acid, photo-dyes and chemicals, coloring materials, and numbers of perfumes. The anthracene oils give, among other things, alizarin, a valuable acid used in the production of dyes, and carbolineum, used as a wood preservative. This latter product is analogous and equal in value to the carbolineum derived from European lignite, which, before the war was imported in large quantities and retailed at 65 cents per gallon in barrel lots.

At first, of course, the simple distillation products will be procured and marketed as such, but as opportunity affords, each of these primary by-products will be taken up and synthetic chemical products manufactured. The exact course of this development is a matter to be determined in conjunction with a careful study of the market.

Almost all of these manufactured tar products have heretofore come from Germany. In 1913 the United States imported coal tar products of the value of $11,000,000 at initiating points, and these, when they reached the consumer, probably cost double that amount. Millions of gallons of creosoting oils for preserving timbers have been imported annually. That supplpy is now cut off and the market value of these commodities on this continent greatly enhanced. It is not unreasonable to expect that in the future a large part of this demand for tar products will be supplied from these immense stores of lignite.

Certain Arkansas and Texas lignites are known to be substantially undeveloped cannel coals, containing a large percentage of volatile matter. It is probable that the day will come when we will distil these lignites to recover products similar to the oils now being recovered from the oil shales of Scotland and elsewhere.

Possible Conservation of Petroleum and Natural Gas

The bringing on to the market of the Texas lignite would release large quantities of Texas petroleum and natural gas for other uses, and the conservation of our petroleum resources is a more important matter than the average man appreciates.

Of our original supply of petroleum, 42 barrels per capita have been used, and only 70 barrels per capita remain for the future. About half of the petroleum currently produced is used as fuel for steam raising. The possibilities in the use of petroleum and its products in connection with the navy, airplanes, the merchant marine, automobiles, motor trucks, tractors, etc., are so great and vital that before long it will be looked upon as an inconceivable folly that oil should ever have been used for steam raising, the most glaring economic perversion that this country has ever been guilty of. (Bulletin 102, part 6, U. S. National Museum.)

"The whole mechanical equipment of modern civilization is dependent upon lubricants made from petroleum. Its exhaustion spells commercial chaos or commercial subjugation by the nation or nations that control the future source of supply from which petroleum will be derived." (M. L. Requa.)

(Continued on page 72)

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - President
H. V. TYRRELL - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50: Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII. TORONTO, Feb. 5, 1920 No. 3

PRINCIPAL CONTENTS

A Unique English Water Dynamometer 45
The Chemical Treatment of Feed Water 48
Some Information Regarding Hydraulics 51
Superheated Steam and Superheaters 56
Electric Power Collection 59
Disconnecting Switches and Bus-Bar Supports 61
Laying Out Boiler and Engine Foundations 64
Editorial 66
New Equipment 68
Operators' Point of View 69
Explosion Hazard From Coal Dust 71
Selected Market Quotations 45

Pioneer of Steam Locomotion

IT IS just 116 years ago this February that commercial use of the locomotive had its inception. In 1804, at Pen-y-darren, in South Wales, Richard Trevithick, the pioneer inventor of the locomotive steam engine, demonstrated its practical value on the Merthyr Tydvil Tramway, hauling 20 tons of ore, at that time considered a remarkable feat for transportation of that character. The first achievement in this direction was a pronounced success, although the initial performance was not all that could be desired, as history tells us that Trevithick had apparently built a machine that he could not control, the engine running off the track and being badly wrecked the first day. The supposition is, however, that the accident was due more to his inexperience as an engine-driver than to any fault in engine construction. From that time onward the steam locomotive has made varied but steady progress, but that just rewards are not always meted out to the master minds is adequately illustrated in the later days of Trevithick's career. In 1814, after a period of successful engineering achievement, he entered on an agreement for the construction of engines for mines in Peru, and removed thence in 1816 to supervise their operation. He returned to England in 1827, and the following year petitioned the English Parliament for a reward for his invention, but without success. He died, penniless, at Dartford, on the 22nd of April, 1833, at the age of 62.

Graded Certificates

INFORMATION has been published concerning the Act grading certificates for a sufficient length of time to enable an estimate as to its reception amongst the engineering fraternity. Generally speaking, opinion seems to be favorable to the Act, although some objections are raised to individual portions of the Act and the regulations respecting it.

The point to which the greatest exception is made is perhaps that relating to the qualifications for a first-class certificate, both as regards practical experience and technical knowledge. At first glance the qualifications may seem somewhat severe, but in no other way can the status of stationary engineering be raised so effectively. The first-class certificate should be one well worth while having, and to achieve this, it must be a fairly hard thing to obtain.

When employers of engineering skill learn that the standards set by the Ontario Board are high and demand genuine worth on the part of the engineer, it will be materially to the benefit of the stationary engineer himself. His pay envelope will undoubtedly be fatter and his reputation more in keeping with his worth.

It may be argued that the first-class certificate will only be available to the limited few and that injury will be done to the older men of the present engineering world. This may possibly be true, but a remedy should not necessitate the lowering of the standard but rather a readjustment of the graded plant requirements. This could be done easily by the Board under Order-in-Council as soon as it were found necessary and with the experience gained during the coming year it will be more fitting to discuss this question later on.

It might be well emphasized that although the engineer cannot obtain a first-class certificate on his application form, much depends upon the manner in which his application form has been filled out, whether he obtains a second or third-class certificate. The application blanks have been issued for a definite purpose and this purpose, briefly stated, is to give the engineer every opportunity to obtain the highest grading possible.

Fuel Oil vs. Coal

OCCASIONALLY someone breaks into print and lauds one of these indispensable sources of heat and power very much to the detriment of the other. Extravagant claims are made, and to those not well versed in the subject of fuel burning these opinions carry weight.

These statements, for instance, make the claim that oil fuel is dangerous, produces smoke, causes corrosion and other evils through its sulphur content, and so on ad infinitum. Such statements only work harm to those bringing them forth and the relative merits of the two fuels for various purposes should be recognized.

Cheapness, or more properly speaking, economy in operation, may be the single object aimed at in determining the type of fuel to use, cleanliness another, and a number of other factors go to make up the weight of evidence which throws the balance in favor of one or other type of fuel, and nothing can be predicated beforehand in most cases as to the outcome. Smoke can be made with the one as with the other, and it is usually present in the use of both under similar conditions. The same applies to other operating features, both advantageous and the reverse.

WHAT THINGS ARE DONE IN NAME OF SAFETY!

Devices Grow and Thrive in This Rare Atmosphere—and What Will Be Coming Out Next?

Editor, CANADIAN MACHINERY:—The pursuit of safety methods is laudable. As an ameliorator of industrial conditions it ranks highly, and the literature diffused so liberally by the High Priests of Safety First add greatly to the gayety of the race. However, like many other good things, it can be overdone, and on some of its devotees it reacts in strange fashion. Looking through the pages of a technical magazine recently, we came across a section headed: "Platitudes for Puzzled Practitioners." This was not the exact wording, but it indicates the meaning. After reading of a bright individual who conceived the idea of putting a fixed obstacle on a lever to prevent a sliding piece sliding too far, we were going to try another section, when a spirited sketch attracted our eye. It showed a hand grasping a cold chisel, and another hand poising a hammer as though to strike. There was nothing in this to cause comment, but on both the hammer and chisel were depicted strange protuberances. That on the chisel was arranged near the end, and looked as though some lady mechanic had tied a ruff round its neck to make it look better. The hammer was decorated right on the end of the shaft, and close examination revealed the fact that the excrescence was an ordinary round washer held on with a coach screw. Now for many years we have used a hammer and chisel, but never saw them fitted up in this manner. Therefore, we anxiously read the text, to find out the raison d'être of such a peculiarity.

It appears that a sturdy mechanic grasped his trusty hammer, and prepared to smite the chisel a resounding blow. Alas, the hand that grasped the hammer was a greasy hand, and instead of striking the chisel, the smooth hammer shaft slid through the greasy grip, and smote an unoffending laborer on the apex of the cranium. Nothing daunted, the mechanic grasped the hammer again and this time his hold was so firm, and his aim so true, that the chisel drove through the metal, slipped through the holder's hand, and hit a second workman who happened to be adjacent. This was too much. Safety First was outraged, and the safety expert called in. One glance sufficed, and the remedy was determined on in a twinkling. Simply fasten a large washer on the chisel, above the hand, and a similar one on the hammer, below the hand, and the trick was done. Oh, safety, what things are done in thy name! For the benefit of those who are interested, we offer some further suggestions:—An inspector should be appointed who will periodically inspect the men's hands, and see that all superfluous grease is removed. Lessons should be given twice a day on the proper way to hold a hammer and chisel. To make absolutely sure, any man engaged in chipping should be enclosed in a boiler plate compartment. Men operating lathes shall be provided with a suit of mail and asbestos gloves in case of being burnt with flying chips. Men engaged in grinding operations shall be located in another room, and watch the operation through a periscope. We might go further, but have fear of being mistaken for a safety expert.

Safety first is an excellent motto, but should be attended with a little common sense.

Where Angels Fear To Tread

THE ubiquitous reporter may well be pardoned for his lack of technical knowledge, although the errors in the daily press often endow those better informed with homicidal tendencies. And while the average newspaper description is inaccurate and misleading occasionally, it is something more—a gem of the purest unconscious humor.

This is the case in connection with a description of a new steel mill which recently appeared in one of the daily newspapers of one of the Maritime provinces. It must be understood that the editors of POWER HOUSE are not responsible for the technical details nor the language in which they are clothed.

Here is how an ordinary conveyor is described:—

> "The pathway in the main resembles a tread mill, minus the angle of elevation—minus the horse, but not horse-power—with this difference, too, that the plate-mill conveyor is made up of rollers which have individual movement, and do not speed along in flattened spheroid assembly and connection as is the case with the tread mill as we know it when moving under the horses' feet."

After a description of various portions of the mill the article goes on to speak of the ingots:—

> "Meanwhile—and now that the way of the plate is made clear — what of the ingots?" (Almost biblical in its rhythm.)

With the making of steel we have little to do, and it is in the description of the power plant equipment that the stationary engineer is most interested and in which he will find most entertainment.

> "When one is told that the process just described calls for 4,000 horse-power from the electrical motor having a place along with a 65-ton flywheel in the adjacent alcove or annex, the reason for direct service by a main shaft of twenty inches leading straight from motor to rolls and mill machinery should be apparent. So, too, now are realized the purposes of the mighty, massive and deep-laid foundations of ferro-concrete underlying the same machinery and robbing it of vibration.
>
> "As illustrative of the electric power required in rolling a plate, a motor which serves this operation is the largest in Canada—so large, in fact, that its component parts defied transportation in anything like assembly. It arrived piece-meal, and over two months are necessary to erect it on the specially-prepared foundation designed to bear the 5,000 tons of dead weight thrown upon it and to neutralize the vibratory force that comes from the 32 revolutions per minute as a result of the 4,000 horse-power. The motor frame is 22½ ft. in diameter, studded with 170 units of lamination, each unit being made up of innumerable thin metallic strips held together and contained in insulated cases; all necessary in the development of the alternating current of 6,600 volts by 'mill type induction process.'
>
> "This is the species of electric power which kills people who come in contact with it, as opposed to the harmless incandescent sort when transformed for domestic use. The technicians could tell you much about this electrical machine built for 60 cycles and 3-phase with a momentary overload of 300 per cent., as well as its calculated economies in the use of current; the percentages saved by dynamic leaking and all that sort of thing. But when told the writer, he only scratched his head and looked wise. . ."

Progress in New Equipment

STEAM JET ASH CONVEYOR ENJOYS LOW MAINTENANCE COSTS

By Guy S. Hamilton

Some engineers, who are not quite convinced of the desirability of the Steam Jet Ash Conveyor, often point to maintenance as evidence of the uneconomical condition surrounding its use.

It is quite true that the abrasive action of the ashes as they travel through the conveyor pipe has a tendency to wear away the conveyor at the more vulnerable points.

This is a condition that cannot be avoided. A conveyor in constant use must wear. No pipe is made that is indestructible.

The American Steam Conveyor Corporation, after much experience in steam jet ash disposal have developed an especially chilled iron known as American Hard Metal. There is perhaps no harder metal on the market and yet, hard as it is, it must wear if enough ashes are discharged through the conveyor line.

Advocates of the steam jet ash convoyer who have used the system for several years and have had actual experience with its operation make usually strong assertions concerning the low maintenance charges of the conveyor. The true way, they say, to find the cost is to consider it from a standpoint of cost per ton of ash handled.

If the conveyor is in constant operation, if a score or more tons of ashes are discharged through it, the grinding and abrasions of the ashes on the pipe and fittings will, of course, be moderately large. If only a few tons of ashes are daily discharged, the abrasion will be proportionally less; if the system is standing practically idle, the wear will be little or nothing.

The use of the conveyor will determine to a large degree the maintenance charges for the system. An investigation into the maintenance costs of a number of large plants using American steam ash conveyors over a period of years bears out this assertion.

A well-known Wisconsin power company have three water tube boilers, each developing 500 h.p. Jones stokers, in use, and the resulting ash produced amounts to 500 tons during the year. In this plant an American steam ash conveyor is used to handle the ashes. The suction line is 65 feet long and the discharge line is 63 feet long. The ashes are discharged into an ash bin from which they are later withdrawn into a wagon.

This conveyor has been in service for three years and the total repair expense has been $66.20 which equals $0.0044 per ton of ash handled.

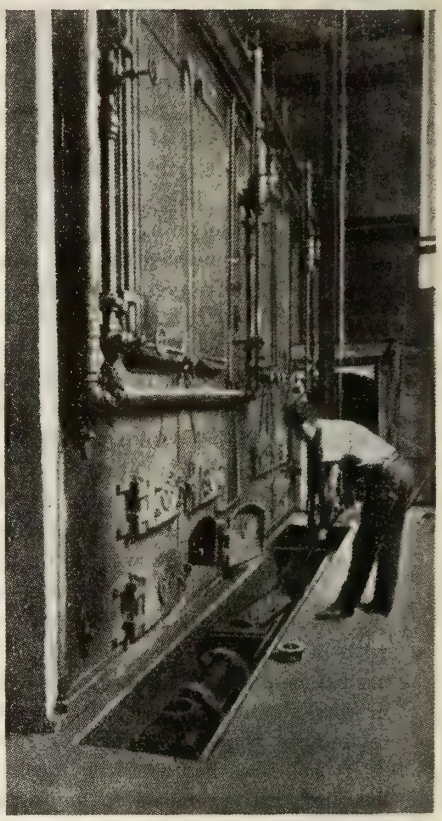
With total maintenance charges at less than one-half a cent a ton, it is doubtful whether any other type of conveyor could handle the ashes so economically and satisfactorily.

Another Wisconsin manufacturing concern has a power plant containing boilers totalling 7,050 h. p. A Jones and three-chain grate stokers are used in this plant. The suction line of the conveyor is 104 feet long and the riser is 62 feet high. The ashes are discharged into an ash bin from which they are later removed into cars.

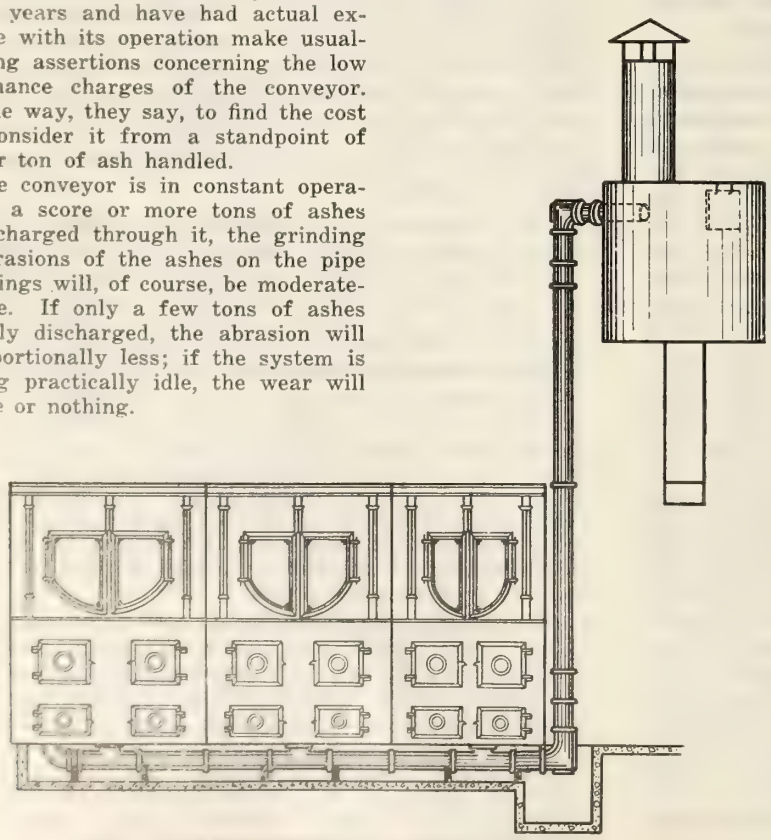
Each year 10,050 tons of ash are handled through this conveyor. The system has been in operation two years and two months, which means that a total of 24,550 tons of ashes have been handled. During this time the repair expense has amounted to $504.48, which figures out 2 cents a ton flat as the maintenance charge.

From these two instances, which have been duplicated many times, it will be seen that the maintenance charges of a conveyor handling an enormous quantity of ashes, is decidedly the reverse of excessive when the cost per ton of ash handled is considered.

This two cents a ton takes care of the depreciation and as the repairs are made, the conveyor is virtualy restored to its previous first-class condition.



SHOVELLING ASHES INTO THE CONVEYOR.



ARRANGEMENT OF CONVEYOR SYSTEM.

The Operators' Point of View

GRADED CERTIFICATE CORRESPONDENCE

The Editor:—Some interesting letters have been published in reference to the new license law for engineers.

One thing in connection with it is obvious to the real engineer, that is, its defects.

The public is not worrying whether an engineer can answer a lot of technical questions, analyze coal, build an electric generator, or figure water and fuel consumption to a fraction of a pound, and every law passed is supposed to be for the benefit of the public. Executive ability and technical knowledge are of interest to employers only in this law. The legitimate purpose of a license law should be to protect life and property and not to discriminate between or abrogate the rights and privileges of citizens.

Engineers having technical and special knowledge of financial value to employers could have a diploma, altogether separate from an engineer's license. There are hundreds of men capable of passing a technical examination and securing first-class papers, who would be "up a tree" if they were forced to take charge of a second-class plant and do the work themselves. I have seen "chiefs" who could pass a technical examination, figure efficiencies, talk like a "blue streak" about engineering, boiler construction, etc., and could not make as decent a job as many so-called third-class men.

As before remarked, the aim of an engineers' license law should be to protect life and property. Does our new license law do this? Not on your life. Most of the plants under 300 B.H.P. are located in cities and towns, under the roadways, sidewalks, and in the basements of buildings; in these plants second and third-class men will be in charge of the boilers. Over the boilers will be hundreds of people at work, unconscious of the fact that under them is located a force that, through ignorance or carelessness, may send them to eternity. And yet this force is entrusted to the care of a man who, the law says, is only part of what an engineer should be.

The first-class license leaves its holder free to earn his living in large or small plants, the second-class licensed man can only earn his living in the small plants, although altogether likely he is just as good and safe an engineer as the former. The natural result will be that the wages of the lower grade license holders will be reduced in time, for the employer is no fool, and will soon learn that his engineer cannot leave his employ unless he is prepared to take a position in a small plant. But if the first-class license man loses his position he can take a position in a small plant until he locates a better job. It may be remarked that the remedy is in the hands of the engineers themselves, all they have to do is to start in and study. It is easy to talk, but there are thousands of middle-aged men, and even many young men, who find it practically impossible to learn and hold a lot of technical knowledge. An honest, just license law is a mighty fine thing, but I am thinking the framers of our license law had a very limited knowledge of engineering conditions outside of their own small circle. I say small, for I feel sure that very few of the engineers who are used to thinking about the trials and troubles of the vast majority of safe engineers outside of their own immediate friends, had anything to do in securing legislation for this very unfair law. Surely if a man is safe with 300 B.H.P. he will be safe with 1,000. There would not have been so much dissatisfaction and there would not have been so much injustice done, if second-class licenseholders had been allowed to handle plants up to this size.

Can nothing be done to remedy this rank class legislation? The editor of this journal should be able to suggest some remedy.

JAMES E. ELLETHORN.

THE CONSERVATION OF COAL

The Editor of Power House:

Regarding the shortage of coal experienced again this winter for power boiler furnaces. The several provincial governments have by-laws for the inspection of steam boilers with inspectors for the protection of life and property, against boiler explosions, but such inspection does not include the condition of the furnace for burning the coal under the boiler.

Having had a life experience, I have seen many plants in factories in a condition not conducive to the conservation of coal.

It is quite possible for from 10 to 50 per cent. of the coal used in many such plants to be burned to waste, through faulty setting of the boiler and furnace or through infiltration of air which, of course, reduces the temperature of the product of combustion, necessitating more coal. Every pound of soft coal requires the oxygen contained in 12 pounds of air, more or less is harmful. Now it is just as impossible for a stoker to know when he is feeding the furnace with the right amount of air without a draft gauge and a flue gas recorder as it would be for him to know the pressure of steam on his boiler without a pressure gauge. Although these instruments have been on the market several years, their use is not yet universal. It is doubtful if we should experience such a coal shortage if their use was made as compulsory as a steam gauge on safety valve. Ships of the American navy can now steam 31 per cent. further on a ton of coal than previous to using them.

Scientific combustion of coal saved one manufacturing firm $200 per day. Another firm, $350 per week, a small factory after installing such instruments saved $1,000 per year in coal.

An electric light company saved $2,500 the first year of their use.

A test was made with six central heating plants in the States resulting in a saving of a quarter million dollars in coal.

Now, Sir, if all factory boiler furnaces throughout the country were inspected by experts and a license to burn coal issued only to these plants that were in a condition to burn it within a reasonable percentage of efficiency, it would result in much good to everyone.

The writer has seen boiler plants that were 87 per cent. efficient, also plants that did not show 40 per cent. efficiency.

The gauges have daily or weekly recording charts. Some there are that will record in the manager's office just what his battery of furnaces are doing.

I have not the least hesitation in stating that no man can hope for complete combustion of the coal without them. Even assuming that his brick work is air-tight (which is a rare case) or that his combustion chamber bridge wall or percentage of air space in grate is right.

No man wishes to burn coal to waste. Especially our factory owners in these days of high cost of everything and keen competition, yet strange to say many are doing so.

The day may dawn when every engineer of a factory will be asked to explain why his furnaces exceeded so many pounds of coal per square foot of grate surface per hour, more than was necessary for the heat generated or power developed. Faulty transmission is another cause of waste of coal, bare steam lines is another cause; radiation from some of cause means condensation of steam, that in turn means loss of pressure, away goes more coal, for the

engines must have the pressure or the machinery will stop.

The writer heard of one company that saved 33 carloads of coal in one year by insulating their steam drums and mains, Much progress has been made in locomotives since the days of "Puffing Billy," but there is yet room for the builders to do some serious thinking in order to reduce the coal consumption which is rarely above 50-65 per cent. on the thermal efficiency obtained in the boiler.

The suggestions offered for saving of coal in power boiler furnaces are not pet theories of mine. Every engineering college professor knows that what I herein state are facts, so would also the American Society of Mechanical Engineers, with which I have the honor of being affiliated.

Knowing these matters as I do, I would consider it a duty to my fellow man and country to make the same known to others for our very existence in this climate depends on coal to keep life in our bodies, besides we should use this gift from Him who made this world in such a manner that we will leave some for those who come after us.

Ottawa, Ont. J. S. KINGSTON.

THE TECHNICAL PRESS AND OTHER THINGS—MAINLY GRADED CERTIFICATE

Are you a reader of technical journals? If not, take the advice of an old fellow and start early.

If I could not secure my POWER HOUSE and other journals, I would feel isolated from the engineering fraternity, for in its pages the ideas, researches, and experiences of many engineers are given me.

The letters suggest topics for discussion, and often give valuable tips, such as can not be found in any text-books.

The question and answer page is the journal reader's consulting engineer. Often the answer given some engineer to a question is just the information he was wanting.

Your employer is apt to form a better opinion of your ability than he formerly held when he notes the regular delivery of your technical journals in the factory mail. The selling section is not the least interesting or the least valuable; only a day or two ago I applied to a local dealer in electrical goods for an article which had been advertised in an engineering journal for some weeks past; he had not even heard about it. I showed him the advertisement, and he is going to put in a supply.

Graded Certificates

Engineering pays, and many good men are making a living in the ranks. It is too bad that politics is allowed to disrupt these same ranks. This is in respect to the graded certificate. Some few years ago the leading stationary engineering journal in the United States said in an editorial that the grading of engineers' licenses seems a little out of place in this day.

The object of the law is wondered at by those who have not been instrumental in procuring its enactment. Of course, the ostensible object is to provide safe men for the operation of steam machinery. The real object seems to be, on the one hand, an attempt to limit the supply of engineers. On the other hand it looks like a scheme by which the engineer is made to pull the chestnuts out of politics for a set of inspectors, who can make or break engineers (?) on any old occasion.

A physician is examined by a committee of some sort and allowed to practise medicine. The kinds of disease which he may legally treat, or the size of a leg he may saw off, are not specified. In other words, the patient dies, anyway.

A pharmacist is registered. It is not stated in the permission given him to distribute drugs that he must only compound prescriptions containing vegetable poisons, while arsenic and calomel must be mixed by a man with a special license.

It would seem that an engineer is, and must be, as much of an engineer if he knows and is safe about a 300 B.h.p. plant and a 5-ton flywheel, as if he were competent to take charge of a 5,000 B.h.p. plant, or 20-ton flywheels.

The dear public has a right to insist that those mysterious forces, expansion of steam and the centrifugal force of the revolving flywheels should be handled only by a safe, sane and conservative man. Engineers should get together, in the lodge room and elsewhere, and form plans to get this Bolshevist-making law changed. Get after Mr. Drury, get after your member, get after your editor, the last named can do a lot if he will only do it.

The second-class license should allow its holder to take charge of any sized plant. Common sense will only be needed to understand that, so far as safety is concerned, he will be just as good, and, perhaps, better, than the technical first. It is all right to have the technical first-class license, give it to any who desires it, and it will be up to the employer to take the so-called high-class man if he wants him. But, brother engineers, it is up to you to put up a strong fight to have this unfair law changed; start at once and do not quit until justice is secured. This license law is unlike the usual Canadian laws. It will give a few men a soft, easy living and prove a hardship and a heart-break to many.

It is the worst piece of injustice ever put through here to hold back an army of honest, hard-working mechanics. I believe that this is not alone my personal opinion; every engineer, without exception, to whom I have talked this matter over, is of the same opinion. Forcing the 2nd and 3rd class men to stick to small plants is the one big injustice. Why, in the name of sense, should a man be compelled to remain in a small plant because he is deficient in ice-making, or cold storage knowledge?

Oh, what is the use? The law is a punk one. The thing to do is to get it killed, or altered, the latter for preference.

JAMES SCOTCH.

TO THE STATIONARY ENGINEER

A number of engineering correspondents have written us respecting various phases of the Graded Certificate Act now in force in Ontario. Many of these letters have been more or less severe in their criticism of the Act, and while the pointing out of defects, real or fancied, is important and of value towards their betterment, little has been given in the way of constructive criticism.

No one is better able than the engineer himself to give suggestions as to improvements to be effected either in the Act or in the Regulations under which it will be carried out, and since each engineer has, or should have by this time, his copy of the Act and its Regulations, he should be in a good position to form his own opinions. Not only so, every engineer has no doubt given the matter considerable thought, and, having read both the Act and Regulations carefully, has his own ideas as to both, and can suggest improvements.

We are, then, asking that the stationary engineer send us a letter in which improvements and suggestions are embodied. No matter what your opinions are, send them in for publication and discussion. The requirements for examination, the type of questions which you think should be asked, the length of service, the size of plants for each certificate, and similar matters are all suitable subjects for discussion.

It is only by free discussion that any legitimate change can ever be brought about, and the columns of POWER HOUSE offer an ideal medium for the freest discussion, leading eventually to a crystallization of the general thought of the engineers of the Province.

One thing more, and equally important—the education of the engineer should be an important feature of the educational system of Ontario. The Department of Education has taken a long step forward by establishing night classes for the engineer throughout the Province. Since these have only been functioning since the late fall, in most cases, it is possible that the subjects taught might not be just what you require, or the courses in other ways could be bettered. Let us have your thoughts regarding this, and send in your suggestions as to what you would like to see taught, and how.

Coal Dust as an Explosion Hazard

Partially Consumed Coal Dust Has Been Found by the U.S. Bureau of Mines to be an Explosion Hazard in Steel Mills Where It Readily Collects on Structural Work

By L. D. TRACY

FOR many years natural gas has been the principal fuel used in the heating furnaces in those mills located in the Pittsburgh district which manufacture bolts, nuts, rivets, picks, mattocks and small forgings.

For a number of years the steady supply of this fuel has been more or less interrupted owing to the increased demand for domestic use and to the increasing difficulty in securing an adequate amount of natural gas.

This condition has led a number of the steel companies to substitute pulverized coal as a fuel for the furnaces. Elaborate installations have been made for pulverizing the coal and conveying it to the furnaces. Soon after the furnaces commenced to operate with pulverized coal, large quantities of fine dust began to accumulate on the platforms over the furnaces, the roof trusses, on the outside of the various pipe lines, electric cables and even on the roofs of the buildings.

Some of the companies, becoming alarmed, requested the Bureau of Mines to make an investigation to ascertain the liability of this dust to cause an explosion.

While conducting this investigation, an explosion occurred in another mill which caused the death of one man and severely burned two others.

Eleven samples of the dust (which for convenience has been termed "mill dust") from various locations in the different mill buildings were taken and submitted to chemical analyses, microscopic examination and also to flame and explosion tests.

From the chemical analyses it was found that the volatile matter in the dusts ranged from 6.3 per cent. to 23.54 per cent., fixed carbon from 50.88 per cent. to 67.08 per cent. and ash from 22.29 per cent. to 32.16 per cent.

Five samples of the pure coal dust, before passing into the furnaces, were subjected to a chemical analysis and it was found that the volatile matter in the coal ranged from 30.50 per cent. to 36.81 per cent., the fixed carbon from 46.86 per cent. to 52.48 per cent. and the ash from 9.26 per cent. to 21.84 per cent.

Under the microscope a sample of mill dust, which by chemical analysis showed 23.5 per cent. volatile matter, was found to contain a very large proportion of very fine partially coked coal dust, a small proportion of fine or medium fine partially coked coal dust and some dust thoroughly coked. In addition, a considerable portion of yellow resinous appearing matter, some particles of carbon which might be termed soot and some small particles of ash were found.

A sample, which by chemical analysis was found to contain but 11.25 per cent. of volatile matter, under the microscope showed only a relatively small proportion of medium sized partially coked coal dust and many thoroughly coked particles.

From these examinations and analyses it would seem seem that, for some reason, the puverized coal was being blown out of the combustion chambers of the furnaces before it had been thoroughly consumed.

The several samples of dust were also subjected to tests to determine the pressure which might be exerted by the dust in a possible explosion as compared with pure pulverized coal; this test was conducted in the Clement-Fraser apparatus (described in Technical Paper 141 of the Bureau of Mines). Briefly, this apparatus consists of a glass globe, possibly six inches in diameter, containing a small platinum coil which is electrically heated. A sample of dust is blown against the heated coil and the pressure of the resulting explosion is recorded by a pressure indicator. In these tests about 0.003 of an ounce of pure pulverized coal was blown by about eight cubic inches of oxygen under a pressure of five and one-half inches of mercury against the platinum coil which has been heated to a temperature of 2200° Fahrenheit. The average pressure obtained was 14.5 pounds per square inch.

A sample of the dust, containing 23.54 per cent. volatile matter, exploded in the apparatus with a recorded pressure of 10.21 pounds per square inch, a second sample containing 20.6 per cent. volatile matter recorded a pressure of 8.7 pounds per square inch and a third sample with 15.91 per cent. volatile matter recorded a pressure of 4.6 pounds per square inch.

It will be noted that the sample containing 23.54 per cent. of volatile matter registered a pressure but little under that of pure coal dust.

When the small quantity of dust which was exploded is taken into consideration and a pressure of over ten pounds per square inch is obtained, it will be readily seen that, with a large amount of dust exploding, the pressure would run much higher, if confined.

Further experiments to determine the explosibility of the mill dust were carried on in the dust explosion gallery of the Bureau. This is essentially a horizontal wooden box, six inches deep by six inches wide and fourteen feet long, made of 2-inch planks, held together by wooden clamps and iron rods, in such a manner that the top may be removed. A metal flap valve covers the back end of the gallery, the other end being left open. At uniform distances along the entire length of the floor of the gallery are 14 holes, into which are fitted ¾-inch pipe jets projecting vertically from a 2-inch horizontal pipe extending beneath the floor of the gallery. The back end of this pipe is closed by a cannon having a capacity of about one-fifth of an ounce of powder, the other end being left open. A loose metal disk covers the end of each jet leading into each hole in the floor of the gallery, thus forming a pocket for the dust, about one-tenth of an ounce, with which each hole was loaded.

Each hole is covered by a small square of coarse, heavy screen held in place by large washers bolted to the floor of the gallery. The purpose of this screen is to diffuse the dust into a cloud of more uniform density.

The gallery was loaded by pouring about one-eighth of an ounce of the "mill dust" in each of the fourteen holes in the floor of the gallery. The squares of screen were then placed in position over each hole.

The cannon in the end of the horizontal pipe beneath the gallery was loaded with about one-sixth of an ounce of powder, and about a third of an ounce of loose powder was placed between the first two holes in the floor of the gallery. After the loading of the gallery had been completed, the top was bolted on and the electric firing wires connected. The explosion of the powder in the cannon served to raise a dust cloud and the loose powder was used to start the initial explosion of the dust cloud.

The cannon and loose powder were fired by means of electric spitters, the cannon being fired two seconds before the loose powder.

From experiements made in the Fraser apparatus, it was believed that the division point between explosibility and non-explosibility would be found in dust containing between 10 and 15 per cent. volatile matter.

Two samples, one containing 13.45 per cent. and one containing 10.99 per cent. volatile matter were tested in the gallery. The first sample was found to be quite explosive, while the one containing 10.99 per cent. is less explosive and would probably require an initial explosion to ignite it.

Tests were also made to determine the inflammability of the dust, one of these being the heating of a clay roasting dish, six inches in diameter, in a furnace to a temperature of 2,000° Fahrenheit. When the dish had reached this temperature, about one-sixth of an ounce of "mill dust" was quickly dropped in a cloud upon it.

Another test was made by blowing a small amount of the dust in a cloud across the flame of a Meker burner.

These methods of testing were valuable as they were almost identical with

the conditions in and around a steel mill where the red hot iron and steel are often in close proximity to clouds of dust.

Two samples containing 20.60 per cent. and 23.54 per cent. of volatile matter burned readily and with more or less explosive violence.

Three samples containing 11.5 per cent., 13.45 per cent. and 15.91 per cent. of volatile matter burned readily, but without the violence of the two preceding samples.

Two samples containing 11.25 per cent. and 10.99 per cent. of volatile matter were found to be slightly inflammable and one with only 7.17 per cent. of volatile matter would not burn at all.

From the above described tests and from similar tests with dust from the steel mills of other companies, it has been fairly well demonstrated that the division point between mill dust which will explode and that which will not explode, is reached when the dust contains about eleven per cent. of volatile matter.

A good example of the great danger from mill dust, caused by the use of pulverized coal, is the fire which occurred a few years ago in a plant in which there were a number of puddling furnaces, some of which used pulverized coal as a fuel. A draft of air blew some of the coal dust over some red hot iron or slag. The dust immediately ignited and communicated the flames to the roof trusses. These were covered with fine dust which caused the roof to burn so quickly that the men barely escaped in safety from the building.

Many of the systems distributing coal dust to the furnaces consist fundamentally of fans which drive the dust from the storage bins through large pipes, from which small feed lines lead to the burners. It is the practice in some mills, when the furnaces are shut down, to stop the fan before all the pulverized coal in the pipe line has been thoroughly blown out. This is a rather dangerous practice for the reason that, when the pressure from the fan is stopped, there is liable to be a back draft from the furnace which may take live sparks into the feed line. These sparks will smoulder until the fan is started again and then will be fanned into a flame, igniting the dust in the feed line with a consequent explosion. The fatal explosion mentioned in the first part of this article was evidently caused in this manner.

The roof trusses, pipes, platforms and all other places upon which any considerable amount of dust might accumulate should be kept thoroughly cleaned. In cleaning these trusses, platforms, and so on, no flame torches or open lights should be used because of the danger of igniting any dust cloud which might be raised.

All electric switches and motors should be kept from dust and all electric wiring should be kept away from any place where dust in large quantities is liable to accumulate. As far as possible the wiring should be carried in conduits.

Provision should be made to protect properly all pulverizing machinery from damage which might be caused by an explosion due to the ignition of coal dust from static electricity in the machinery. All conduits, grinders and other parts in which an electric spark is liable to be produced should be grounded. Care should be taken that there is no way in which the coal dust can come in contact with hot metal; especially where pulverized coal storage bins are in close proximity to hot metal or hot slag.

In some of the furnaces in which natural gas has been used, it is customary to keep both the gas and pulverized coal connections ready for service. If coal is being used, the gas connection should be cut out as there is a chance that a leaky valve may allow gas to accumulate in the main coal feed and become ignited by a back fire from the furnace.

The substitution of powdered coal for natural gas in the heating furnaces of the steel mills is of comparatively recent date, and there is hardly any doubt but that the practice will become more general in its application as an adequate supply of natural gas becomes more difficult to obtain.

As the problem of mill dust and the consequent danger therefrom seems to be prevalent in some plants using pulverized coal, it would seem imperative that every mill official should take precautions to prevent loss of life and property by an explosion or fire from this dust. —U. S. Bureau of Mines, Reports of Investigations.

NOTES ON LIGNITE

Continued from page 65

"Efforts are being made in France to introduce the distillation of lignite for tars. The Societe de Distillation des Combustibles, Paris, is constructing an improved Zeigler type of furnace similar to that used for the distillation of peat, a type yielding about 7 per cent. of tar.

"In one place in Germany, where the system was adopted, 70 to 80 per cent. of marketable products was obtained from lignite tar, namely 15 to 20 per cent. paraffine wax, 5 to 20 per cent. kerosene; 5 to 15 per cent. of creosotes and organic acids; the remainder being light products, petrol, etc., or heavy products such as gas-oils, and lubricating oils.

"Concurrently with the great interest taken in the development of the shale-oil industry in America, it is worth while to consider the possibility of utilizing the large deposits of low-grade lignites for another set of greatly-needed chemicals, including the fixed nitrogen, which can be converted into ammonium sulphate. Among the available products are benzol and toluol, and the gas can be employed in many places for industrial purposes." (Mining and Scientific Press, May 11, 1918.)

If we are to prevail against our enemies in time of war and maintain our commercial prestige during peace, we must not be less diligent than either friends or foes in the matter of developing and conserving our natural resources.

In respect to the world's future demand for fuel oils, the "London Financier," the leading financial paper of London, says in a recent issue:

"Of all the commercial propositions of the world, probably none has greater potentialities than the oil industry. Although throughout the centuries a staple product of the earth, oil, until comparatively recent years, was never utilized to any extent as a motive power owing to the poverty of invention in respect to engines adequate for its proper exploitation in that respect.

"The war, however, has brought about many wonderful changes, necessity having truly proved the mother of invention, and, among other things, oil engine invention has received a vast stimulus, with the result that perfection in the manufacture of the necessary machinery is now being rapidly approached, and, at the same time, scope for the usefulness of liquid fuel enormously extended.

"It is indeed quite reasonable to prophesy that the next generation will witness the practical disappearance of coal as the motive power for railways and ships, so that 'King Oil' may become a greater potentate on both land and sea than the veteran monarch of motion, 'King Coal.' "

A market for the fuel oils derived from carbonization of lignite is assured.

This project of developing our lignite resources is not a small matter.

Take the North Dakota section as an illustration:

Into this section there are now being imported a minimum anual tonnage of two million tons of bituminous coal and one million tons of anthracite, every pound of which should, and some day will, be replaced with fuel from the Dakota lignite field.

To replace these three million tons would require the carbonizing annually of six million tons of lignite, yielding three million tons of solid fuel, 18 billion cubic feet of surplus gas (costing nothing), 45 thousand tons of sulphate of ammonia, and 60 million gallons of tar distillates, comprising benzol, carbolic, creosoting and anthracene oils, paraffin, etc.

The waste in dollars and cents involved in two years' importations of the foreign coal into that territory would probably pay for all the equipment necessary to carry on the industry on the scale outlined.

Bear in mind, too, that the Texas lignite situation affords an even greater opportunity for economic saving. The opportunity in Alaska must be nearly, if not quite as large. And there are many smaller deposits of lignite scattered over the southern and Western states where relatively smaller savings can be made in similar fashion.

In several sections of Texas there are merchantable deposits of iron ore. Limestone is close at hand. The development of these deposits has been unprofitable because of the high price of coke, but under the present stimulus of high prices for pig iron, a blast furnace will soon be put into operation at Rusk, notwithstanding the fact that the Alabama coke,

Continued on page 46

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Add 5% to list above.

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	26 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 67	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 75
Steel bars, base, Toronto	4 75
Steel bars, 2" to 4" base	6 00
Steel bars, base, Montreal	3 75
Best grades	15%
Iron bars, base, Montreal	3 75
Reinforcing bars, base	4 75
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28	$7 00	$6 75
Sheets, Black, No. 10	6 50	6 50
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	9 25
Premier, 10¾ oz.	....	9 65

PROOF COIL CHAIN

B

¼ in.	$13 00
5-16 in.	11 00
⅜ in.	10 00
7-16 in.	9 80
½ in.	.....
9-16 in.	.....
⅝ in.	.....
¾ in.	.....
⅞ in.	9 20
1 in.	9 10
Extra for B.B. chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

¼ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	22¼
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard	30. 10%
Cut leather lacing, No. 1	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and leg screws	30
Stove bolts	50
Plate washers	50
Machine bolts, 7-16 and over	10
Machine bolts, ⅜ and less	20
Blank bolts	25
Bolt ends	10
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hex., blank	add 1 75
Nuts, hex., tapped	add 2 00
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs	40c 05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	75
Wood screws, O.&R., bright	77½
Wood screws, flat, brass	55
Wood screws, O.&R., brass	65½
Wood screws, flat, bronze	50
Wood screws, O.&R., bronze	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 68
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A.	list plus 43
Emery Cloth	list plus 37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd.	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets ..... list plus	10
Planer head bolts, with fillet ..... list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws ..... list plus	20
Collar screws ..... list plus	20, 80
Thumb screws	40
Thumb nuts	75
Patch bolts ..... add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. ..... add	2 00

METALS

METALS

Lake copper	$24 25	$25 00
Electro copper	24 00	25 00
Castings, copper	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided	$0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.

NOTES ON LIGNITE

Continued from page 72

which will be used, will cost $16 per ton at Rusk. The carbonized lignite, or the carbonized lignite briquets, should replace coke at not more than half the price. The lignite, iron and limestone lie within a few miles of each other. The development of a steel industry in Texas surely should obviate the necessity of large shipments of iron products from eastern United States into that section.

The concerns now engaged in mining lignite are not strong financially. They cannot afford to hire the technical and engineering skill which can be supplied by the Bureau of Mines. They need and are asking for help, and it is believed that a measure of governmental assistance on the technical features presented is amply warranted.

While any encroachment by the Government upon what is popularly deemed the field of private industry may be looked at askance by the public; yet, if the nation's natural resources are to be conserved and the fullest possible benefit gotten from them, some authority having a wider vision than any single industrial concern intent upon earning dividends must exercise a certain degree of surveillance and afford a measure of constructive help in co-ordinating the innumerable features of industrial interrelationships. A constructive economic policy of this character is a true Government function and should insure rather than jeopardize legitimate gain from private enterprise.

Our pride should be not in our mere possession of this bountiful land,, but in the extent to which we discover its resources and in the degree of efficiency to which we devote them to the service of mankind.

CANADIAN RAILWAY CLUB HOLD MERRY TIME AT ANNUAL DINNER

THE seventeenth annual dinner of the Canadian Railway Club was held on the last night of January, at the Windsor Hotel, Montreal. About 300 were present at the tables and all did justice to the food (and drink) placed before them. The dinner was presided over by J. Hendry, president of the club, with Lewis C. Ord as toastmaster. The Hon. Arthur Meighen and Rev. George Adam were the guests, and with them at the head table were: W. M. Neal, late secretary of the Canadian Railway Board; W. H. Winterrowd, H. H. Vaughan, J. M. S. Carroll, R. M. Hannaford, Jas. Coleman, W. H. Sample, T. C. Hudson, W. McNab, A. A. Goodchild, W. A. Booth, A. A. Maver, Wm. H. Robb, W. A. Kingsland, Norman Holland, and G. M. Wilson.

In proposing the toast to "Our Railways," W. H. Winterrowd gave a brief resume on the history of railroad development in Canada from the time that the first train was put in operation 92 years ago, up to the present time, particularly emphasizing the effective special service rendered by the railroads during the past five years. The reply to this toast was ably given by W. M. Neal, formerly general secretary of the Canadian Railway War Board, and recently appointed as assistant general superintendent of the Quebec district of Canadian Pacific. His brief address was largely taken up by a review of the achievements of the Board in getting the effective co-operation of the various railroads under the auspices of the C.R.W.B., whereby there had been great saving in labor and operating costs. Mr. Neal gave numerous figures to illustrate his remarks.

The toast to "Our Guests," which was proposed by T. C. Hudson, was responded to by the two chief speakers of the evening, the Hon. Arthur Meighen, Minister of the Interior, and Rev. George Adam. In his address, Hon. Arthur Meighen spoke on the gradual, but progressive, development of Canadian railroads, and defended the policy of the Government in their acquisition and control of additional mileage. He emphasized the changing industrial conditions that were virtually forcing the Government to take over the Grand Trunk. In speaking on this matter he said: "I pass the subject up only with the statement that that acquisition, like the previous one, was not brought about through any restless ambition to become great railway operators and owners, but it was the result of our railway crisis, the result of some mistakes and, indeed, of the very evolution of railroads.

The first instalment of machinery and power equipment that will be used in connection with the new plant of the St. John Dry Dock and Shipbuilding Company, at Courtenay Bay, has been delivered to the site. This shipment consists of four carloads and will form part of the twenty carloads that will be required to fit out the plant. The machinery, when unloaded, will be stored in an adjoining warehouse until the buildings are ready to receive it.

BOOKS

on all branches of Engineering and every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT

Books Bought Best Prices Given

W. & G. FOYLE, Ltd.

12-125 Charing Cross Road, London, England

WANTED

Representatives to handle special line of British made "Elastic Steam Jointing Cement" (for all joints) and Iron Cement for casting, etc. Exclusive territory offered parties conversant with trade. Replies treated confidential. Apply Box 151, Power House.

OPPORTUNITIES

TENDERS INVITED

SEALED tenders will be received up to and including March 1st, 1920, to cover the installation of a distribution system of electric lighting in the town of Capreol, Ontario. Plan and specifications on request.

W. H. MATHEWS,
Town Clerk.

WANTED

First-class machinery draftsman, by large Canadian in city near Toronto. In making application give details of experience, age and salary desired, etc. Apply Box 205, Power House.

WANTED

Power House Engineer, holding second-class Provincial certificate as assistant to chief engineer, for large industrial plant near Montreal, must be experienced in the operation of D.C. generating sets, transformers, air compressors and hydraulic pumps. Permanent position for the right man. Applicants speaking English and French given preference. State experience, qualifications, age and salary expected. Box 206, Power House.

Where Do You Live?

We are going to put a representative in every town in Canada. Be the one in your territory.

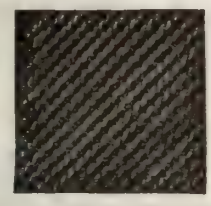
We teach you how to build a permanent, substantial business. Whole or spare time. Write for particulars to-day.

Dept. B., Agency Division
153 University Ave., Toronto, Ont.

STATIONARY ENGINEERS — THOSE WHO wish some practical tuition for their Graded Certificates from a practical power house engineer holding highest certificates are invited to communicate with T.H.F., Box 208, Power House.

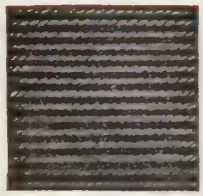
Manager wanted, for Canadian National Newspapers & Periodicals Association. To act also as Secretary-Treasurer, and carry on the Association's general work, under the direction of the President and the Board of Directors, study the interests of the various classes of publications in the Association, and plan and carry on promotion work in their interests. Applicants should understand advertising and merchandising. Apply in writing only, stating age, full details of experience, and salary expected. Applications will be treated as confidential. Address Acton Burrows, President, Canadian National Newspapers & Periodicals Association, 70 Bond Street, Toronto.

"SPANDO"



CROSS SECTION
"SPANDO" PACKING

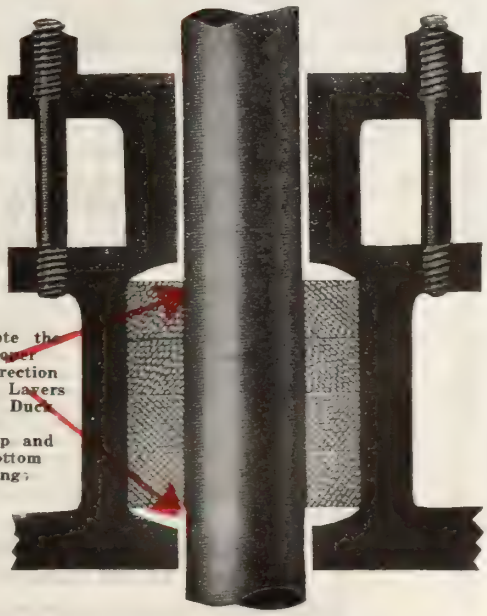
THIS is the Registered Trade Mark which guarantees the Original and Genuine SPANDO Cross Expansion Piston Packing. It is *your* protection as well as *ours*. Insist on having SPANDO. Do not accept any of the numerous substitutes which are put forth as *"Just as good as Spando."*



CROSS SECTION
REGULAR PACKING

Regular square packing in general use under pressure as illustrated will expand but little.

"SPANDO" PACKING IN SERVICE



"SPANDO" SQUARE PACKING

Under pressure as illustrated will expand 100 per cent.

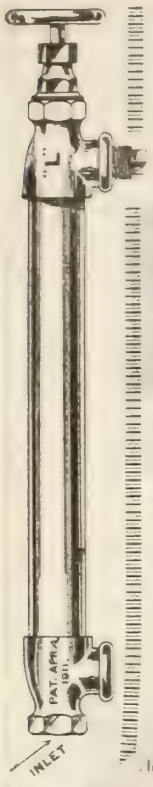
These Test pieces of Packing were square before pressure was applied.

Send for samples and make this test yourself in a vise.

Valve Engineering Company

160 King St. West, Toronto, Ont.

Use The LONG STEAM for TRAP SATISFACTION



Automatically drains jacket kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with great success. Read this letter.

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson, Superintendent

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

J. T. LONG
84 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.
4

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 24 TO 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

At the luncheon given by the Engineering Institute of Canada on the first day of the convention, a discussion on the growing necessity of new methods in the construction and maintenance of highways was a feature of the session. It was suggested that some federal system of co-ordination be adopted to build roads on regular plans throughout their length so as to adequately meet the requirements of modern motor traffic. The rapid extension of motor traffic made it imperative that a standard road should be maintained on the main highways, and that everything should be done to encourage some co-operative plan of permanent and uniform roadways.

Continuing to recognize the undersupply of bituminous coal for the full operation of nominal railroad service, officials of the Canadian roads have stated that with few exceptions the curtailment of trains and other activities, requiring coal as fuel, will be effective for some time yet. The duration of this period will depend on the severity of the winter and the time required to return the coal supply to normal.

Changes at Hamilton.—The Canadian Fairbanks-Morse Co. announce that Mr. R. V. Donaldson has been transferred from London to take charge of their business at the Hamilton branch. Mr. Dave White, who has been with the Canadian Fairbanks-Morse for some time in Hamilton, has started in business for himself in that city.

Five workmen of the Hall Engineering Company, of Montreal, were slightly injured while repairing a boiler at the Low Level pumping station, when a tube on an adjoining boiler burst, enclouding them in steam. Little damage was done to the plant, but the burns of the men were painful, but not of a serious character.

Pratt and Cady Co., Inc., have issued a folder entitled: "Take the Hobbles Off Production." This folder invites the reader to join in a movement for the reduction of the high cost of production by standardizing manufactures and by the use of standard lines wherever possible.

The Green Fuel Economizer Co. announce the opening of their own office at No. 1006 Finance Bldg., Philadelphia, Pa. The office will be in charge of Mr. W. F. Wurster, assisted by Mr. G. E. Kille. The company was formerly represented in this territory by the Baker-Dunbar-Allen Company. Mr. Wurster has been doing engineering and sales department work with the Green Fuel Economizer Company for the past six years.

Guelph After Six. — The Industrial Committee of the Guelph Chamber of Commerce met and dealt with the application of six American firms who are anxious to locate their Canadian branches in Guelph. The landing of two or three of the firms for the city looks very promising. A sub-committee was appointed to deal with the formation of a Guelph Realty Company. Committees to look up detailed information on the following subjects are to be appointed: Power factor sites, taxation, water, transportation and education.

New Light System. — Superintendent Williams, of the Canadian Pacific Railway, anounced that an automatic electric light system of signals is to be installed this summer on the 65 miles of Canadian Pacific railroad track between London and Toronto. The new system will save oil and labor. Mr. Williams also stated that practically a quarter million dollars will be spent by the C. P. R. on improvements in the division during the summer of 1920.

Are You Able to Turn Your Spare Hours Into Dollars?

If not—and you are really trying to cash in on the spare moments you have during the day or after working hours—if you have made up your mind to take hold of some proposition and sail right in and actually increase your monthly income without hindering your regular work—surely you will want to know about MACLEAN'S plan for making each spare moment count. And even if you are already making money during your spare time—still you can add to your income with very little additional efforts. For you can have full particulars of MACLEAN'S plan absolutely free. If you will merely drop us a card we will send you the complete details of this plan. It will cost you nothing to find out exactly how others with spare time have materially increased their monthly earnings. For full information or the agency in your locality, write and right now,

Dept. WB
MACLEAN PUBLISHING COMPANY, Limited
143-153 University Ave., Toronto

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

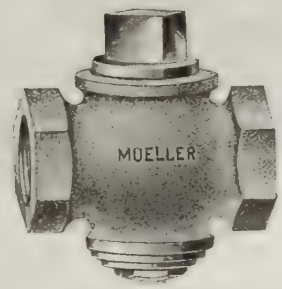
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

MADE IN CANADA

MUELLER
Steam Cocks

ROUGH BRASS, GROUND KEYS,
NUT AND WASHER BOTTOM



A3000
CODE—Orator

WE MAKE
MUELLER

Basin and Bath Trimmings, Bibbs, Sill Cocks, Ferrules, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps; Regulators and Reducing Valves for Water, Air, Steam and Oil; Bubbling Fountains, Gas Cocks, Globe, Angle and Check Valves, Etc. Forgings in Brass; Castings in Brass, Bronze and Aluminum; Specialties for Automobile Companies, including Bronze Bushings, Gasoline Cocks, Etc.

Consistently uniform with the quality of MUELLER Globe, Angle and Check Valves the MUELLER line of Steam Cocks is particularly adapted for the power house where after all it is the *service* that counts.

Sixty-five years' experience in the brass foundry business is embodied in these individually inspected and tested cocks.

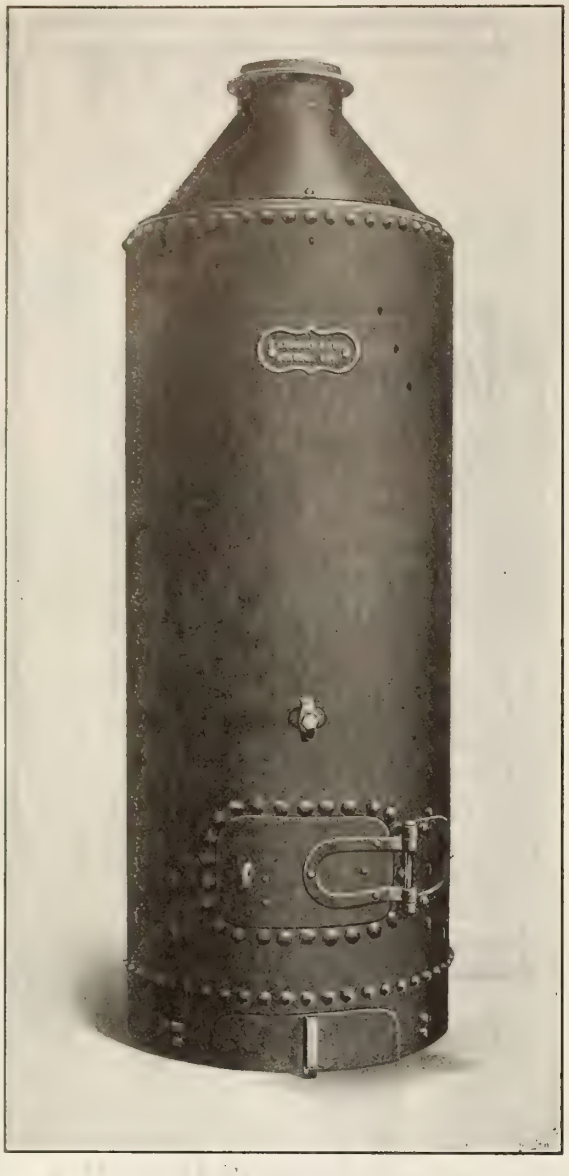
Additional information upon request.

H. MUELLER MFG. CO., LTD.

SARNIA CANADA

Send for our Canadian Catalogue A

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS



UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube (Patented)

Return Tubular

Upright

Locomotive

We specialize in the making of

Smoke Stacks

Tanks of all Types

Plate work of any description

Grey Iron Castings

E. Leonard & Sons, Ltd.

Head Office and Works:
LONDON, CANADA

Established 1834

LEONARD

Carling BLOWERS SUPERIOR

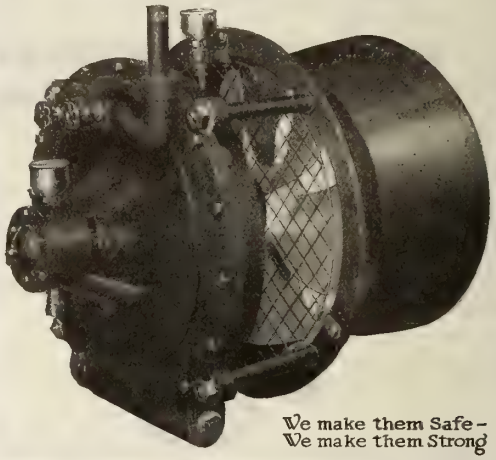
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

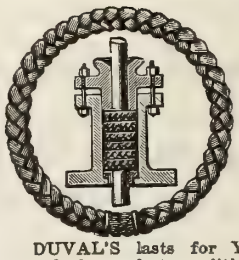
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB
Board of Trade Building, Montreal

CRANE MALLEABLE FITTINGS

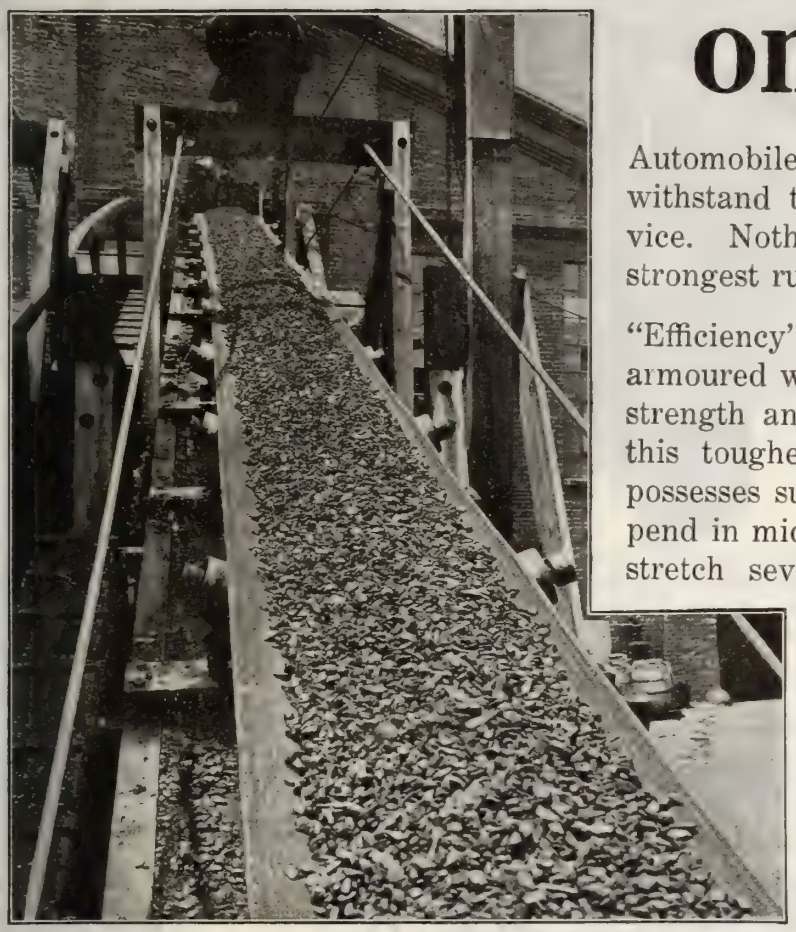
CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST PATRICK ST

MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

Conveyor Belts that Stay on the Job



Automobile Tire Treads encounter and must withstand the most abusive, abrasive service. Nothing but the very toughest and strongest rubber stock will stand it long.

"Efficiency" Conveyor Belts are heavily armoured with Tire Tread Rubber of great strength and elasticity. A single cord of this toughened rubber, one inch square, possesses sufficient strength to readily suspend in mid air a big load of hay and will stretch several times its original length without breaking.

"Efficiency" Conveyors, like highest grade Auto Tires, are made for the most exacting service.

Though of immense strength they trough perfectly, and, of their own weight, automatically conform to the idlers.

Other very important features in their construction we are unable to detail here, but they represent economy in operating cost for you. When in need of Conveyor Belting let us send a representative to demonstrate them.

Rubber Belting for Every Purpose.

Rubber Goods of all kinds for Every Mechanical Service

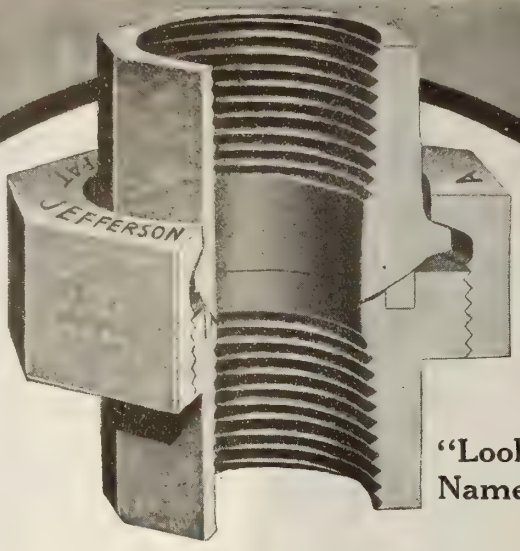
Gutta Percha & Rubber, Limited

Head Office and Factory: Toronto, Ont.

Branches:

Halifax, Montreal, Ottawa, Toronto, Fort William, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria

JEFFERSON



"Look for the Name on the Nut"

JEFFERSON UNIONS are particularly adapted to the requirements of underground pump service. The Brass Seat Ring makes a tight brass-to-iron joint which cannot corrode, and is easily disconnected. The Spherical Ground Joint takes care of alignment difficulties and makes possible a tight joint even if the line is not exactly straight.

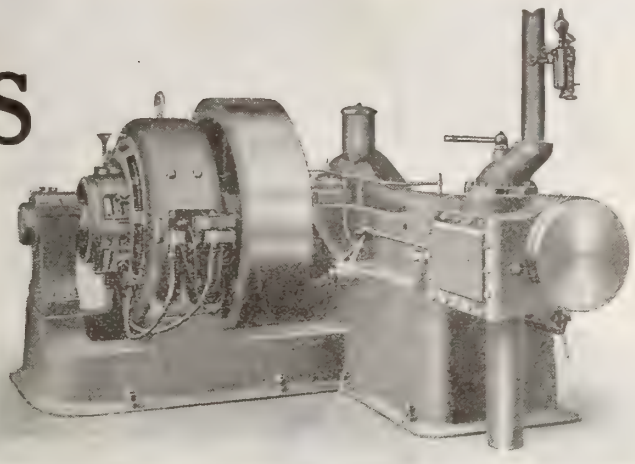
And there are other important reasons why JEFFERSONS are better. "The Name on the Nut" protects you against substitute "just-as-good" unions. You would have a mighty hard time trying to make tight a leaky union with a "just-as-good" promise.

Ask your Jobber and JEFFERSONS. He knows every union that's made and can tell you just why JEFFERSONS are better. Write TODAY for our Catalog "UNIONS"

The Jefferson Union Co.
Lexington, Mass.

ROBB POWER PLANTS

Robb designs with accurate workmanship ensure economical power plant service.



Engines

Corliss, slide valve, vertical, horizontal, simple and compound.

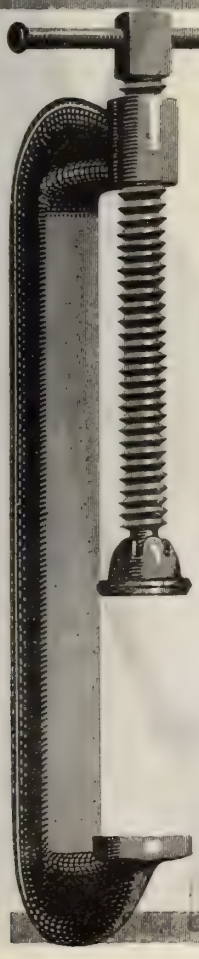
Boilers

Water tube, return tubular, improved Scotch marine and portable.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office:
Phone Westmount 6800

Toronto Office:
20 Victoria Street



WILLIAMS' SUPERIOR DROP-FORGED CLAMPS

THERE'S a Williams' Clamp for every purpose.

If it's extreme strength and heavy service—Williams' "Vulcan" line provides both.

11 sizes, ¾ to 12½ inches capacities.

If it's general utility—without need for maximum strength—Williams' "Light Service" line will fit the case, 8 sizes, 2 to 12 inches capacities.

If it's stability and utility—medium service—Williams' "Agrippa" line offers the solution. 7 sizes, 4 to 18 inches capacities.

If it's Tool Room work requiring comparatively small openings of jaws — Williams' "Vulcan" Tool Makers' line should be chosen. 4 sizes, 1 to 4 inches capacities.

All are made of a special, high-grade steel. After forging they are submitted to a refining process, or "heat treatment," which increases their stiffness and strength and reduces the liability of springing.

Engineers' Tools Booklet on Request.

J. H. WILLIAMS & COMPANY

"The Drop-Forging People"

78 So. Clinton St., Chicago, Ill. 78 Vulcan St., Buffalo, N.Y. 78 Richards St., Brooklyn, N.Y.

THE A. G. LOW CO., LTD., 78 Pacific Ave., Saskatoon, Sask.
Agents for Manitoba, Saskatchewan, British Columbia and Alberta

DEPENDABILITY!

THE Emergency Fleet Corporation accepts Sturtevant Electric Generating Sets because they are absolutely dependable in service.

Sturtevant
(TRADE MARK)

ELECTRIC GENERATING SETS

are built to U. S. Navy Specifications and accepted without alteration in design. They are carefully designed and built to give lasting satisfaction after long periods of severe operation. They are compact, self-contained units, consisting of a Sturtevant steam engine direct-connected to a conservatively rated Sturtevant electric generator. They are made with automatic lubricating systems, either gravity or forced feed. All reciprocating parts of the engine are entirely inclosed within the engine frame, which is provided with oil- and dust-proof covers. Removal of these covers gives ready access to all parts. Our Bulletin 239-U gives detailed facts about these sets.

B. F. STURTEVANT CO., OF CANADA, LTD.
HEAD OFFICE AND WORKS: GALT, ONTARIO
SALES OFFICES: TORONTO AND MONTREAL

Sturtevant
Reg U.S. Pat. Off.
PUTS AIR TO WORK

VULCABESTON

Temperature at 1500° Fahr. and Vulcabeston Held

And it will continue to hold as it does under all conditions.

The long asbestos fibre that gives strength to resist squeezing out, the binder that never cracks nor completely dries out, its imperviousness to moisture—these and other qualities make

VULCABESTON
RED FIBRE SHEET PACKING

dependable under whatever conditions of temperature, moisture, pressure, or corrosion it may be used.

It is truly "The Universal Packing", the one packing for every need.

Ask your dealer or write us for a sample and put Vulcabeston to the test.

The Johns-Pratt Company
Hartford, Conn. U. S. A.

Dealers in all large cities

"VULCABESTON" RED FIBRE STEAM GASKET SHEET PACKING COMPRESSED ASBESTOS

20-2

UND. LAB. INSPECTED

ECONOMY Renewable FUSES Mean DOUBLE PROTECTION

ECONOMY renewable FUSES were approved—IN ALL CAPACITIES—by the Underwriters' Laboratories on Dec. 9, 1919—the old "APPROVED IN ALL CAPACITIES" renewable fuse using an inexpensive bare link to restore a blown fuse to its original efficiency.

Economy renewable Fuses—from 0 to 600 Amperes in both 250 and 600 Volts bear the Underwriters' approval label. Economy "Drop Out" renewable links also bear the inspection symbol.

There were millions of Economy Fuses in use before this approval was granted—a fact applicable to no other electrical device listed in the code as requiring approval.

Both the unrestricted use of Economy Fuses and the granting of approval were due to the fact that these fuses live up to all claims made for them — accurate, efficient, economical and safe.

The use of ECONOMY renewable FUSES means double protection—the dependability of the fuse itself—the regular inspection by the Underwriters' Laboratories.

Approved In All Capacities

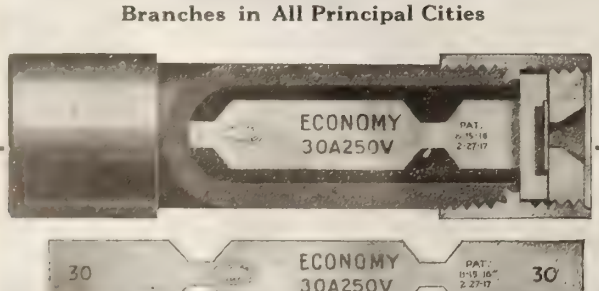
Economy Fuses, approved in all capacities, ferrule and knife blade types, are stocked and sold by all leading electrical dealers and jobbers in the United States and Canada.

Economy Fuse & Mfg. Co.

of Canada, Limited

Unity Bldg., Montreal

Branches in All Principal Cities



Water Problems

Submit your water problems to

E. J. PHILIP & SONS

Ontario representatives of

Roberts Filter Mfg. Co.

Manufacturers of Water Filters for

Municipal, Industrial or Residential Uses

Any Capacity

E. J. PHILIP & SONS

57 Queen Street West

TORONTO - CANADA

ENGINEERING EQUIPMENT

DEPARTMENT OF LABOUR

Ontario Government

Minister:
Hon. W. R. Rollo.

Deputy Minister:
W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a STATIONARY steam plant of 50 B.H.P. or over, in the Province of Ontario, must hold a Stationary Engineer's certificate from the Board of Stationary & Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers.

After January 1st, 1920, the Certificate issued by the Board will be of four grades, viz., First, Second, Third, and Fourth. Application forms for graded certificates will be mailed upon request after the above-mentioned date. The certificates now issued by the Board will be graded into Third and Second-Class upon renewal, same being classified from the information contained in the renewal application which will be sent to each certificate holder.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse-power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1st, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request. The B.H.P. and other information contained in these forms is to be used for statistical purposes. A Registration Certificate will be issued to each applicant. All applications, or requests for same, should be mailed to the Chairman.

W. C. MCGHIE, CHAIRMAN OF BOARD

NOTICE TO MANUFACTURE DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, entering the Province of O tario, and boilers exchanged repaired, are subject to G ernment Inspection as prescr ed in the Steam Boilers' A 3 George V., c. 61.

Before any work of repair alteration is commenced on boiler, notice must be sent the Department stating the ture and extent of the repa or alterations proposed to made. If the Chief Inspec should consider such repairs alterations of an extensive ch acter, the boiler must be spected in accordance with Regulations by an Inspector thorized under the Act.

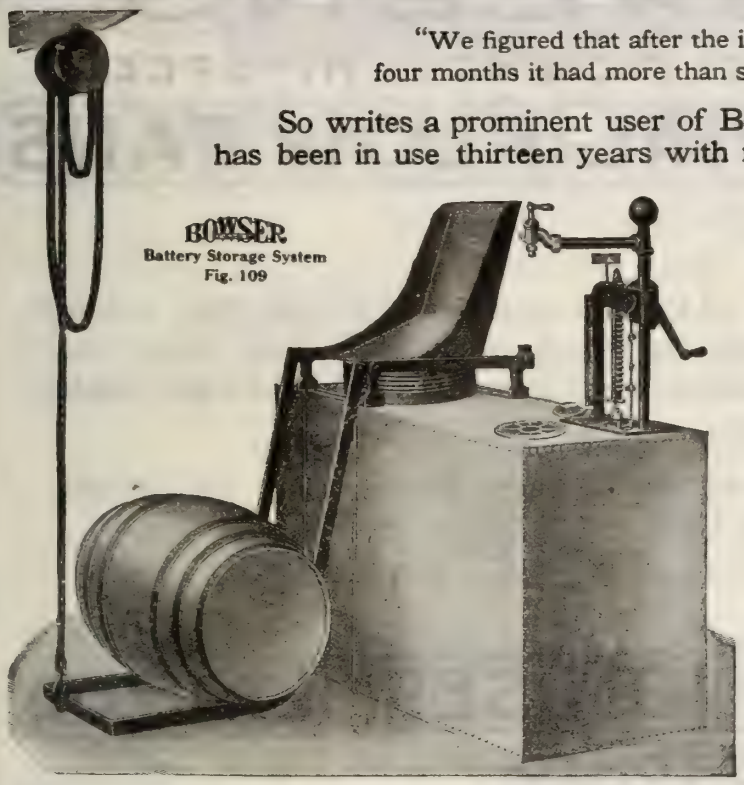
All communications should addressed to the Steam Bo Branch, Department of Labo Parliament Buildings, Toron

D. M. MEDCALF, CHI INSPECTOR OF STEA BOILERS

Why Don't You Save Too!

"We figured that after the installation had been in three or four months it had more than saved its entire cost."

So writes a prominent user of Bowser Oil Storage. Their equipment has been in use thirteen years with no operating troubles or upkeep cost.



If you are not using Bowser Storage Systems for your oils you are losing money every day.

BOWSER ESTABLISHED 1885

Systems Do Save

You can save the Bowser Way. Our literature shows how. Write for it at once.

BOWSER COMPANY, LIMITED
68-68 Fraser Avenue
TORONTO, ONT.

LONDON
32 Victoria St. S.W. 1
HAVANA
Lonja del Comercio 427
PARIS
5 Rue Denis-Poisson
SYDNEY
6 Castlereagh Street

What a Canadian Advertiser Says:

The following letter, by no means an exceptional one, accompanied a renewal advertising order received on January 10th, 1920. Such expressions emphasize the fact that our policy of "Efficiency in Power Plant Equipment and Service" is accomplishing splendid results for readers and advertisers.

"Gentlemen:—

"Enclosed please find our contract for space in 'Power House' for the coming year.

"I wish at this time to express my very high opinion of the value of your paper, both from an editorial and advertising standpoint. As a matter of fact, after many years' experience in space-buying, I have reached the conclusion that the value of space in a paper is of value to the advertiser in direct proportion to the value of the editorial matter to the reader. You certainly have a very capable editorial force, and we want to compliment you upon this feature of your paper as well as to express our thorough appreciation and satisfaction with the results secured through our advertisements."

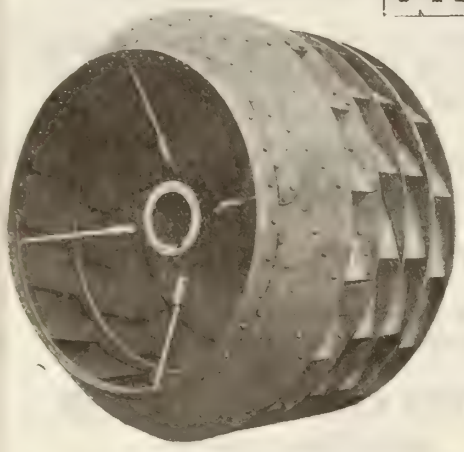
Are You a Reader of "Power House"?

The subscription price is $2.00 per year for 24 books, brimful of choice, up-to-date information.

Are You an Advertiser in "Power House"?

Full information and rates supplied quickly on application. A.B.C. Audit of Circulation.

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

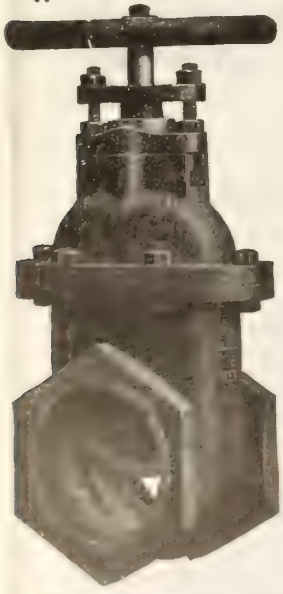


In addition to low power consumption, accessibility and sturdy construction, have many other features which recommend them to the careful buyer.

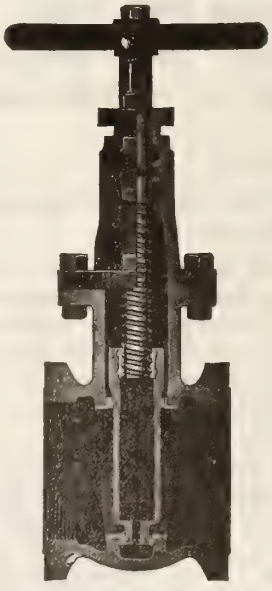
Write for our new Radial Flow Fan Bulletin No. 152H.

GREEN'S ECONOMISER, LIMITED.
TORONTO

KERR
("New KEYSTONE" Pattern) GATE VALVES



If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

WILL USE NO OTHER

ROSEMARY MANUFACTURING CO.

Roanoke Rapids, N. C.

Magnolia Metal Co. 9-6-18

Gentlemen:—

We have been using your MAGNOLIA BABBITT METAL for the past FOURTEEN years and we think so highly of its quality that we will use no other.

With best wishes for your continued success, we are

Yours truly,

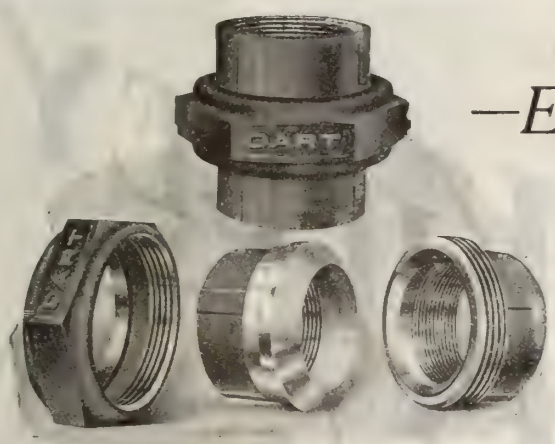
T. W. MULLEN, Supt.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Offic and Factory:

Montreal: 225 St. Ambrose St.



—Economy

DART UNION PIPE COUPLINGS STAY TIGHT

Your Jobber Sells Them

The Joint Is

BRONZE TO BRONZE

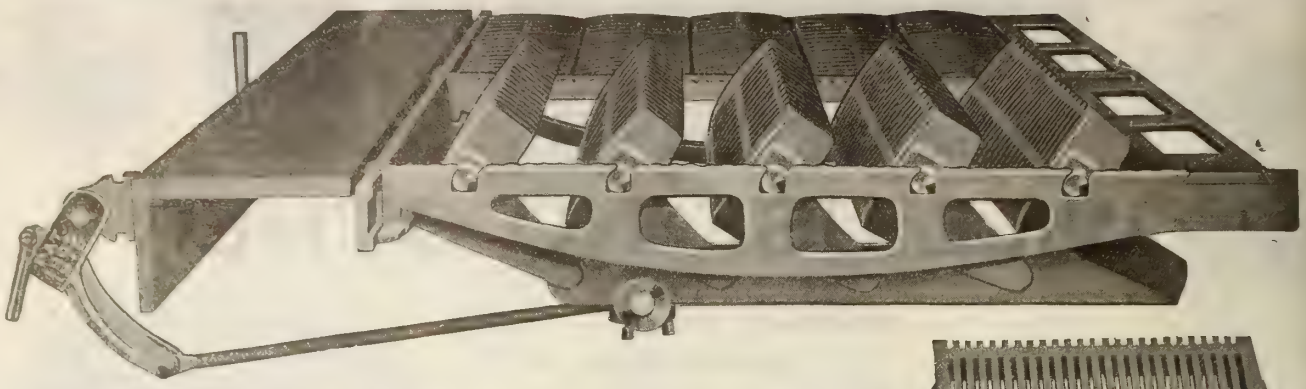
Both Face and Seat

—No Deterioration

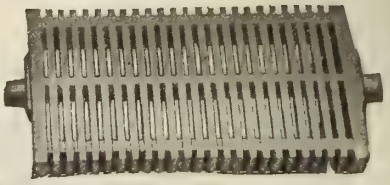
The Bronze to Bronze feature, together with the Extra Heavy Malleable Iron Pipe Ends and Nut make loosening up in service **impossible.**

Never scrap Dart Unions — USE AGAIN—They're always efficient.

Dart Union Co., Limited
Toronto, Canada



CYCLONE GRATES



Burn All Grades of Fuel With Maximum Results No Clinkers No Waste

Investigate Our 30-Day Trial Offer

CYCLONE GRATES Burn all grades of coal and give **maximum** results. Their 60% air space and 90% under-draught insures perfect combustion. No fuel in ashpits where they are installed; no clinker formations either. To prove to you that CYCLONE GRATES are easy to install, and when installed will save you a lot of fuel expense and give you the best furnace satisfaction you have ever had, **we are prepared to make you a 30-day trial offer. Why not investigate?**

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G. 3660 Toronto, Ontario

AGENTS:

OTTAWA.—J. W. Anderson, Room 7, Bank Street Chambers.
ST. JOHN, N.B.—F. W. Blizard, 329 Charlotte St. MONTREAL—Mason Regulator Co., Ltd., St. James St. HAMILTON—Robt. Fitzsimmons, 8 Grove St. WINNIPEG—Vulcan Iron Works

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

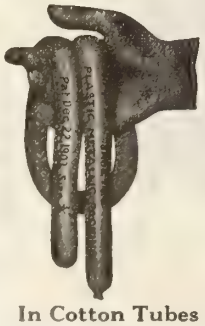
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

KIELEY

Traps
Separators
Regulating Valves
Back Pressure Valves
Pump Governors

For Every Service

Reliable STEAM, WATER and AIR

SPECIALTIES

Simple and stury in design, low cost of operation and accuracy in regulation—these are the advantages that accrue when you equip your plant with KIELEY Specialties. We can supply all your requirements promptly. Write for catalogue of the full KIELEY line.

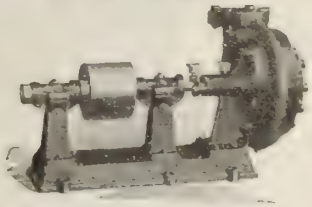
THE ARTHURS. LEITCH CO., Kent Buildind TORONTO

AMERICAN-MARSH PUMPS

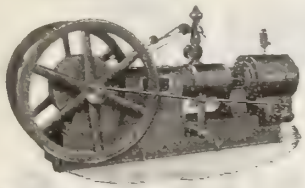
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



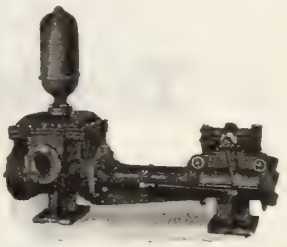
American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors

Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

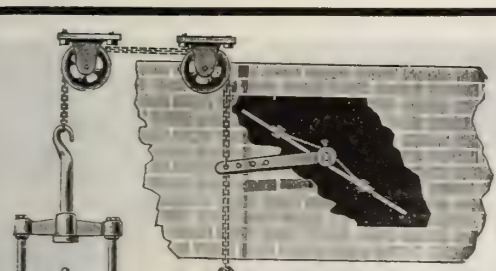


Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

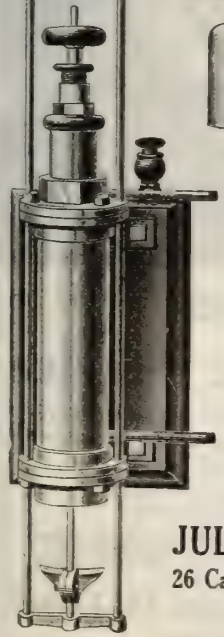
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the



CURTIS

Improved Damper Regulator

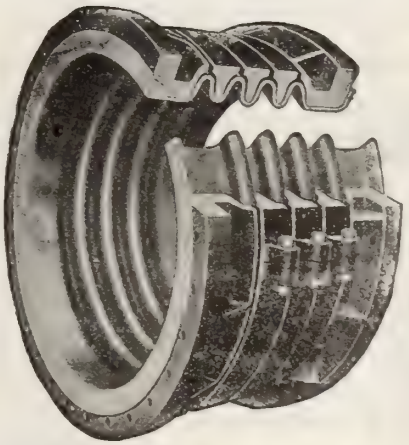
It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1919 catalog showing the Curtis line of Engineering Supplies.

JULIAN D'ESTE COMPANY

26 Canal Street **BOSTON, MASS.**

Agencies:
83 Barclay St., New York City.
174 North Market Street, Chicago, Ill.



BADGER

SELF - EQUALIZING EXPANSION JOINTS

Note the corrugations that expand and contract, thus preventing leakage and looseness.

Write for our new book to-day.

E. B. BADGER & SONS CO.

63-67 PITTS ST., BOSTON

Canadian Agents
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

"McAVITY" VALVES

The Embodiment of **Service**

Giving **Lasting Satisfaction**

Made by

T. McAVITY & SONS, LTD.

ST. JOHN, N. B., CANADA

Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Hand Frame	No. of Blade for Power Machine			
		Light Machine	Medium Machine.	Heavy Machine	Extra Heavy Machine
Light Angles, Channels, Tee Iron, Ornamental			262		
Heavy A... Channe... Tee Iro...			255		
Light S...			5	254	256
Heavy...			5-B	2	256-B
Steel...					
Condu...			2	25	
Brass					
Solid S...				B	B
Cold R...					C
Ma...hin...					
Tool Ste...					
Cast Iron					
Brass					
Sheet Metal a... Tubing					
Less than 18 gage	203	253			
Over 18 gage	102	252			

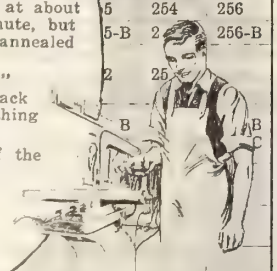
Get the S. P. M. Right

Don't run blades too fast in power machines. You can cut soft steel, if you use compound, at about 100 strokes per minute, but don't try it on unannealed tool steel.

"Haste makes waste" just as much in hack sawing as in anything else.

Send for a copy of the Starrett Catalog No. 21 "CD" and Chart "CD"

42-983.

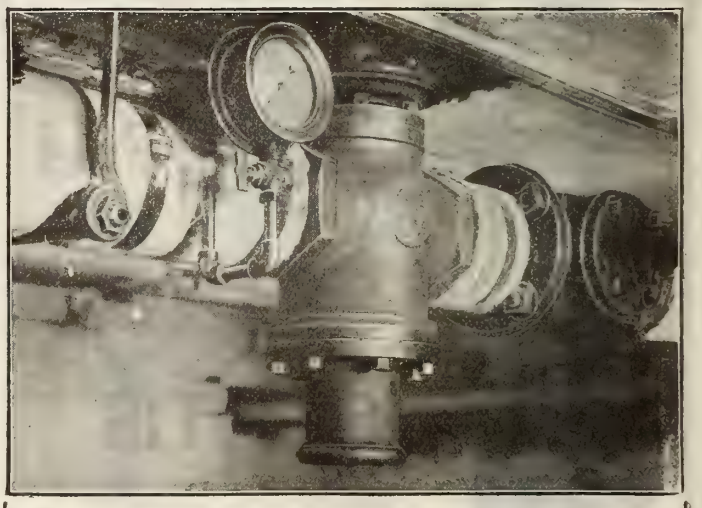


...the Starrett General Catalog and on boxes containing the blades

Get the Starrett Hack Saw Booklet Sent Free

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.

THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS



Mason Reducing Valve installed in the Protestant Hospital for Insane, at Verdun, Montreal.

Proof of Reliable Service

Mason Reducing Valves are strong, durable, practical and reliable. The installation shown above has seen twenty-four years' service.

Mason valves once installed become a fixture, representing continuous, economical service.

Supplied by all dealers and jobbers; not genuine unless the Mason trade-mark is cast on the body.

The Mason Regulator & Engineering Co., Limited

Formerly H. L. Peiler & Company.

Toronto Representative:
The Arthur S. Leitch Co.,
1002 Kent Building.

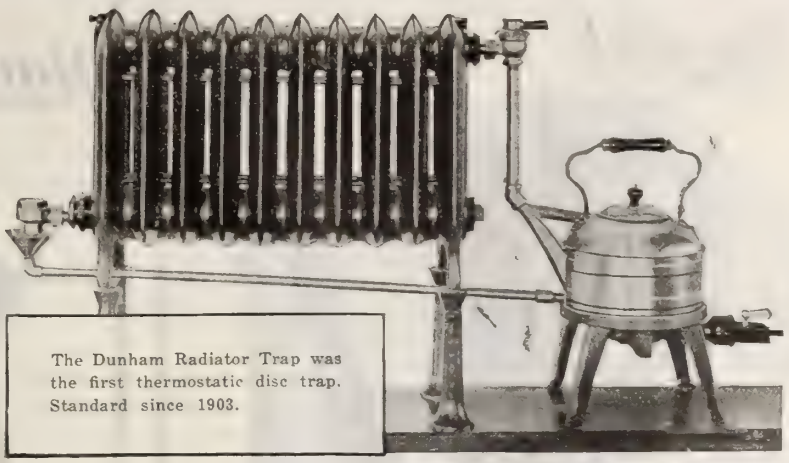
Head Office and Factory:
135-153 Dagenais St.,
Montreal.

Heating a radiator with a teakettle

It was done at the Ottawa Technical School before a group of engineers who were amazed at the demonstration. It proved beyond question that low pressure steam will quickly heat a radiator to 100% efficiency if the trap is right. It undisputably proved that the Dunham Radiator Trap functions perfectly.

Since 1903, the Dunham Radiator Trap has been eliminating any chance of trap trouble in thousands of installations. It was the first thermostatic disc trap. Think of this when you think of traps, and remember that the Dunham Trap is only one element in Dunham Heating Service. The entire service offers much to the man who plans, sells and installs the heating system—and more to him who pays the bills.

If you welcome suggestions that do not obligate you, get in touch with our nearest office. For authoritative information, write for booklet, "Data on Dunham Heating."



The Dunham Radiator Trap was the first thermostatic disc trap. Standard since 1903.

The DUNHAM HEATING SERVICE

Made-in-Canada

C. A. DUNHAM COMPANY, LTD.

TORONTO, ONTARIO

HALIFAX VANCOUVER WINNIPEG
OTTAWA MONTREAL CALGARY
LONDON: 64 REGENT HOUSE, REGENT STREET, W.1

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

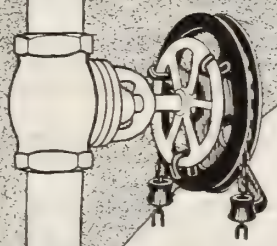
If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company

BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.



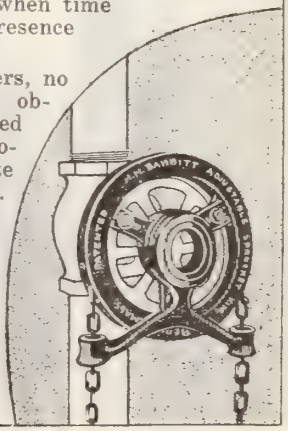
EASY TO ATTACH

A man, a monkey-wrench, and fifteen minutes are all that are necessary to attach a

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

to that out-of-the-way valve. Just think of the time this will save whenever the valve must be closed or opened, perhaps when time is very valuable—in the presence of an emergency.

No hunting for stepladders, no climbing over pipes or obstacles. A Babbitt-equipped valve, no matter where located, is as easy to operate as a valve under your hand.



BABBITT STEAM SPECIALTY CO.

NEW BEDFORD, MASS.

Western Distributors:—Jenkins Bros., 300 West Lake St., Chicago, Ill.

Canadian Agents:—Engineering Specialties Co., Ltd., Toronto, Ont., Canada

93-43

Superb Tone

Lunkenheimer Whistles

"you hear them everywhere"

Their tone is distinct, far-reaching, clear and harmonious.

They are economical because the orifice through which the steam passes is so shaped and located that a maximum volume of sound is obtained with a minimum expenditure of steam.

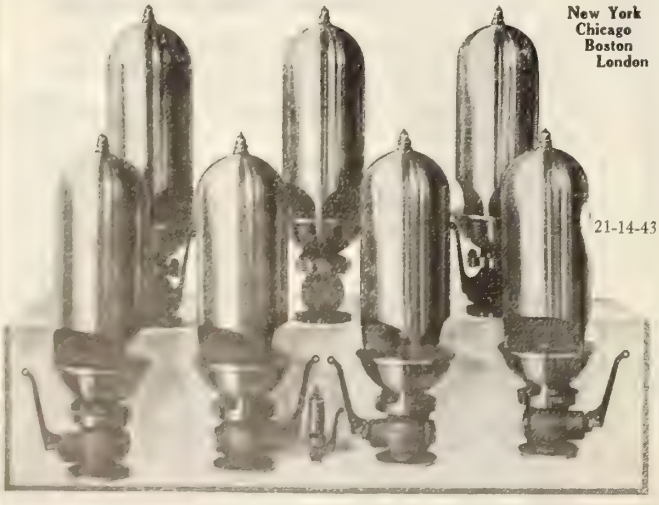
A variety of types for use on Factories, Locomotives, Steamships, Motor Boats, Steam Shovels, Traction Engines, Signal Systems, etc.

Specify **Lunkenheimer** and insist on their installation. Your local dealer can furnish them; if not, write us. Write for Whistle Booklet No. 520DC.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties in the World
CINCINNATI, OHIO, U.S.A.

New York
Chicago
Boston
London



21-14-43

Handle it Mechanically

Every Engineer and Power Plant Manager should have a copy of the new Catalog on the Jeffrey Carrier. Each of its 96 pages contains information of value to the man interested in Coal and Ash Handling Machinery. The JEFFREY Carrier is completely described and important shop views and installations are shown. Blue prints giving all necessary dimensions, clearances, etc., for embodying the Carrier in your Power Plant drawings are included within the covers of this Catalog.

Write TO-DAY for your copy—ask for Catalog No. 210-4.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

This 18-inch Spartan Double Belt was installed July 1917 in the plant of the Western Malleable Co., Beaver Dam, Wis. It has been frequently exposed to steam without injury.

This Husky Belt Stands Steam

STEAM quickly plays havoc with most belts. Not so with this Spartan Leather Belt, which for more than two years has been frequently exposed to this destructive agency.

Why? Because it is made of Spartan Leather—a specially tanned leather which resists exposure to steam, oil, chemical fumes, heat, and other conditions which quickly destroy ordinary leather.

The greater load-carrying power of Spartan is due to its unusual pliability and high co-efficient of friction.

With production costs at unheard-of levels. Spartan's wonderful efficiency is of more interest to you to-day than ever before.

Spartan is one of the Graton & Knight Standardized Series Leather Belts. In that series, there is a belt standardized for every drive. Write for our book, "Standardized Leather Belting."

The advice of our Engineering Department is at your disposal on any power-transmission problem. Ask us questions about belts and their uses and treatment.

THE CANADIAN GRATON & KNIGHT, LIMITED

OAK LEATHER TANNERS AND BELT MAKERS

MONTREAL, CANADA

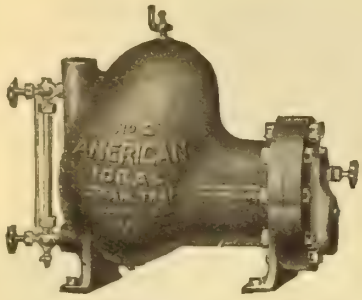
Canadian Representatives: Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon Vancouver, Windsor, Winnipeg, Victoria. *Branches and Distributors in all Principal Cities.*

Graton & Knight
Standardized Series
Leather Belting

Tanned by us for belting use

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Complete Steam Trap Service



means:

Removal of all excess condensation without loss of steam, No maintenance expense.

This service is given by the AMERICAN IDEAL STEAM TRAP.

Saving Steam is saving Coal.

Saving Coal is saving Money.

Saving Coal is more vitally necessary now than ever before.

Write for our Trap Booklet.

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Strength and Lubricant of

TRADE MARK

"PALMETTO"

REG. U.S PAT. OFFICE

causes it to outlast all other packings a nd gives perfect satisfaction under most difficult conditions of service.

STRENGTH is secured by strands of high tensile strength braided up in layer upon layer construction.

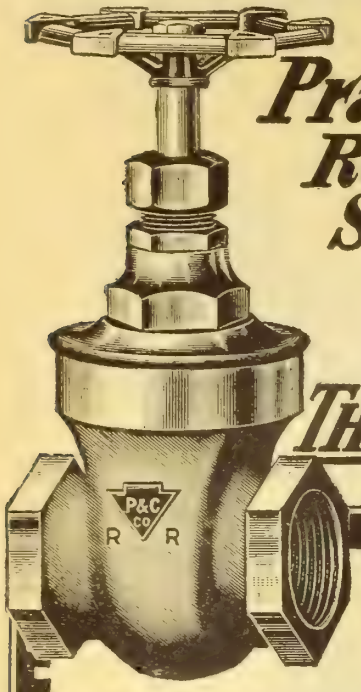
LUBRICANT for keeping the packing soft and doing away with rod friction is secured from the graphite grease forced into each strand before braiding.

GREENE, TWEED & CO.
109 Duane St. SOLE MANUFACTURERS New York

Canadian Distributing Agents:
The CANADIAN FAIRBANKS-MORSE CO., LIMITED
Montreal, Ottawa, St. John,
Toronto, Winnipeg, Calgary,
Saskatoon, Victoria,
Vancouver

Let us send you a free working sample.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



Pratt & Cady Renewable Seat Gate Valves BUY THEMSELVES

Every time the seat of a Pratt & Cady "Renewable" wears out—as any valve seat eventually must—the valve really buys itself. For all that is necessary to make this worn valve as good as new is to insert two new seat rings at a cost of a few cents.

You are thus saved the cost of buying a new valve—which would have been necessary had you used an ordinary valve. This saving really pays for your

PRATT & CADY
RENEWABLE SEAT GATE VALVES

The few cents you pay for new seat rings is far less than the cost of removing an ordinary valve from the line.

New seat rings can be inserted in a P. & C. Valve in a few minutes without removing the valve from the pipe line.

Pratt & Cady Valves can be renewed indefinitely. Many are still giving good service after more than a quarter of a century of use.

Made of iron and bronze in all sizes, for all purposes.

You'd be interested in our Valve Book. Shall we send it?

PRATT & CADY CO., INC.

Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Hot Water Service Heaters, Power Pumps and Asbestos Packed Cocks.

Hartford, Conn.

Canadian Representatives:

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
Windsor Winnipeg Saskatoon Calgary Vancouver

TRADE P&C CO MARK

Advertise for Good-Will

"The last twenty years have witnessed a great development of advertising as a selling force," George Frank Lord, advertising manager of the E. I. du Pont de Nemours & Co., told the Pittsburgh Advertising Club.

"I venture to predict that in the next five years advertising will be recognized chiefly as a great buying force. Instead of using advertising to sell merchandise we will use it to buy customers. For the purchase of good-will it will be classified, even by accountants, not as current expense, but as a long-time investment; a sort of bond that yields dependable interest annually and amortizes itself in ten years, but keeps on returning interest indefinitely.

"If advertisers and advertising men will keep their minds fixed on this idea of buying good-will, or buying satisfied customers, instead of selling merchandise, many of the most difficult problems of advertising will disappear. Appropriations will not be based on last year's earnings, the current year's estimate, the sales department's gross margin, or the tentative impulses of the board of directors, but on clear analyses of the amount and kind of good-will needed for the ideal future of the business, the time required or available to develop it, the total amount it will be worth, and how the expenditure of that total will be made in various years.

"The advertising policy will not be shifted by the weather, the crops, temporary trading conditions or changes in organization. The business itself will have a definite, enduring policy, and the advertising will express it.

"There will be no lying copy, nor merchandise that is made only to sell, and not to use; because such things do not buy customers and are destructive of good-will, the great asset the advertiser is seeking.

"Whether an advertiser formally adopts the policy of buying good-will or not, the good-will value of his advertising is all he really gets for his money. The advertising that buys satisfied customers adds to his good-will, and that which creates dissatisfied purchasers subtracts from his good-will.

"Success is merely the result of having more plus than minus in the good-will account. Since the whole history of advertising proves this is true, why should we not recognize this truth and consciously get in line with it?"

Why Lay Up Fire Brick Again —And have the same trouble year in and year out?

The ordinary brick lining with its joints gives way under the varying furnace temperatures, crumbles and falls down. With Betson's Plastic Fire Brick you can practically eliminate this maintenance of brick work.

BETSON'S REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

is the pioneer and tried boiler refractory material, and has twenty years of practical experience behind it. Betson's takes up expansion and contraction internally. It is easy to lay up. It forms a monolithic lining without joints and there is nothing to work loose or fall down. It can be used for the entire boiler—furnace, door arches, rear arches, baffles, bridge walls, etc.

Let us quote you on Betson's Plastic Fire Brick for your boiler needs. Or send for our practical booklet to-day.

Canadian Distributor:

International Chemical Company

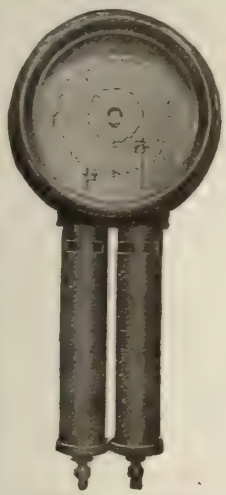
44-46 Lombard Street **Toronto, Canada**

35

UEHLING WASTE METER

COMBINED

CO_2 AND TEMPERATURE RECORDER



Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO_2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

CO2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company

2 Empire Building **New York City**

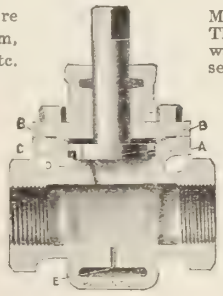
HOMESTEAD

QUARTER TURN VALVES

Save Time

Not only do they save valuable time by virtue of their quarter-turn principle, but possessing a straightway, unobstructed flow they assure better service than globe and gate valves.

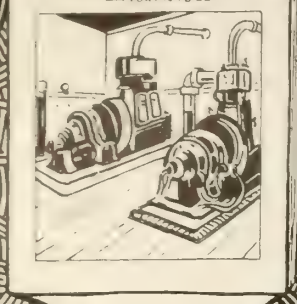
Homestead Valves are used for air, steam, water, oil, acids, etc.

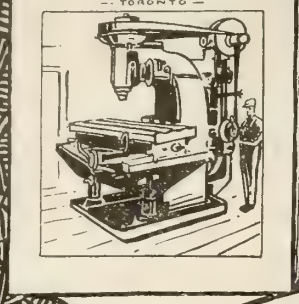


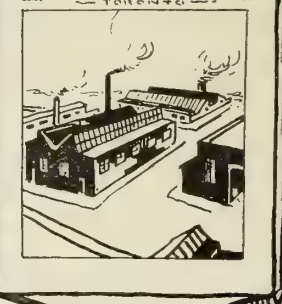
Made in straightway, Threeway and Fourway patterns for all services.

Homestead Valve Mfg. Company

Pittsburgh, Pa. : : **Works: Homestead**







For Self-Promotion And Sales Promotion Use These Publications

POWER HOUSE

Twice a month—$2.00 per year.

Serves the power plant engineer—Steam, Electric Refrigeration, Hydraulic.

CANADIAN MACHINERY

Weekly—$3.00 per year.

Covers the metal working field—serving shop executives, purchasing agents and owners. First-class mechanical paper and market paper combined.

CANADIAN FOUNDRYMAN

Monthly—$1.00 per year.

A paper for the foundry owner, superintendent and foreman. Claimed by its readers to be unexcelled.

MARINE ENGINEERING

Monthly—$2.00 per year.

Interprets marine engineering in its broad sense, serving the shipbuilders, navigation companies and their officers. (The editor holds an extra first-class B.O.T. certificate).

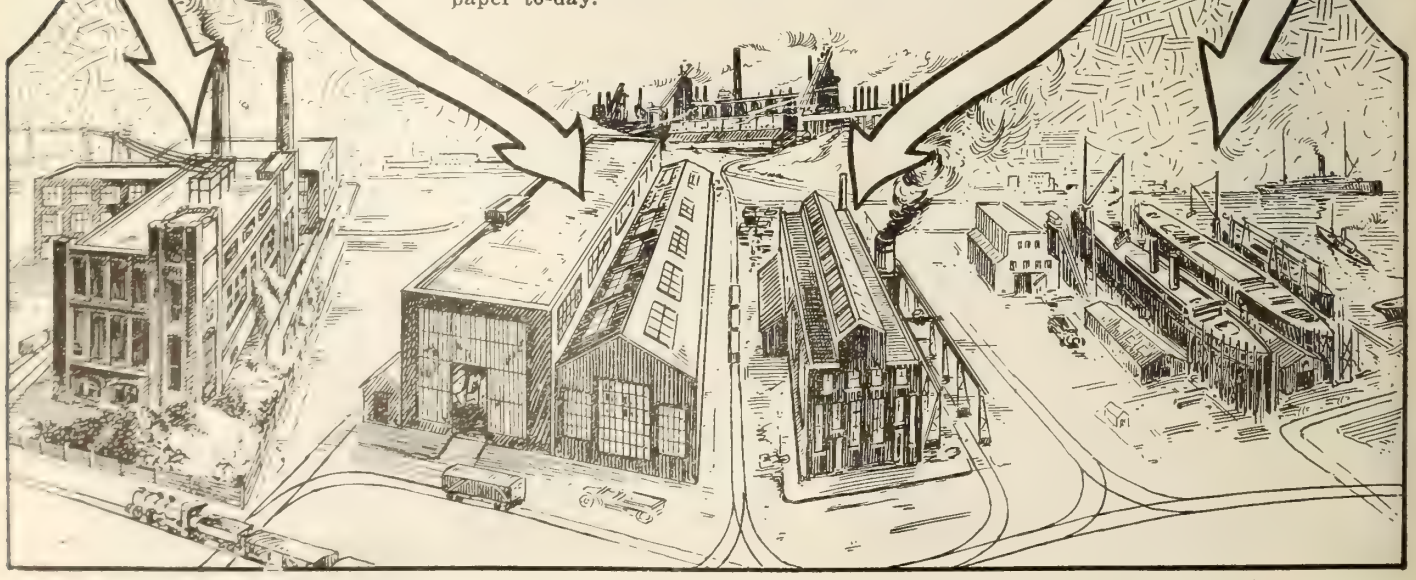
Published by

THE MACLEAN PUBLISHING CO., LIMITED

143-153 UNIVERSITY AVE., TORONTO

A company whose idea of service has made it the largest concern of its kind in the British Empire.

Thirty years' experience and dozens of practical men in your own line, stand ready to serve you. Let them! Subscribe for your paper to-day.



Does the Work of From Twenty to Thirty Men

NO matter what you handle, it will pay you to consider the use of a Link-Belt Crane—if you desire low handling costs and high efficiency.

It does'nt pay to employ hand labor for moving any materials nowadays that can be handled with greater speed and economy by machinery.

One man and a Link-Belt Crane can unload all your materials, store your coal, switch your cars and do many other jobs. If you now had a crane, we venture the prediction that you would not part with it for considerably more than you paid for it.

Write for Crane Catalog No. 370.

CANADIAN LINK-BELT COMPANY
LIMITED
WELLINGTON & PETER STREETS, TORONTO

LINK-BELT
LOCOMOTIVE CRANES

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets

Write for Catalogs
Place X in Square

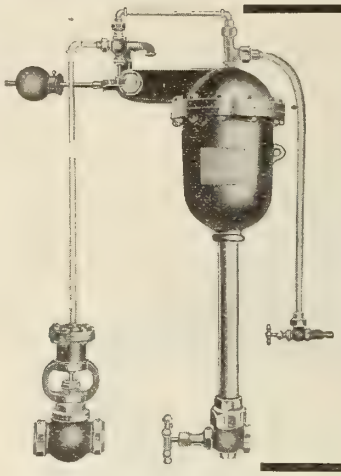
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



Make Sure of Constant Level and Stop Worrying

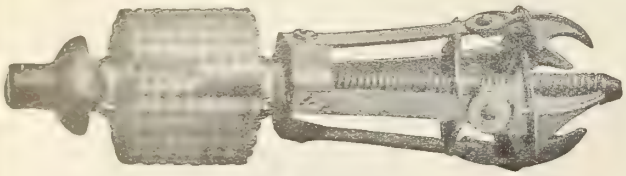
Eliminate the danger of boiler explosion due to low water or a wrecked turbine or engine due to high water by feeding your boilers automatically with

Vigilant Water-Feed Regulators

They hold the water level constant at middle gauge—the safest and most logical point — that insures better economy, and protects the boiler against excessive expansion and contraction stress.
A paying investment for any plant. Write for Catalog now.

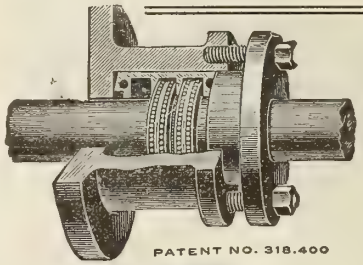
The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	905,103
" "	775,194	" "	934,629
" "	791,300	" "	979,208
" "	805,660	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.
Incorporated 1897

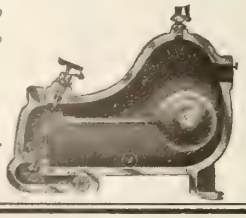
McDANIEL IMPROVED **STEAM TRAP**
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street PHILADELPHIA, Pa

Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.
Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

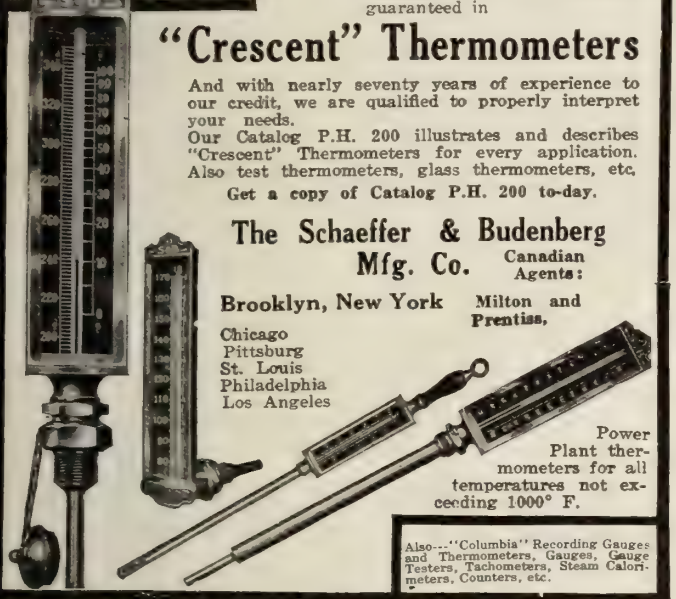
Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss,

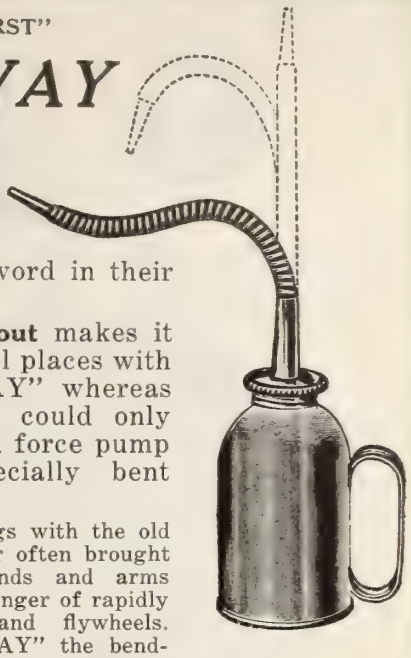


Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

"SAFETY FIRST"

ALL-WAY RAILROAD OILERS



are the latest word in their line.

The **flexible spout** makes it possible to oil all places with one "ALL-WAY" whereas previously they could only be reached with force pump cans with specially bent spouts.

Lubricating bearings with the old straight spout oiler often brought the engineer's hands and arms very close to the danger of rapidly revolving gears and flywheels. With the "ALL-WAY" the bending of the spout removes this danger. Sizes No. 4, 1 pint—10 in. spout. No. 5, 1 quart—11 in. spout.

If your dealer cannot supply you write us.

We also manufacture the well-known "All-Way" Oil Can—saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

WE WELD
EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. Write for our latest catalogue.

Patterns *Machine Work*

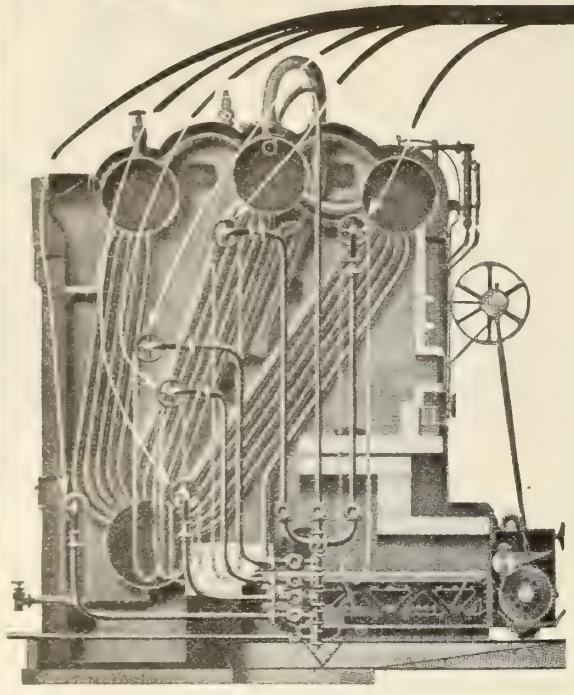
The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us

6 Reasons



Why this boiler is operated economically

The six reasons are the six Diamond Soot Blower units with which it is equipped. These mean—lowered coal consumption (by 4 to 8 per cent.)—increased boiler efficiency and capacity—decreased use of steam for cleaning—and greatly decreased labor for cleaning.

Diamond Soot Blowers thoroughly remove all particles of soot and fine ash deposit which prevent heat transference (as an insulator soot is five times as effective as asbestos), leaving the tubes clean and free to transmit heat to the water within.

There are hundreds of successful Diamond installations in Canada. Note for instance: Canadian Consolidated Rubber, J. R. Booth & Son, Canadian Locomotive, St. Lawrence Sugar Refining. Goldie & McCulloch, Toilet Laundry, Howard Smith Paper Mills, Montreal Tramways, Riordan Pulp and Paper, Ford Motor, etc.

If your boilers are not equipped write for full information, requesting Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ontario

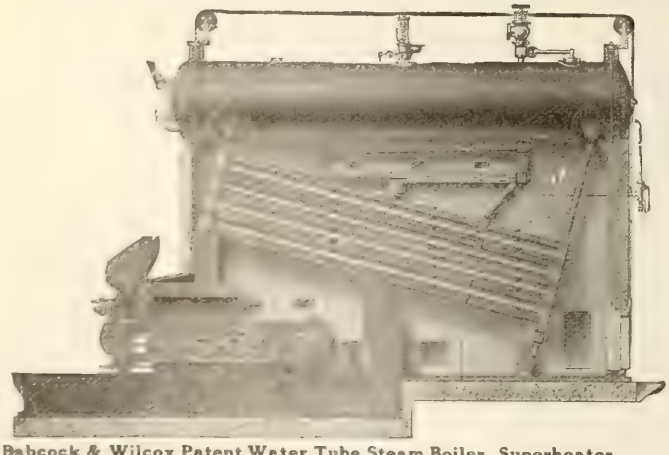
Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

—ALSO—

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton. Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto. Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS

MacLean Publishing Co., Toronto.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

MAC GOVERN & COMPANY INCORPORATED POWER MACHINERY

WATER TUBE BOILERS

Quantity	H. P.	Make—	Pressure
2	150	HOGAN	110 lbs.
2	204	BABCOCK & WILCOX	160 "
1	212	BABCOCK & WILCOX	160 "
2	250	STERLING	150 "
8	250	STERLING	160 "
1	270	BABCOCK & WILCOX	130 "
2	300	ATLAS	130 "
3	300	STERLING	175 "
1	305	STERLING	160 "
5	308	HEINE	140 "
2	328	BABCOCK & WILCOX	125 "
2	360	ERIE	150 "
1	380	STERLING	153 "
2	400	WICKES	150 "
1	450	HEINE	180 "
1	500	STERLING	175 "
1	500	HEINE	200 "
3	509	BABCOCK & WILCOX	...
4	512	BABCOCK & WILCOX	200 "

MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, **Plants: Lincoln, N.Y., and Linden, N.J.**

Buyers and Sellers of New and Used Machinery

A CONTINENT-WIDE SERVICE

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

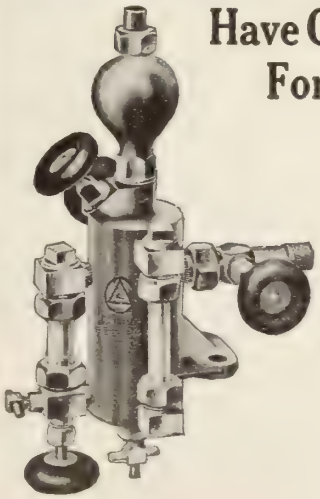
The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimo Mfg. Company

Roxbury (Boston,) Mass.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.

WALKERVILLE, ONT.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM

Crane Limited, Montreal.

FITTINGS

Crane's Limited, Montreal.

FITTINGS, CAST IRON

Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, IRON PIPE, ENAMELWARE

Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS

Crane Limited, Montreal.

FLANGED STEAM FITTINGS

Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES

Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES

Crane's Limited, Montreal.

FLOORING COMPOSITION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS

Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS

Shell Bar Boico Supply, Ltd, Toronto.
Babock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS

Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE

Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL

Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS

Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS

Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING

Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER

Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS

Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH

Jointless Fire Brick Co., Chicago, Ill.

FUSES

Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.

Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS

Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER

Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2

Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING

S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE

J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS

Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY

Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT

Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING

Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER

Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER

Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT

Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE

Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO

Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS

Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING

R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE

Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM

Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL

Wilson Mfg. Co., J. C., Belleville.

GREASE CUPS

Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY

Shell Bar Boico Supply, Ltd., Toronto.
Babock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equip. Co., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING

Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY

W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE

Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS

Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS

Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS

Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE

S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE

J. H. Williams & Co., Brooklyn, N.Y.

HANGERS

Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS

Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM

Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT

Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC

Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS

J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE

Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE

Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER

Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS

Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS

Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE BREAKING MACHINES

Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS

Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES

Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE

American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC

Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED

L. S. Starrett Co., Athol, Mass.

INJECTORS

Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING

Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK

Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS

Johns-Pratt Co., The, Hartford, Conn.

INSULATORS

Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER

Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS

Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING

S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS

S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING

R. G. Long & Co., Toronto, Ont.

LACE LEATHERS

Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO

Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING

Graton & Knight Mfg. Co., Montreal.

LINK BELTING

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK

Green's Economiser, Ltd., Toronto.

LUBRICATORS

Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS

Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS

S. F. Bowser Co., Ltd., Toronto, Ont.

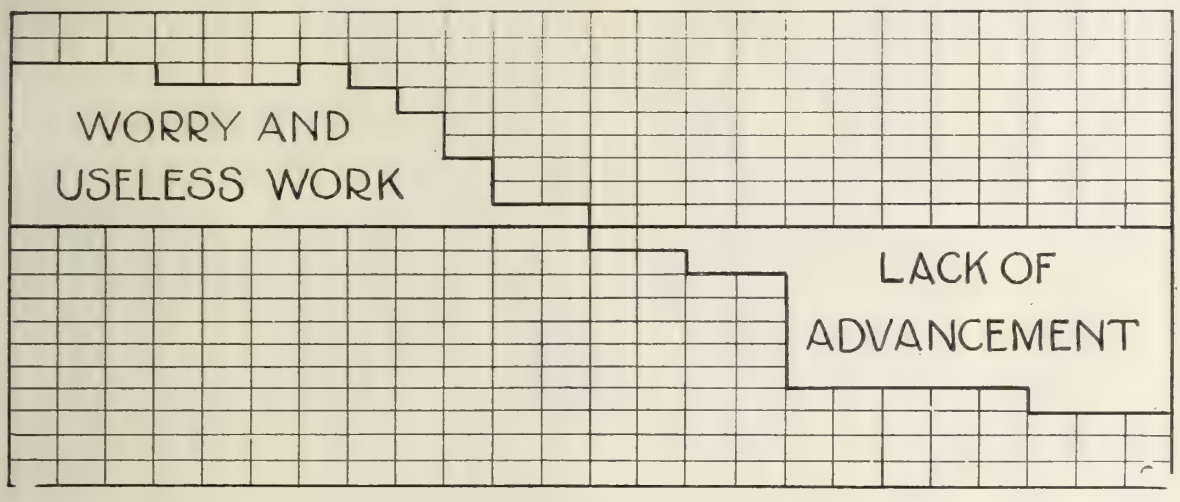
LUBRICATORS, FORCE FEED

Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN

Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithaca, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
[illegible] Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
[illegible] Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
[illegible] Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

We're "Bulls" *on* Canada

PROSPERITY, rising stock values and a vast amount of "Loose" money,—all these have led to the biggest year of speculation Canada has known—1919. The trading in Montreal exceeded all previous records, and "Everybody's doing it." Stenographers and bank messengers are making a few dollars; financiers and plungers are making their millions. And, don't you forget it, many are losing, too.

In this leading article in the February 1st MACLEAN'S the mania for "taking a chance" is discussed and R. Laird Briscoe tells why there are not many losers—yet. Two men have made $6,600,000—this article tells how simply it's done. One typist bought a $2000 car with a $100 bill. It's really very simple when you know how—**IF** you guess right.

J. K. Munro Says:

THERE will be an election before Fall—it's among the probabilities. Sir Robert Borden took the Premiership with him to South Africa. What will he do with it when he returns? Why didn't he nominate a successor before he left? Why could Sir Thomas White have the job if he wanted it, and why wouldn't he make a good leader to go to the country?

These and other questions are discussed and answered in Mr. Munro's snappy, vigorous, pithy style.

Balking the Bolsheviks

A CANADIAN woman had some extraordinary adventures in Roumania with the Bolsheviks. She is Mme. Pantazzi, and was Miss Ethel Greening, of Toronto. She tells how she and her husband escaped death's door by the narrowest of margins—not once but several times. Incidentally, she tells more of the wonderful adventures of that Admirable Crichton of cosmopolitan free-lances, "Klondyke" Boyle—also Canadian as MacLean's readers know.

Flaherty of Belcher Island

THIS is where the natives wear duck feather kimonas, in a part of Canada which even the geologists and explorers didn't know existed until a few years ago. Of course, you would expect the discoverer to be an Irishman—and in February 1 MACLEAN'S you can read how Flaherty found his island, and what he discovered there—the richest iron ore deposit in the world, but—can it be transported to market?

Other Features are:

"Breed," by Archie P. McKishnie.
"The Thread of Flame," the Basil King serial.
"His Majesty's Well-Beloved," the concluding instalment of the Orczy serial.
"Canada Has a Movie Future," by Allan Dwan.
"Spanish Doubloons," more of Camilla Kenyon's rollicking adventure story.
"Mr. Phipps of the 'Old Firm'," by A. Appleby Terrill.

MACLEAN'S is issued Twice-A-Month

starting with this issue. An important point to remember. If you want to keep up with things **nationally Canadian,** you'll have to get the MACLEAN'S Twice-A-Month habit.

Over 350,000 Canadians Read

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

February 1st Issue *Now on Sale At All News Dealers* ***20c.***

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
Defender Automatic Reg. Co., St. Louis.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Showing ease with which Plibrico is laid in place.

PLIBRICO

A High Grade Refractory for Furnace Linings.

BETTER THAN FIRE BRICK

for furnace linings, baffle construction and repairs.

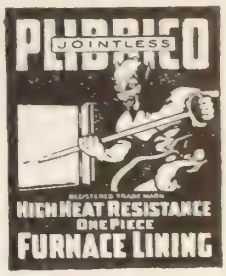
1. It's Jointless.
2. It's Plastic.
3. It's air and gas tight.
4. It will stand 3100 deg. F.
5. It will save fuel.
6. It can be installed by inexperienced labor.
7. It will outlast fire brick.
8. It can be used in any boiler, furnace or oven.
9. It can be used wherever fire brick is used.
10. It cannot be excelled for patching broken and burned out linings.

Any Engineer can see the economy and advantage over Fire Brick. Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.
1130-1150 Clayton St., Chicago

Beveridge Paper Co., Ltd., Montreal, Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.
and Canada.

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

When Writing to Advertisers
Kindly Mention this Paper

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

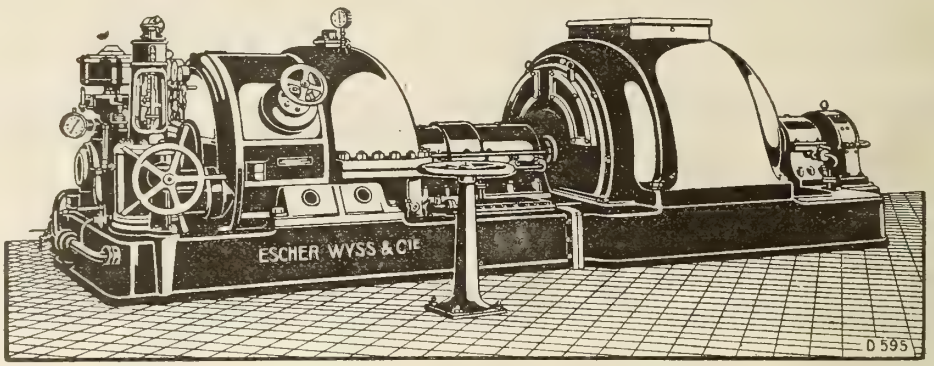
WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

23/19

Don't clog your mind wheels up with the mud of unreliable out-of-date reading. Get the latest technical information on Power House Equipment by reading POWER HOUSE, Canada's only paper devoted entirely to the practical engineer's interests

$2.00 *SUBSCRIPTION PRICE Send in yours TO-DAY* **$2.00**

THE MACLEAN PUBLISHING COMPANY, LIMITED - 153 UNIVERSITY AVENUE, TORONTO

INDEX TO ADVERTISERS

A
All-Way Oiler Co. 75
American Steam Pump 61
American Steam Gauge & Valve Mfg. Co. 68
Armstrong Cork & Insulation Co. 11

B
Babbitt Steam Specialty Co.... 63
Babcock & Wilcox 76
Badger & Sons, E. B..... 61
Betson Plastic Fire Brick Co.... 71
Boving Hydraulic Eng. Co. 74
Bowser & Co., S. F. 57
Busch-Sulzer Bros.—Diesel Engine Co. 75

C
Can. Assoc. Stationary Engrs.. 81
Can. Consolidated Rubber Co . 8
Can. Detroit Lubricator Co... 79
Can. Fairbanks-Morse Co. 65
Can. Link-Belt Co. 73
Can. Johns-Manville Co. 7
Can. Steam Boiler Equipment.. 60
Chaplin-Fulton Mfg. Co..... 74
Classified Ads. 46
Coppus Engr. & Equip. Co..... Inside front cover
Carling Turbine Blower Co.... 50
Crane Limited 50

D
Darling Bros. 85
Dart Union Co. 59
D'Este Co., Julian 61
Department of Labor..... 56
Diamond Specialty Co. 76
Direct Separator Co. 66
Dominion Coal Co. 74
Dunham & Co., C. A. 63
Durabla Mfg. Co. 68

E
Electric Welding Co. 75
Economy Fuse Co. of Can. ,Ltd. 56
Empire Manufacturing Co..... 3
Escher, Wyss & Co. 86

F
Foyle, W. & G. 46
Frick Co. 11

G
Garlock Packing Co. 6
Garth Co. 74
Goodyear Tire & Rubber Co.... 14
Goldie & McCulloch Co. 16
Graton & Knight Mfg. Co..... 67
Greene, Tweed & Co..... 69
Green's Economizer, Ltd. 58
Gutta Percha & Rubber Co.... 51

H
Hays Corporation, Jos. W..... 4
Holmes Metallic Packing Co.... 74
Homestead Valve Mfg. Co..... 71

I
Inglis Co., John..Inside back cover
International Chemical Co..... 74

J
Jeffrey Mfg. Co. 64
Jefferson Union Co. 52
Jenkins Bros. 15
Johns-Pratt Co., The 55
Jointless Fire Brick Co..... 85
Jamison Cold Storage Door Co. 12

K
Kellogg & Co., E. H. 48
Kerr Engine Co. 58

L
Laurie & Lamb 2, 50
Leitch Co., The Arthur S..... 60
Leonard & Sons, Ltd., E..... 50
Linde Can. Refrigeration Co... 10
Lunkenheimer Co. 64
Long, J. T. 48

M
MacGovern & Co. 79
MacLean's Magazine 83
Magnolia Metal Co. 59
Mason Regulator Co. 63
Mason Regulator & Eng. Co.. 62
McAvity & Sons, T. A..... 62
Metlskin Co., Inc 66
Morrison Brass Mfg. Co., Jas. Outside back cover
Murphy Iron Works 9
Mueller Mfg. Co., H..... 49

N
Norwalk Iron Works Co..... 13

P
Penberthy Injector Co. 5
Philip & Sons, E. J. 56
Pilley Packing & Flue Brush Mfg. Co. 74
Pratt & Cady Co., Inc. 70
Pyro Products Co.....Front cover

R
Robb Engineering Co. 53

S
Sanford Riley Stoker Co..... 9
Scaife & Sons Co., Wm. B.... 85
Schaeffer & Budenberg Mfg. Co. 75
Schmidt Co., B. L. 13
Starrett Co., L. C. 62
Sturtevant & Co., B. F. 54
Steel Mill Packing Co..... 60

T
Trimont Instrument Co. 79

U
Uehling Instrument Co. 71

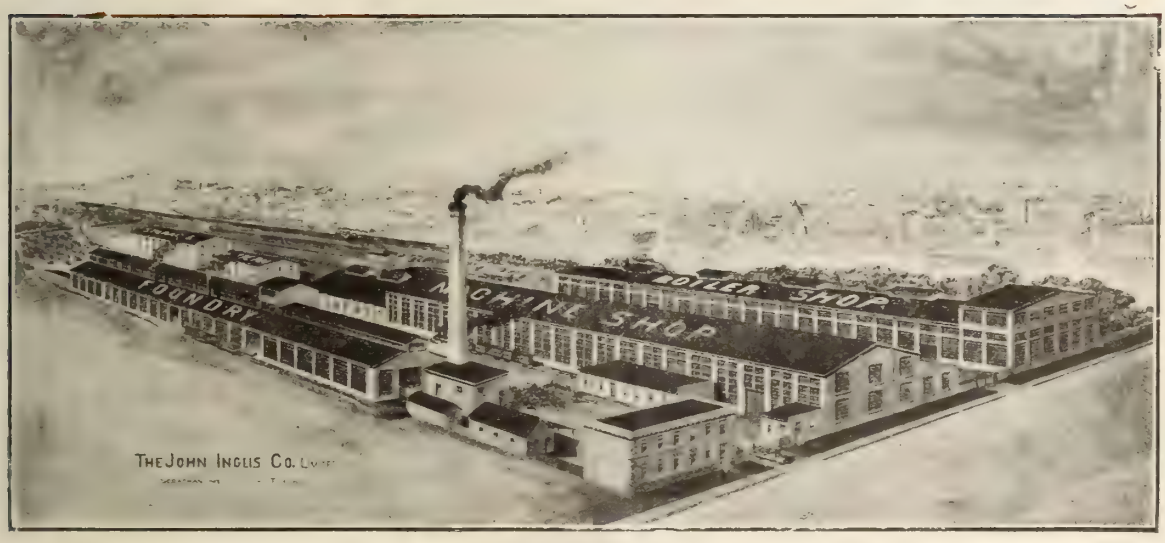
V
Valve Engineering Co. 47
Victoria Foundry Co. 75
Vilter Mfg. Co. 10
Vorhees Rubber Co., Ltd..... 68

W
Wall, W. J. 48
Waterous Engine Works Co... 1
Watson & McDaniel Co. 74
Williams & Co., J. H..... 53
Williams Co., Franklin 66
Wilson Mfg. Co., J. C. 75

Y
Yarnall-Waring Co. 9
York Mfg. Co. 12

The John Inglis Co. Limited

14 Strachan Avenue
TORONTO, CANADA



Tanks, Boilers and Engines

of all kinds, for any service

Send Us Your Inquiries

Representatives in Eastern Canada:
JAMES W. PYKE & CO., Limited, 232 St. James St., MONTREAL

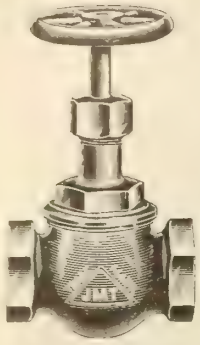
Ottawa Representative:
J. W. ANDERSON, 7 Bank St. Chambers, OTTAWA

MORRISON'S

Boiler Mountings

Engine Supplies

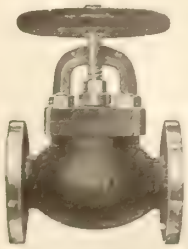
Steam Specialties



J.M.T. Globe Valve.

J.M.T. "Y" Valve.

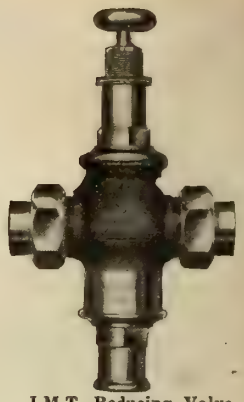
Hose Gate Valve.



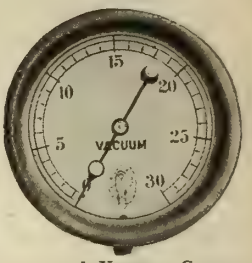
"Beaver" Globe Valve.

"Beaver" Globe Valve
Bronze

The Guarantee TRADE MARK J.M.T. REGISTERED *of Quality*

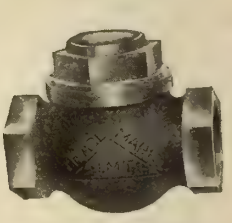


J.M.T. Reducing Valve



Pressure and Vacuum Gauges.

Morrison Automatic Drainer, operates on water pressure.



J.M.T. Check Valve.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 4. Publication Office, Toronto—February 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

"Look for the Name"

A SAFE GUIDE IN VALVE BUYING

All Penberthy Valves are Government Approved

All Penberthy Valves

are of the

Outside Bonnet Construction

The first radical improvement made in brass valves for many generations.

Penberthy Valves are recognized by leading engineers as representing the most modern and progressive ideas in

VALVE CONSTRUCTION

MANUFACTURED BY

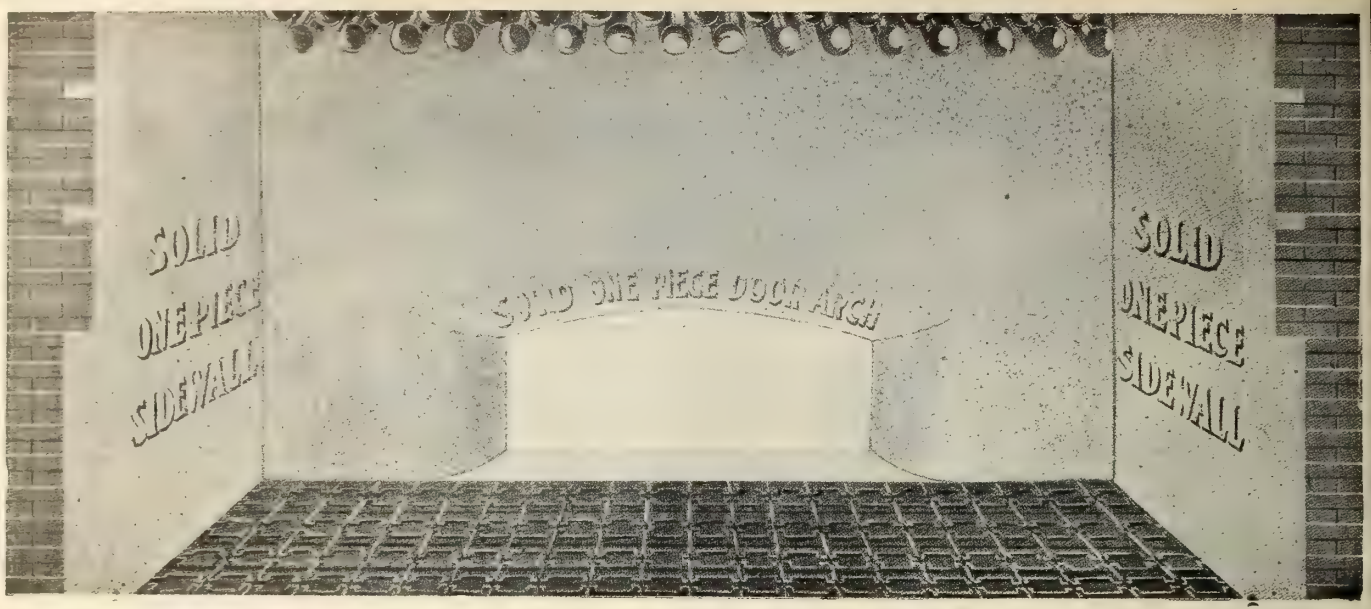
PENBERTHY INJECTOR CO., LIMITED, WINDSOR, ONT.

PYRO-PUTTY

TRADE MARK REG U S PAT OFF

FIRE BRICK IN PUTTY FORM

The World's Best Furnace Lining Material



Sketch above represents the fire box of a water tube boiler lined with PYRO-PUTTY

PYRO-PUTTY should be used for building Door Arches, Side Walls, Bridge Walls, Baffles, Rear Arches, Curved Stoker Arches, Dutch Ovens and complete furnace linings of every description.

PYRO-PUTTY is superior to Standard Fire Brick of the highest quality **because** it can be installed **all in one piece**, instead of there being several hundred separate bricks and several hundred joints.

PYRO-PUTTY comes to you in a stiff moist, pliable, "ready to use" condition. Simply pound it in with a mallet and smooth it off with a trowel and the job is done.

WHEN A WORN FURNACE LINING IS PATCHED WITH PYRO-PUTTY THE PATCHES INVARIABLY OUTLAST THE BALANCE OF THE LINING

Repairs to your present fire brick linings can be made at a considerable saving of time and at less expense than would be possible with standard fire bricks.

PYRO-PUTTY is put up in barrels weighing 700 lbs. each NET WEIGHT. A barrel is equivalent to 100 standard fire bricks.

Why not order a few barrels now? You'll soon want more because PYRO-PUTTY always makes good.

Write to-day for further information and prices

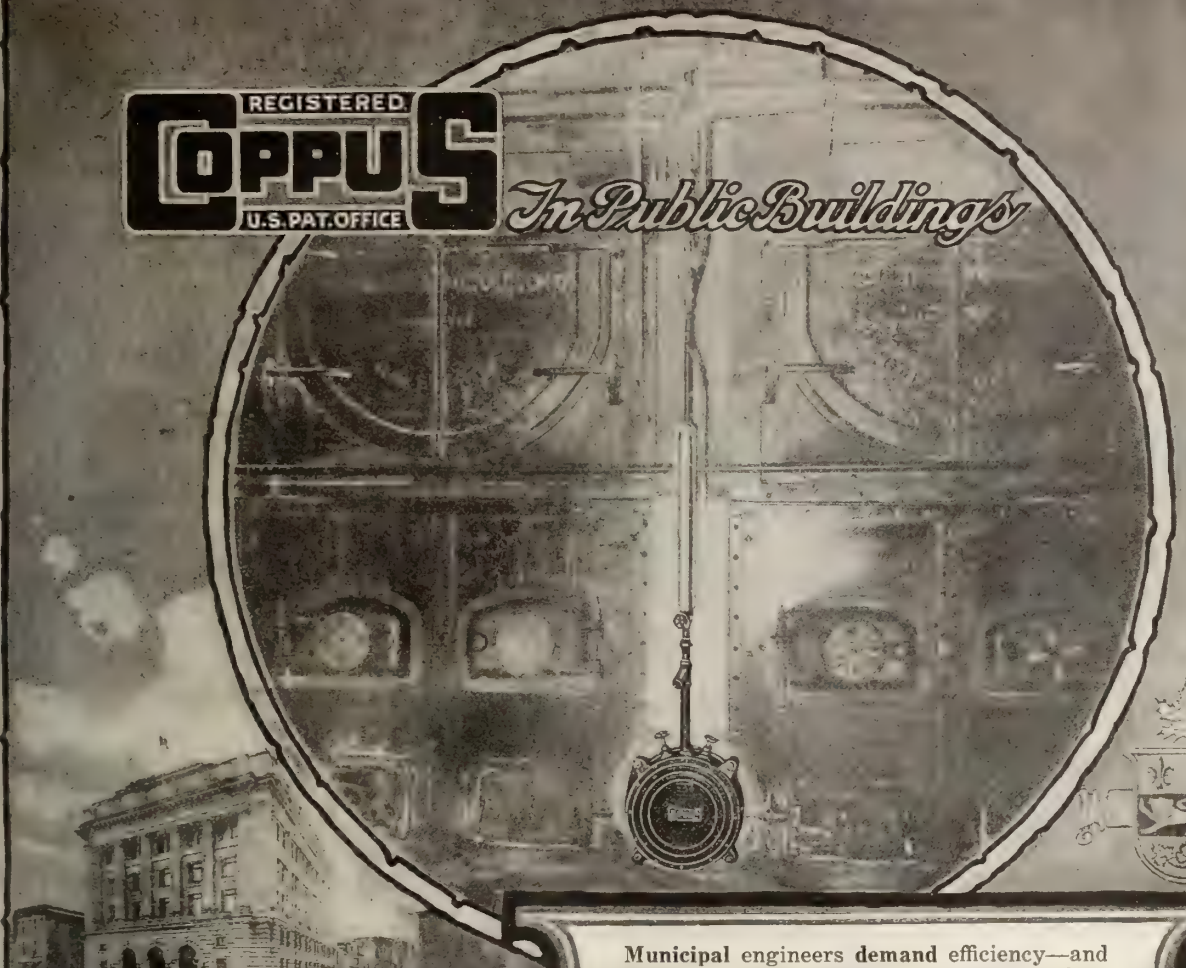
"A few barrels of Pyro-Putty should be part of the emergency equipment of every steam power plant"

PYRO PRODUCTS COMPANY

P. O. Box 685, Toronto, Ontario

REGISTERED
COPPUS
U.S. PAT. OFFICE

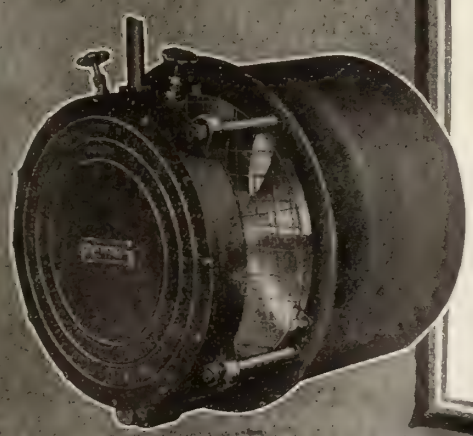
In Public Buildings



Municipal engineers **demand** efficiency—and **insist** on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the **highest** standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save you money." Write for Blower Catalog.



"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

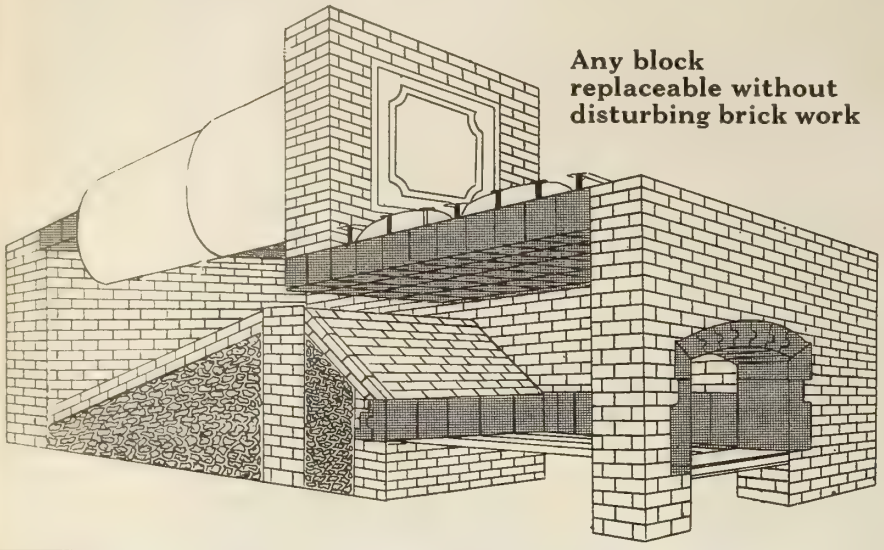
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta

COPPUS TURBO BLOWER

GATES Patent Furnace Linings



FOR REDUCED BOILER ROOM UPKEEP

Made from our specially shaped fire brick of the finest quality, with close-fitting joints that offer no projections for the formation of clinker and greatly reduce the possibility of costly air leaks through the setting.

A handy man can renew any one of the interlocking blocks without disturbing the brick work. The fuel economy and saving in furnace upkeep will quickly pay for an installation.

Specialists in all kinds of power plant brick work. Catalogue on request.

Manufacturers of all kinds Special Shape Fire Brick

GATES REFRACTORIES, Limited

St. James' Chambers
Church and Adelaide Sts. TORONTO

Head Office:
382 St. James' St. MONTREAL.

HOYT

A Name that Stands for Consistent Quality

BABBITTS

FROST KING

An ideal, all-round babbitt metal. Stands up under high-speed and heavy duty where ordinary babbitts quickly wear out.

NICKEL GENUINE

You can use no better babbitt than this for gas engines or wherever high speed is essential. Nickel Genuine is exceedingly tough and durable.

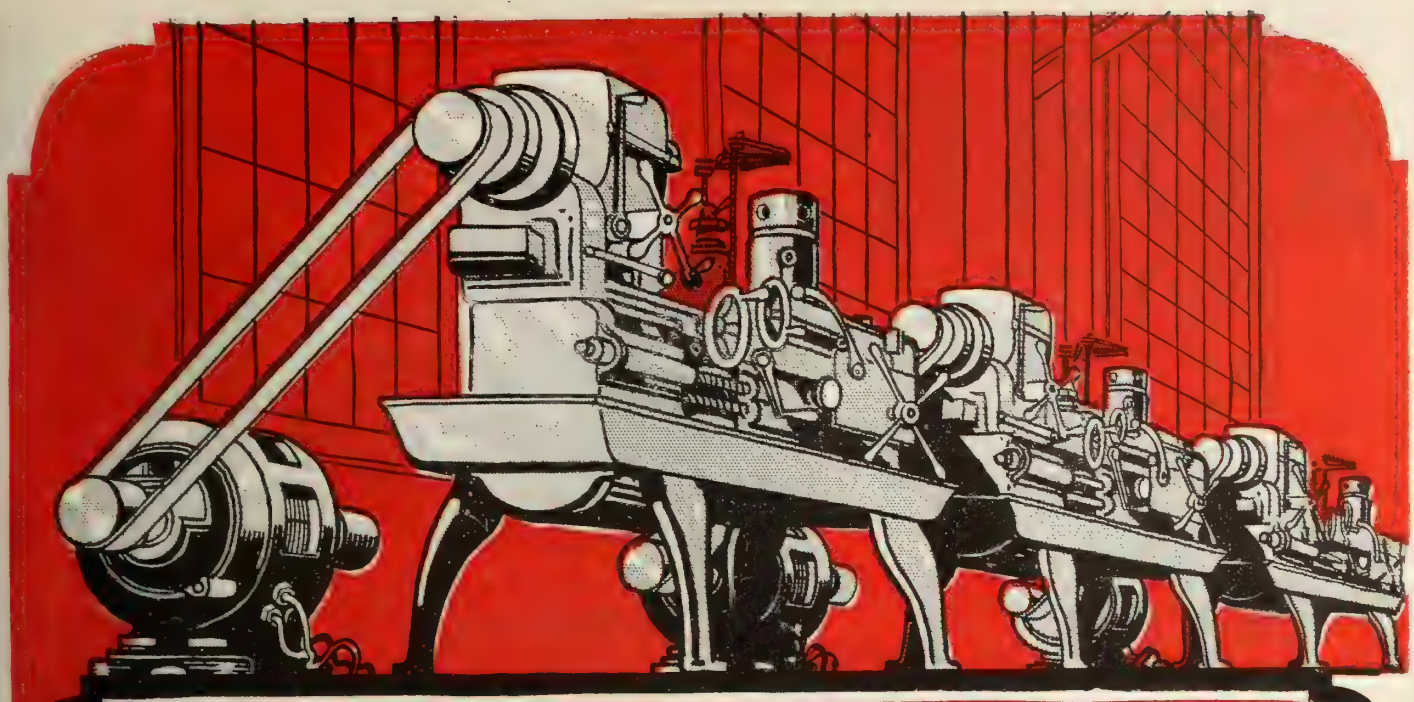
Hoyt Babbitt Metals have stood the test for nearly 50 years.

Hoyt Makes Babbitts For Every Purpose

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

POWER HOUSE, February 20, 1920, Vol. XIII., No. 4. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Every Ounce of Energy

AMONG the most important factors in keeping production up and operation costs down is the efficient transmission and utilization of every ounce of energy developed by power-generating machinery. A high friction load means a corresponding reduction in the power available.

The burden of this rests entirely on the correct lubrication of every machine, axle, pulley and shaft. *Nothing but scientific lubrication throughout your entire mechanical equipment will enable it to contribute its full quota to the success of your business.*

Imperial Lubricants are specially designed for each type of machine under actual service conditions. Their use will bring increased income through greater production, and reduced expenses through smaller depreciation of machinery.

Imperial Lubricants are prepared with infinite care. Each one has real merit as its recommendation. There is the proper lubricant for every individual part of your machinery. They are Canadian made, and their high, uniform quality is assured by the use of only the finest crudes.

Imperial Lubrication Engineers will be glad to consult with your own engineer or mechanical superintendent in deciding the proper lubrication of your machinery. The benefit of their knowledge and experience is yours without charge or obligation.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Arlo Compressor Oil

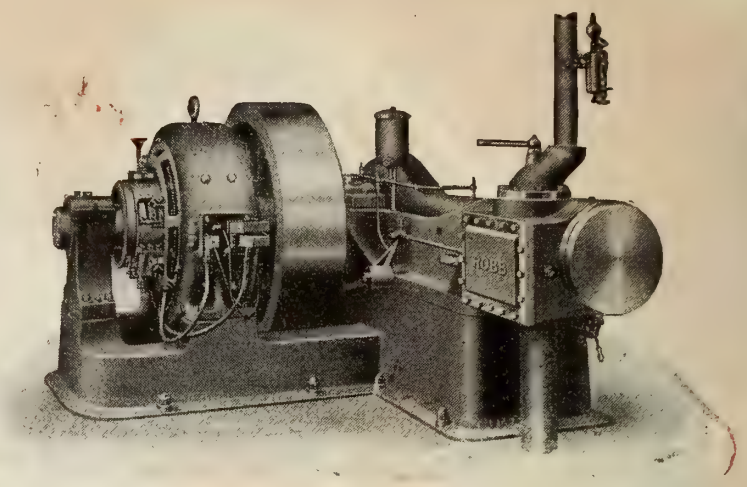
Write us at 56 Church Street, Toronto, or at any of our branches for appointment or lubrication information.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

ROBB
POWER PLANT EQUIPMENT



Engines
Corliss, slide valve, vertical, horizontal, simple and compound.

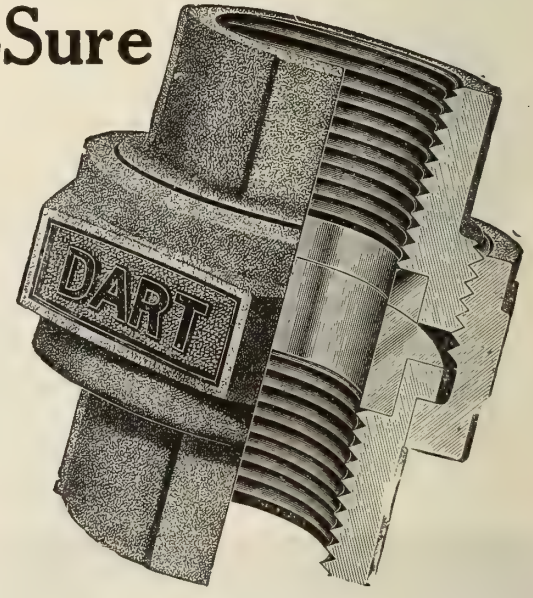
Boilers
Water tube, return tubular, improved Scotch marine and portable.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office
Phone Westmount 6800

Toronto Office
20 Victoria Street

YOU WILL
Make Security Double-Sure
BY USING
Dart Unions



THESE PIPE COUPLINGS NEVER LOOSEN UP AND LEAK

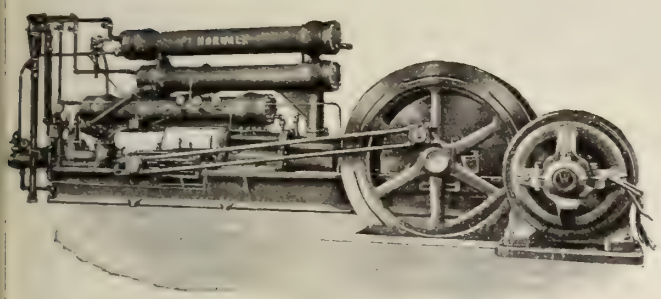
Both Face and Seat being Bronze makes deterioration and loosening up at the joint **impossible.**
Then, too, there is added security in the heavy iron parts—they will not stretch or pull apart.
Use again and again—they're always efficient.
Your jobber sells them.

THE JOINT IS
BRONZE TO BRONZE
BOTH FACE AND SEAT

Manufactured and Guaranteed by DART UNION CO., LIMITED, TORONTO

NORWALK
AIR & GAS · COMPRESSORS

Judge Quality by Results



24-inch Stroke Four-Stage, Chain-Driven Air Compressor.

High quality in an air or gas compressor shows itself in two ways—in uniform reliability and in operating economy.

Norwalk Compressors have built their international reputation on those factors, having kept them as distinguishing marks throughout all the manufacturing developments of forty years.

"Norwalks Always Do the Work"

Bulletins on compressors for air, oxygen, hydrogen, carbonic acid gas or acetylene on application.

THE NORWALK IRON WORKS COMPANY
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

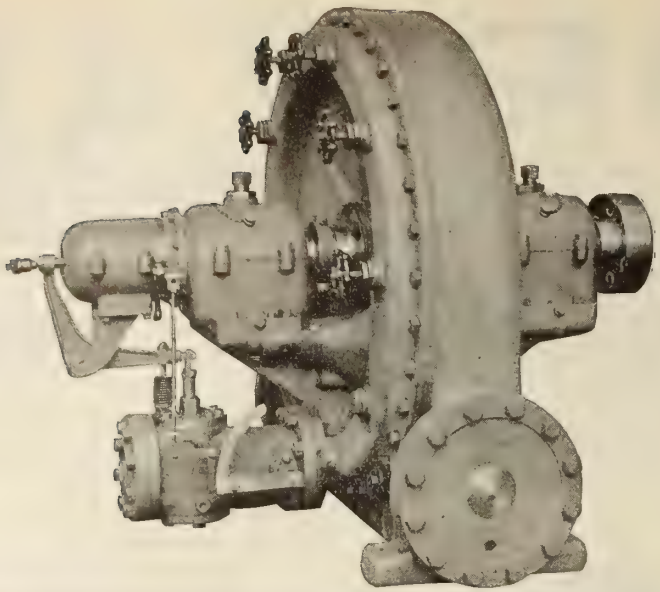
Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA



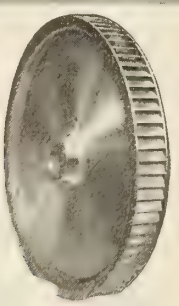
Sturtevant
(TRADE MARK)

STEAM TURBINES

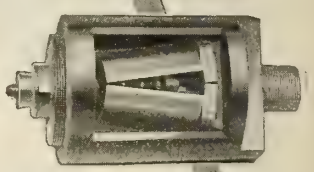
Uninterrupted performance for eight or ten years without a cent's worth of repairs is not unique for these turbines. It is an actual fact that *they do* give continued satisfaction with minimum upkeep. The solid rotor, integral nozzle and reverse buckets, independent emergency valve, and accessible bearing adjustment device are a few features which keep your engineer unhampered with breakdowns. You cannot well ignore investigating the reasons why these turbines are so well thought of by thousands of satisfied users.

Catalog 256-U tells about them

Nozzle and Reverse Buckets



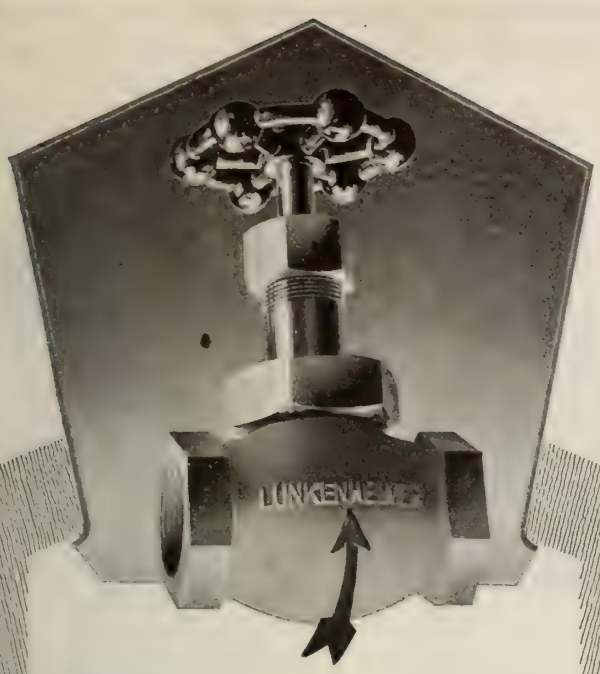
Rotor



Governor Mechanism

B. F. Sturtevant Company of Canada, Ltd.

Head Office and Works: Galt, Ontario
Sales Offices: Toronto and Montreal



The Name

LUNKENHEIMER

ON

Regrinding Valves

is assurance of maximum valve service. It symbolizes perfection in design and construction—the result of years of scientific development under every conceivable working test.

Incorporating but few, large and liberally proportioned parts with material compositions formulated especially for the duty each part performs, durability in the highest degree is assured. The regrindable seating surfaces and renewability of all the parts are added factors for continuous service and permanence in the line.

Globe, Angle and Cross with inside screw and with outside screw and yoke, and Horizontal, Angle, Vertical and Swing Check Patterns for 200 and 300 pounds working steam pressures.

Leading dealers sell them. Specify LUNKENHEIMER and insist on having the genuine.

Write for descriptive booklet No. 517—DC.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, O., U.S.A.

New York Boston
Chicago London

Lunkenheimer products are registered for use in Canada. Write for list of registration numbers.

3-20-43

No Stoker is Better Than its GRATES

MURPHY AUTOMATIC **FURNACES**

Back of every feature of MURPHY GRATE construction are *many* sound reasons. Consider how these features save you dollars—in fuel—in labor—in maintenance.

The long — narrow — but deep sections give eighteen to twenty-eight square inches of cooling surface to every inch of exposed grate surface.

The liberal air space (47% to 52%) gives double the capacity of the boiler "without one penny for draft."

The correct proportion and distribution of ribs on the stationary grates, combined with the greatest accuracy of machine moulding have solved the sifting problem

The continuous movement of the ribless grates ¾" above and ¾" below the surface of the stationary grates—breaks up the fuel bed — prevents avalanching — keeps the grates clinker-free — and advances the ash gradually to a point where it is removed by the clinker grinder. It is this action that gives the Murphy Furnace the faculty of ***burning anything that has heat in it.***

Yet with all these advantages, the Murphy Grate of to-day is built to the same policy that has characterized every improvement. First, to make all parts standard; second, to make every piece interchangeable; third, to advise users of new developments so that they may keep their equipment up to date—and operating at top notch efficiency.

For information on the Riley Underfeed Stokers for large boilers, see February 5 advertisement or send for Riley Stoker catalog HR-2.

MANUFACTURED EXCLUSIVELY BY

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube (Patented)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

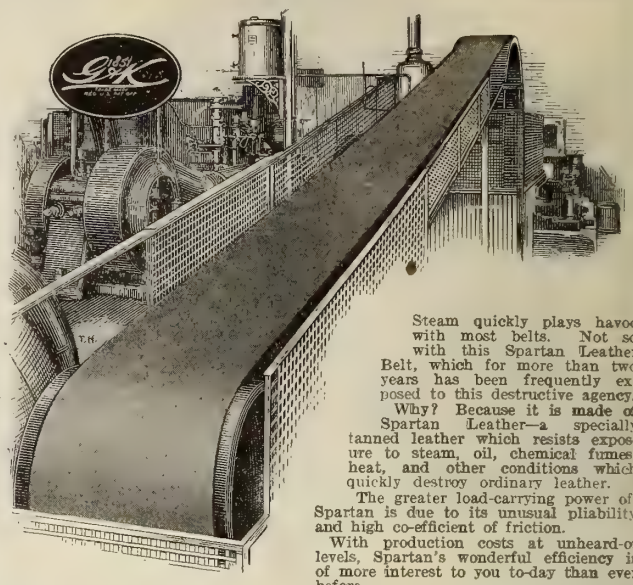
E. Leonard & Sons, Ltd.

Head Office and Works:
LONDON - - CANADA

Established 1834

LEONARD

THIS HUSKY BELT STANDS STEAM



This 18-inch Spartan Double Belt was installed July, 1917 in the plant of the Western Malleable Co., Beaver Dam, Wis. It has been frequently exposed to steam without injury!

Steam quickly plays havoc with most belts. Not so with this Spartan Leather Belt, which for more than two years has been frequently exposed to this destructive agency.

Why? Because it is made of Spartan Leather—a specially tanned leather which resists exposure to steam, oil, chemical fumes, heat, and other conditions which quickly destroy ordinary leather.

The greater load-carrying power of Spartan is due to its unusual pliability and high co-efficient of friction.

With production costs at unheard-of levels, Spartan's wonderful efficiency is of more interest to you to-day than ever before.

Spartan is one of the Graton & Knight Standardized Series Leather Belts. In that series, there is a belt standardized for every drive. Write for our book, "Standardized Leather Belting."

The advice of our Engineering Department is at your disposal on any power transmission problem. Ask us questions about belts and their uses and treatment.

CANADIAN GRATON & KNIGHT, Limited
MONTREAL, CANADA

Canadian representatives:
The Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary
Saskatoon, Vancouver, Windsor, Winnipeg, Victoria
Branches and Distributors in All Principal Cities.

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

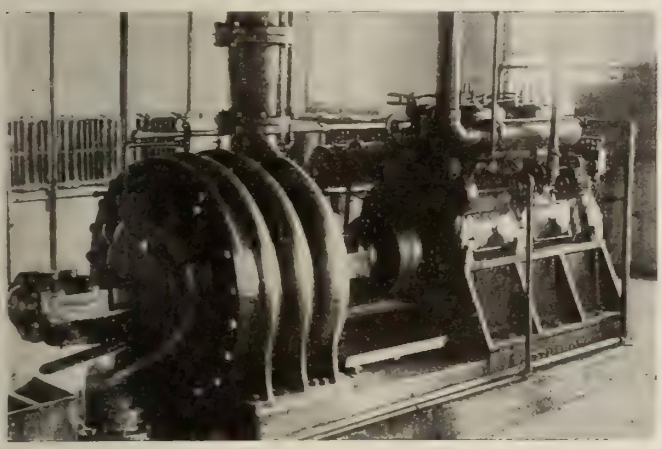
Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
TORONTO

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

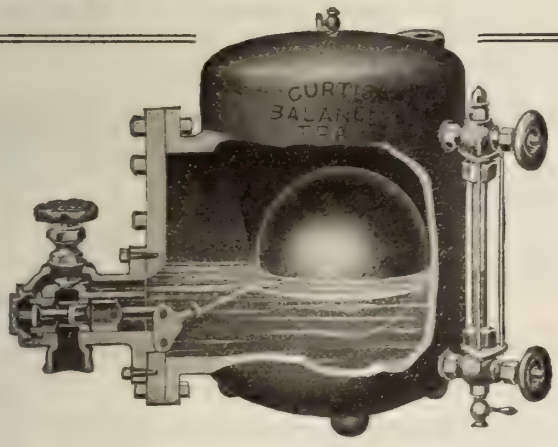
Conforming to factory inspection laws, the high speed Sterling commercial engines have their working parts, including the flywheel, complete enclosed as a protection for the operator.



Sterling Model F, 4-cylinder, 75 B.H.P. engine direct connected to Worthington 3 stage fire pump at Berthierville, Quebec, suction 6", discharge 6", capacity 900 Gals. per min., Speed 900 R.P.M.

STERLING ENGINE COMPANY
Dept C-4 BUFFALO, N.Y., U.S.A.
12 to 300 H.P., speeds 400 to 1400 R.P.M.

CURTIS Engineering Specialties

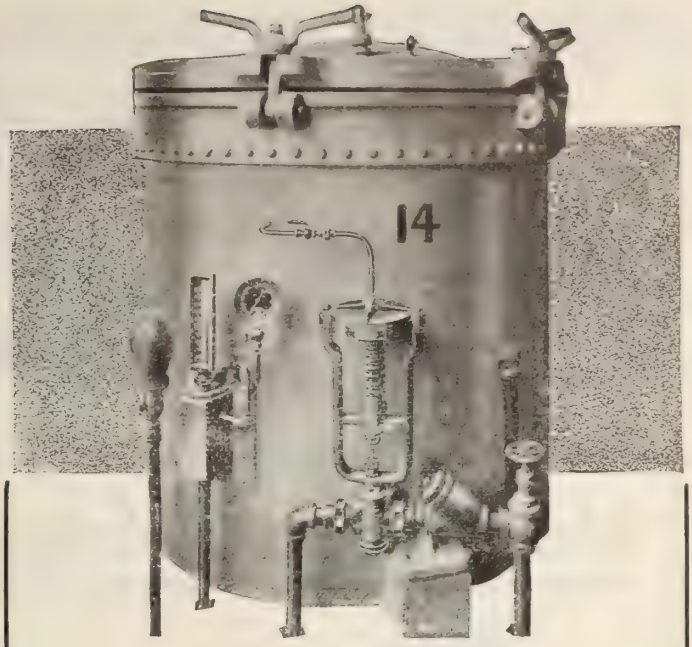


Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.



Maintain the Correct Pressure

Don't Waste Power and Don't be too Economical

The TAG Self-Operating Pressure Controller, if applied to a manufacturing process, as illustrated, or to any steam, air, or hydraulic power main, will control the pressure automatically without attention on your part.

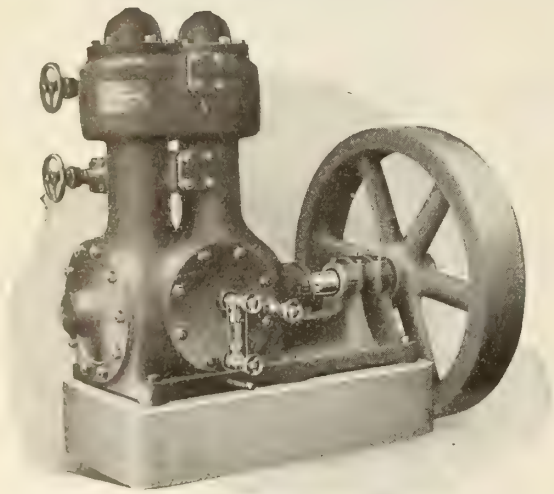
The TAG Controller will throttle a 150-lb. pressure down to any desired point below 70 lbs. and maintain that pressure day and night until the power is shut off.

Doesn't that mean a big saving to you in fuel, power and labor? Isn't it worth investigation?

Investigation is easy. Our Bulletin PP-388 describes the TAG Self-Operating Pressure Controller. Our service is at your disposal.

C.J. TAGLIABUE MFG.CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

Self-Lubricating

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

In Bulk

GUARANTEED TO LAST THREE YEARS

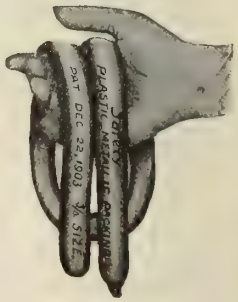
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes

—for every purpose

WILLIAMS' Superior Drop-Forged Wrenches are made in nearly one thousand sizes with openings from 3/16 to 7⅝ inches (4.8 to 194 mm.)—"a Wrench for every purpose." And every one is the product of drop-forgers with nearly half a century's experience behind them. That's why *good mechanics* invariably prefer Williams' Wrenches.

Ask for a Copy of Our New Catalog

J. H. Williams & Co.
"The Wrench People."

78 Richards Street, Brooklyn, N.Y. 78 Vulcan Street, Buffalo, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask.
Agents for Manitoba, Saskatchewan, Alberta and British Columbia

Williams' Drop-Forged Wrenches

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

You Know You are Safe

When "SAFETY-FIRST" SEXTON tackles your—

FIREBRICK WORK

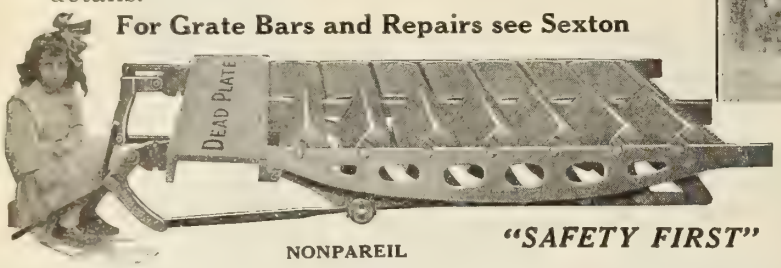
Sexton Boiler Settings are seen in some of the most important plants in Toronto. Names of these plants on request. Ask them what they think of "Safety-First" Sexton's work.

NONPAREIL

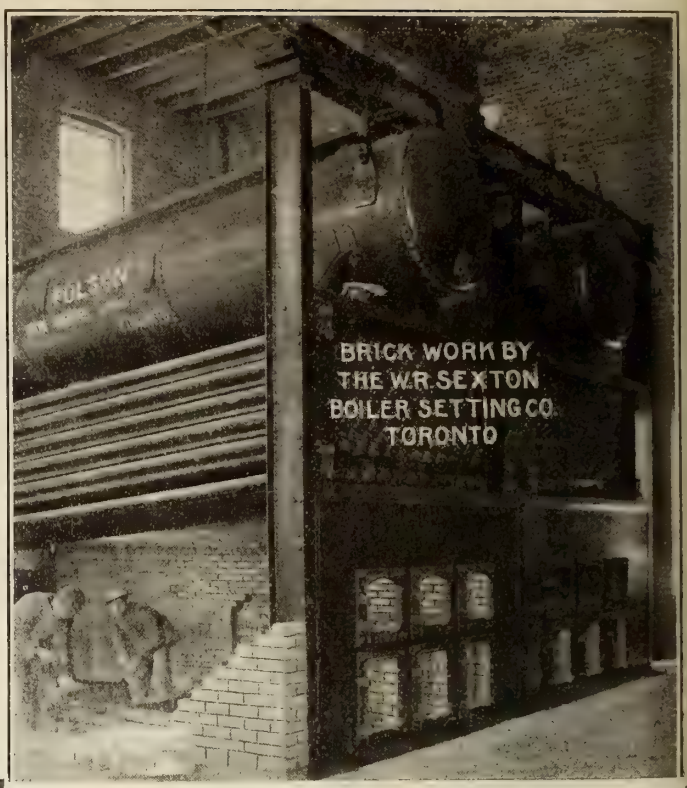
Shaking and Dumping Grates Save Fuel

Do you want to save 10 per cent. of your fuel expenses? You do this without a doubt. Prove it for yourself by putting NONPAREIL Shaking and Dumping Grates in your furnaces on a 30-day trial basis—write for the details.

For Grate Bars and Repairs see Sexton



NONPAREIL *"SAFETY FIRST"*



THE W. R. SEXTON BOILER SETTING COMPANY

127 D'Arcy Street, Toronto

Established 1900 Phone, College 682

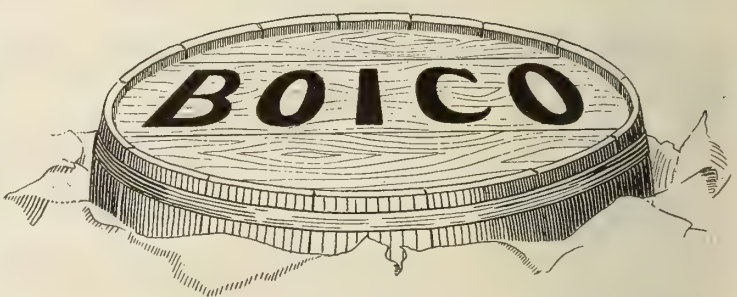
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

Mr. Jos. W. Hays, *Author*

Mr. Joseph Harrington
Chicago
Formerly Advisory Engineer, National Fuel Administration for State of Illinois

Mr. Fred R. Low
New York City
Editor of Power

Prof. S. W. Parr
Urbana, Ill.
Department of Chemistry, University of Illinois

Mr. Arthur L. Rice
Chicago
Editor, Power Plant Engineering

W. L. Abbott,
Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill.

Mr. David Moffat Myers
New York City
Formerly Advisory Engineer, National Fuel Administration

These Men are America's Leading Combustion Experts

Every step of the training has their careful censorship, giving you the fruits of their broad and successful experience.

Hays School of Combustion
1108 State-Lake Bldg.
Chicago, Ill.

Better Jobs— Bigger Salaries

Let These Men Show You How to Get Them

Are you interested in sure and rapid advancement to a really worth while position in one of the best paying professions in the country today? If you are it will pay you well to read this announcement. It tells how you, with or without previous training, can prepare yourself in a short time for an attractive position that insures a lucrative salary and an assured future.

Remember—this profession is a new one—unlike all others, it is still uncrowded—and the demand for trained men far exceeds the supply. That's why your services will be in demand when you have acquired the necessary training. That's why you can count every effort a sure and wonderfully profitable investment.

Easy to Learn— No Experience Necessary

In most professions, to become proficient, long periods of intensive study, followed by years of hard training, are necessary. In this new profession—Combustion Engineering—the necessary training can be acquired in a few short months. Why? Because all the knowledge and experience—all the scientific research and experiments—all the labor and study of seven of America's leading Combustion Engineers have been condensed and classified to such a remarkable extent that what formerly required years of study can now be learned in a fraction of that time.

This training from the very first can be applied to the practical every-day problems of any power plant. At some point in the course you must spend some time in power-plant work if you have not already had the experience. That may prove to be your field or you may make it the stepping stone to an executive position. In either case your services will increase in demand and value as you progress in the training.

America's Leading Combustion Engineers Teach You

On this page are photographs of our educational staff. Probably you know some of these men personally. At least, all or most of them, are known to you by reputation.

Jos. W. Hays is the author. His reputation as a writer on Combustion Efficiency is world wide. In this course he has surpassed himself. Every lesson, every chapter, is written in such an interesting, comprehensive way, that the reading of the course is as pleasant as it is profitable.

Associated with Mr. Hays as reviewing and advisory editors are **I. E. Moultrop, W. L. Abbott, Jos. Harrington, Fred R. Low, David Moffat Myers, Prof. S. W. Parr and Arthur L. Rice.** These names alone are proof positive of the thoroughness and completeness of the course.

Especial attention has been given to make this course easily understood by everyone. It is stripped of all unnecessary technicalities and is written in a way that you can quickly grasp and understand. It is prepared especially for the man on the job—the busy man in office or boiler room who can commence putting his knowledge into practice the moment he starts the course.

Send for this FREE BOOK—TODAY

To enable you to get a better idea of just what this course is—just what it covers—why it is a guide to a better job and a bigger salary—why it enables *you* to cash in on the big salary awards that fall to the Combustion Expert—to make all these things clear to you, we have prepared the book "Opportunities for the Combustion Expert." Send for a copy of this book today. It's free.

Mail the Coupon

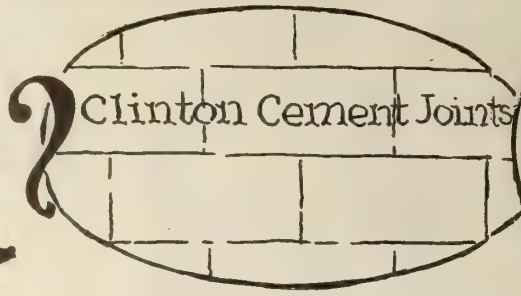
Simply fill in the coupon and mail it to us. We'll send you a free copy of "Opportunities for the Combustion Expert" by return mail. Time is valuable. Get started today while the opportunities are greatest. Mail the coupon—Now.

HAYS SCHOOL OF COMBUSTION
109 North State St., Chicago

Without obligation, send me a free copy of "Opportunities for the Combustion Expert and details of the Hays Course.

Name.....
Street.....
City.....State.....
Firm.....
Position.....P.H.2-20

Which ?



CLINTON CEMENT

Send for 5-Pound Can of Clinton Cement — It's FREE

Here is an opportunity to prove the quality of Clinton Cement without costing you a cent. Send for this five-pound can and put it to a rigid test. Watch how it sets. It makes the joints of the firebrick tight—to stay tight. Sets smooth and firm, yet allows for expansion and contraction. Stands a heat up to 3000 degrees Fahrenheit. Clinton Cement saves fuel and increases furnace efficiency by preventing cold air leakage. **Use it always!**

Clinton Cement Joints Are Superior to Fire Clay Joints.

Send for our free trial can to-day. All charges prepaid. You are under no obligation to us in accepting the offer.

Standard Machinery & Supplies Limited

261 Notre Dame St. West, Montreal

HEATING BY HOT WATER & HOT WATER SUPPLIES

HIGHEST EFFICIENCY GUARANTEED

Instantaneous Heater, with connections for Fresh and Salt Water and Steam

ROW'S PATENT CALORIFIERS are strongly recommended for heating water in bulk for supplying a number of Baths and Lavatories. Also for HEATING CIRCULATIONS for PUBLIC INSTITUTIONS, HOTELS, etc.

ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

ROW'S PATENT

CALORIFIERS

FEED WATER HEATERS

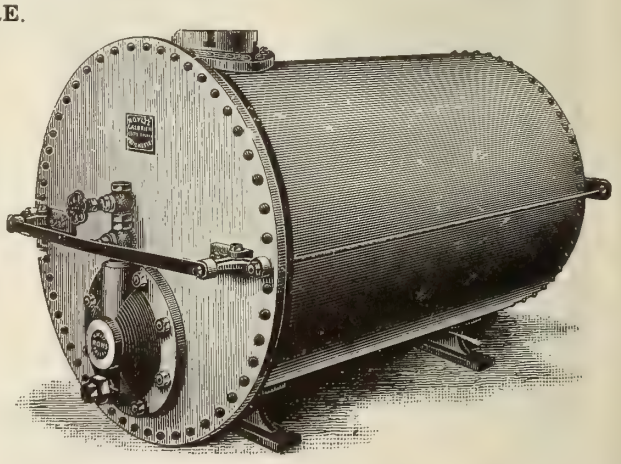
RADIATORS

Suitable for Hot Water or High Pressure Steam

STEAM and GAS KETTLES

EVAPORATORS

CONDENSERS



PATENT CALORIFIER. STORAGE PATTERN

ROYLES LIMITED, ENGINEERS AND SPECIALISTS **IRLAM, MANCHESTER** ENGLAND

"MEAD-MORRISON"

CANADIAN MM C

CANADIAN MM C

HOISTING MACHINERY
LABOR SAVING PLANTS

Ashes Handling Machinery
Hoisting Towers
Cranes, Gantry
Cable Ways
Boiler House Equipment
Coal Crushers
Conveyors — McCaslin Gravity Bucket
Cable Railway Systems
Bridges — Man Trolley and Rope Operated, Material Handling
Cars—Automatic, Cable and Electric
Coal Pockets
Coal Handling Machinery
Coal Screening Plants
Ship Bunkering Equipment
Ore Handling Equipment
Electric Transfer Cars
Transporters— Electric Monorail
Ship Loaders
Car Dumpers

HAVING recently purchased the manufacturing plant of M. Beatty & Sons, at Welland, Ont., and the Canadian business of the Mead-Morrison Mfg. Co., of Boston, New York and Chicago, we take pleasure in announcing our new organization—

CANADIAN MEAD-MORRISON CO.
LIMITED

We are MANUFACTURING IN CANADA the well-known Mead-Morrison products, as well as the Beatty line of Dredges, Derricks, Hoists, etc.

Steam Hoisting Engines
Electric Hoists
Gasoline Hoists
Belt Hoists
Engines — Hoisting, Pile Driving, Bridge Erecting, Mining.
Contractors Centrifugal Pumps
Grab Buckets — Clam Shell and Orange Peel
Weighing Larries
Winches—Power Driven
Swinging Engines — Steam and Electric
Winches—Motor Truck
Car Pullers
Dredges
Quarry Hoists
Derrick Hoists
Derricks and Derrick Irons
Cargo Hoists
Trawler Winches
Ship Winches

Contractors for Complete Labor-Saving Plants

We will be pleased to assist you in your hoisting and material handling problems.

CANADIAN MEAD-MORRISON CO.
LIMITED

ENGINEERS MANUFACTURERS & CONTRACTORS

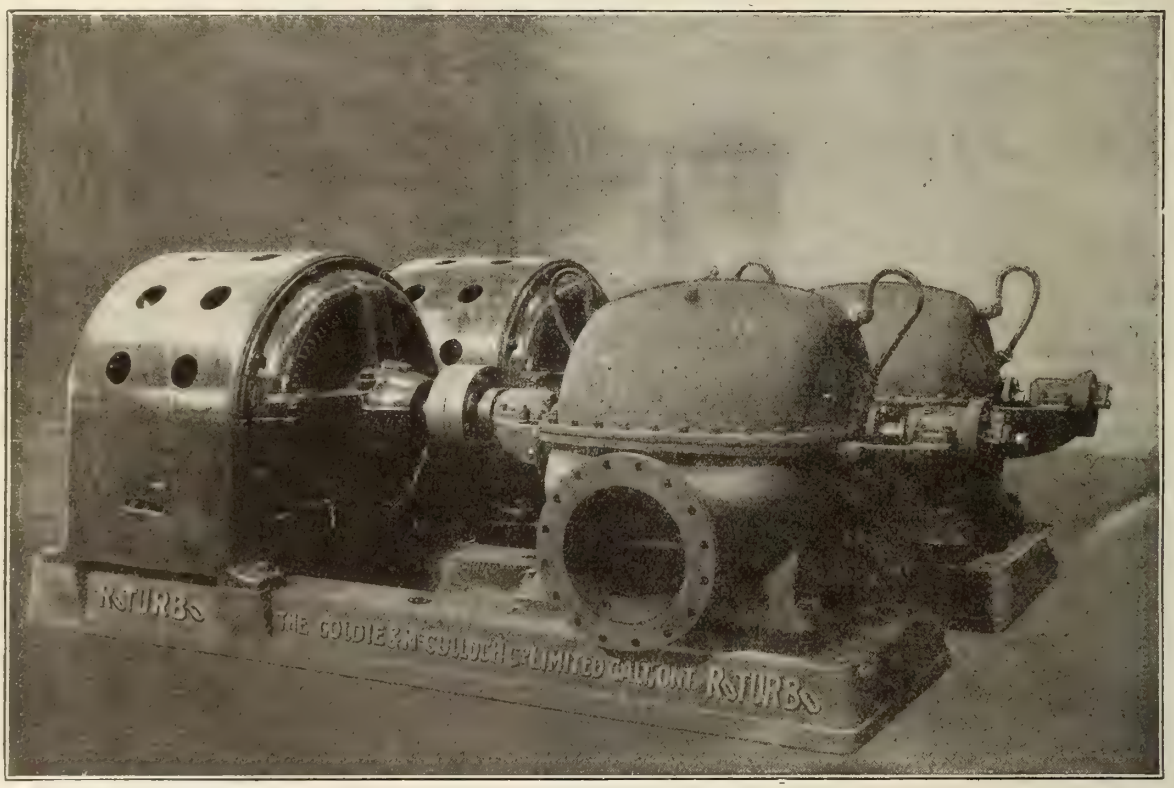
Works
WELLAND, ONTARIO

General Sales Offices
285 BEAVER HALL HILL, MONTREAL

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed by us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bld'g.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

An Explosion Pump in Irrigation Service

The Direct-Acting Explosion Pump Contains no Pistons or Other Reciprocating Mechanism Beyond an Oscillating Column of Water Upon Which the Gaseous Products of Combustion Act

THE accompanying illustration, Fig. 1, and drawings, Figs. 2 and 3, show the gas producer plant and the details of construction of the gas producers of Akerlund design, while the arrangement of the direct-acting explosion pump in irrigation service at Del Rio, Texas, may be noted in drawings, Figs. 3 and 4. This first installation in this country of a large six Humphrey direct-acting explosion is used by the G. Bidell Moore estate for the irrigation of a tract along the Rio Grande, of twelve thousand acres.

The Moore Estate has purchased Humphrey pumps and Akerlund-type producer for wood and coal burning. The pumping station is located some 15 miles by road from Del Rio, the nearest railroad station. Eagle Pass bituminous coal could be delivered at the plant for $4 per ton, while fuel oil would cost some $2 per bbl. Much of the land covered with mesquite wood will have to be cleared before cultivation, therefore the use of this wood as fuel until clearing was completed seemed attractive and its possibilities in gas producers has been fully investigated with highly satisfactory results.

This explosion pumping station is located directly upon the banks of the Rio Grande River at a point where a rock ledge extends entirely across and creates a slight fall. A forebay is being excavated in the river bed adjacent to the pumping station and just above the ledge. At the downstream end, the forebay is being closed by a small concrete dam and in this is placed a 66-in. circular sluiceway which can be closed in by a 66-inch butterfly valve-operated from the interior of the station.

Normally, this valve will be kept open so as to keep the forebay free of silt deposits, as the river is very muddy. The intake to the pumping station is five feet in diameter. At its outer end it is protected by a screen inclined at a slope of 1 on 3. The Humphrey pump is designed to pump a minimum of 28,000 gal. per min. against 37 ft. though the designers are confident of showing 30,000 gal. on test and the hydraulic works have been designed for the latter figure. The guaranteed thermal efficiency is 20 per cent. when using producer gas of over 100 B.T.U. per cu. ft. The pump and play-pipe are 66 inches in diameter, the latter being 100 feet long. The pump is housed in a reinforced concrete well, 34 feet deep, shown in the accompanying figure, designed, to resist the full hydrostatic pressure of flood waters.

The operating floor is 3 feet above the lowest river level. The water level in the pump well is maintained at constant elevation, irrespective of the river stage, by a float-controlled hydraulic gate valve operated by pressure from the high canal. A gasometer is placed in the gas main leading from the producer to the pump. This, for safety in case of backfires, is a steel tank with the lower end open but sealed by the water in the pump pit.

Also installed in the pump pit is a 1 kw. electric generator direct connected to a small turbine operated by water from the canal, and a two-cylinder air compressor which can be driven either by the turbine or by an explosion engine operated by producer gas or gasoline, also a 3 inch centrifugal pump belted to the gas engine of the air compressor for draining the pump well. The top of the conical roof of the superstructure is provided with a 36 inch exhaust cowl. Fresh air is admitted to the pump pit at the operating floor level through a 24 inch pipe with a top cap designed to force air down by wind action.

The pipe opening into the pit carries an 18 inch motor-driven blower on hinges so as to be swung into place for service when the wind velocity is too low to secure sufficient natural ventilation. The play-pipe discharges into a reinforced-concrete surge tank, 36 x 12 ft. The discharge pipe extends 9 inches above the normal water level in the canal. The guaranteed lift of the pump is fixed at 37 feet; as this is not sufficient to irrigate a tract of some 500 acres in the immediate vicinity of the pumping station, it is intended to use the wave action in the surge tank to raise a small supply canal. The arrangement for this is not shown on the accompanying figure.

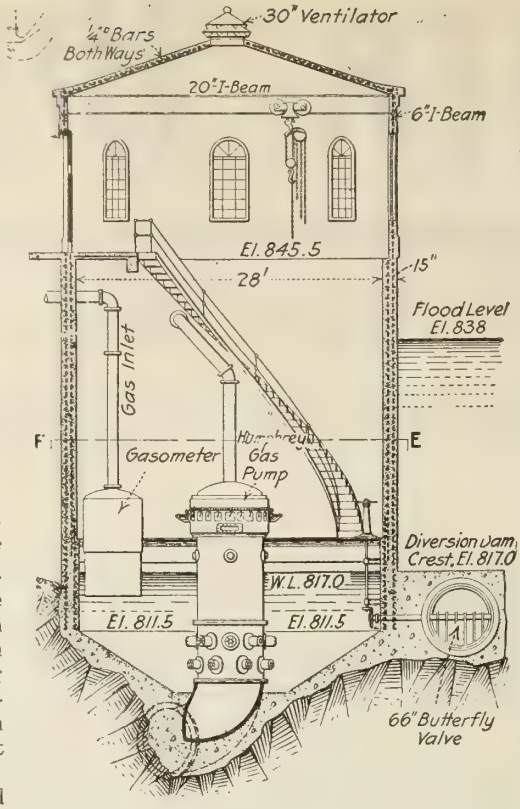
The surge tank is also designed to act as a grit chamber, the grit to be washed into the river through a 18 inch cast-iron pipe. In the operation of the Humphrey-type pump a charge of gas-air mixture is exploded in

FIG. 1. GAS PRODUCER PLANT FOR EXPLOSION PUMP

a chamber above the water surface, no piston being used. The explosion drives the water downward, closes the water inlet valves and sets the whole water column in the play-pipe in motion. The inertia of the moving column of water permits the burned gases to expand below atmospheric pressure when both exhaust and water valves open. There follows a return source of the liquid column until the water reaches the exhaust valves and closes them by impact.

There is a second forward surge set up by the trapped compressed gases and when the pressure again falls below atmospheric a fresh charge of gas and air is drawn in. This is finally compressed by the second return surge and exploded, when the cycle repeats. The inlet and exhaust valves are interlocked so that the proper sequence of operation is maintained. In the American Humphrey designs the complicated arrangement of rods and bell cranks by which the interlocking is accomplished on the large Chingford pumps in England, has been superseded by a simple sprocket chain thrown around the valve belt, engaging valve-arm studs and moving a short distance first in one direction and then in another to shift the lock from one set of valves to the other.

It is of interest to note that the period of oscillation is about proportional to the square root of water-column length; in this case the pump will have approximately 12 cycles per minute. There are two types of ignition equipment, jump-spark plugs operated from storage batteries and coils, and "wipe spark" or arc igniters taking current from the turbine-driven generator. To start, an initial charge of gas and air will be forced in by compressed air, all the valves being held shut. After explosion the play-pipe oscillations thus initiated are strong enough to work the valves.



4. IRRIGATION EXPLOSION PUMP, MOORE ESTATE, DEL RIO, TEXAS

The gas-producer plant noted in Fig. 1 is of special interest located very close to the pump house on higher ground and it comprises a vertical-down-draft generator with a water pan on top and a vapor ring around the combustion belt; air is admitted to the vapor ring and the mixture of air and steam enters the fuel chamber above the green charge. The gas is led off through a spray-cooler, a wet scrubber, exhauster, dry purifier and delivery pipe. On trial runs of the producer with mesquite wood, it was found that the average wood burned per hour was 436 lbs., the average gas made per hour being 23,850 cu. ft. and the average gas made per lb. of wood was 54.7 cu. ft. The average b.t.u. per cu. ft. of gas was 114.5, the average wood per sq. ft. of fire area being 20.8 lbs., and wood per horsepower hour used was 1.76 lbs. The details of construction of the Akerlund gas producers may be of interest.

The Akerlund gas producer noted in Fig. 2 operates on the up-draft principle under pressure. A steam jet blower supplies steam and air from below in the proper proportion and this mixture, as it passes through the fire, supports the reaction which result in the combination of fixed gases known as producer gas. The producer shell is a simple steel cylinder resting in a cast iron ring, built in sections, which is supported on piers in a water-seal. The ring projects into the water, forming the seal, and ashes are removed through water around the lower edge of the ring without any escape of gas and without interfering with continuous operation. The shell has a straight lining of standard firebrick; in diameters of eight feet or larger, these

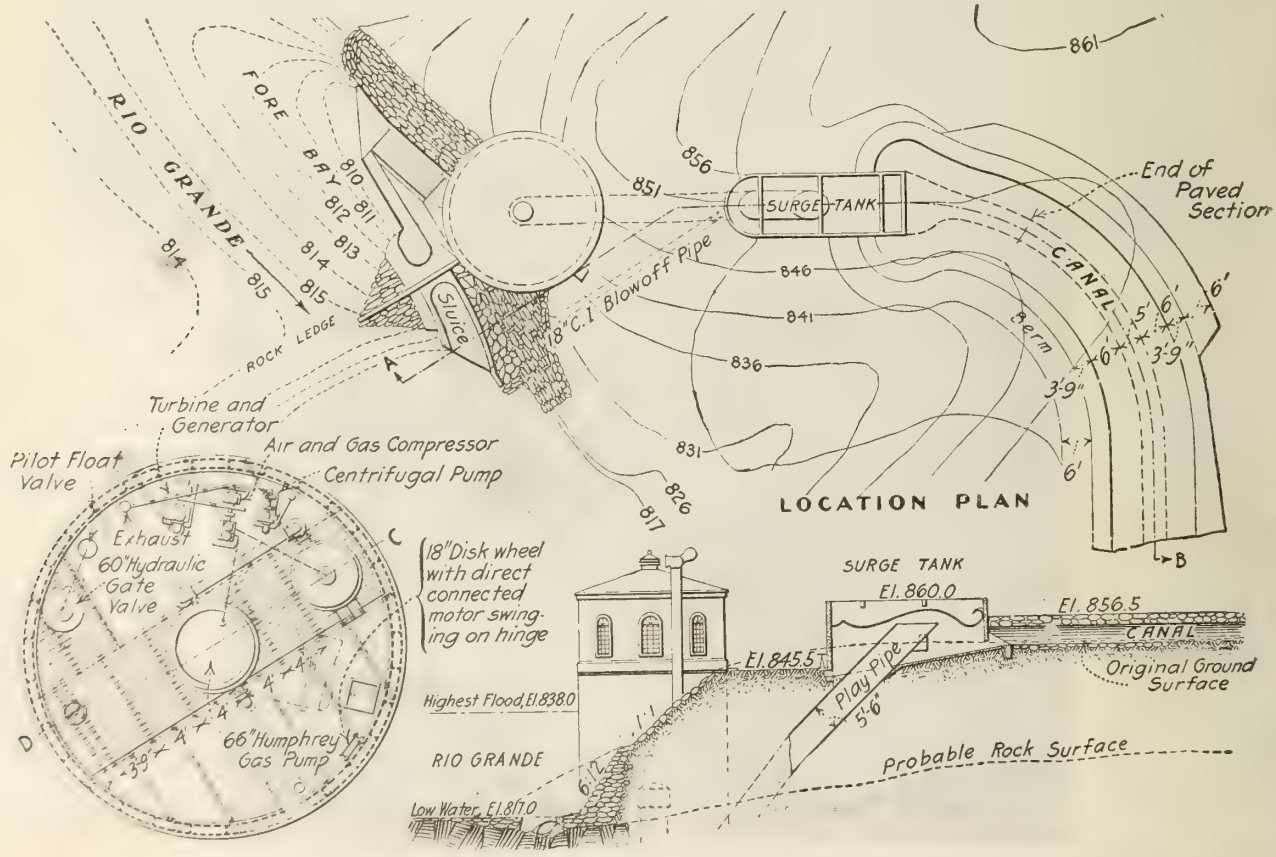


FIG. 3. PLAN OF IRRIGATION EXPLOSION PUMPING STATION

bricks are arched slightly to the centre at top to project as far as the central water-cooled section.

The lining has no slopes or projections which might serve as a lodging place for clinkers and ashes and thus cause bridging, which is a serious trouble with improperly designed gas producers. The

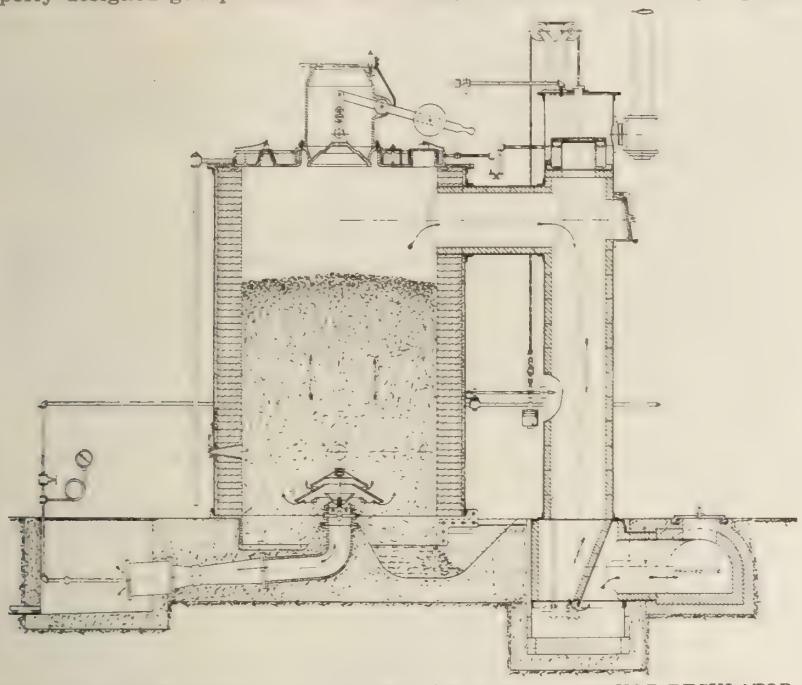


FIG. 2. GAS PRODUCER OF TYPE WITH AUTOMATIC PRESSURE REGULATOR

blower is designed to deliver the proper proportion of steam and air in the blast.

It is maintained that the efficient operation of a gas producer is dependent upon the even distribution of the blast through the fire. To promote ideal conditions in this respect, the blower discharges through a blast hood built in sections, larger diameters requiring more sections than the smaller sizes. Thus blast hoods are built up from the same set of castings and the sections overlap to prevent clogging by ashes or clinkers.

The water-cooled top plate is built of cast iron in sections and the outer ring consists of segments bolted to the top angle of the producer shell. The central water-cooled section of the top is a solid casting, which rests in this ring. This makes a self-supporting top, which is entirely independent of the brick lining. Gas producers which support the central water-cooled section of the top plate entirely on the brick lining are subject to troubles when the lining begins to deteriorate. The top plate remains in good condition indefinitely, and by a slight addition to the first cost of the plant greatly reduces the cost of repairs and prevents the possibility of serious leaks in case the brick lining should settle or give way even slightly.

It will be noted that the charging hopper is of the double-valve type, distributing fuel by dumping through an opening made by lowering a bell. This has proved to be the simplest method of supplying fuel to the fire and distributing it evenly over the surface of the fuel bed. The capacity of the hopper is the same as the consumption of the producer for a certain period, usually from one to two hours, so that reasonable care to charge fuel for periods of corresponding duration will give all the advantages of continuous automatic feeding.

There is a central gas off-take for large units mechanically operated in capacities from 500 h.p. up. The gas is taken off through a hood, centrally located below the fire. In addition to the supply of air and vapor which is introduced above the fire, there is a secondary supply of air and vapor which is introduced through a number of tuyeres set in the brick lining just below the coking zone.

The path of this secondary air and vapor is from the perimeter of the fire downward and radially to the central gas outlet. In connection with the supply of air and vapor introduced above, this insures uniform combustion throughout a comparatively large area and makes it possible to build this form of gas producer in units beyond the usual limit. The air and vapor supply for the central off-take design is automatically regulated.

CROSS EXAMINATION

A reader sends an old newspaper cutting containing an amusing travesty by "S.L.H." of a cross-examination. The scene is a coroner's court in some hole-and-corner country town which has sprung into notoriety by reason of a railway accident. The general manager of a big company has been brought down and is giving evidence:

Coroner: "I take it that you have some knowledge of railways?"

Witness: "I have had daily experience in railway affairs for more than 50 years."

Coroner: "Then you probably know the difference between a locomotive and a cattle truck?"

Witness: "That is so."

Counsel (feeling that he must say something): "I put it to you that there is a difference between the two?"

Witness: "There is."

Counsel: "A real difference, and not a mere imaginary or theoretical distinction?"

Witness (horribly bored): "Oh, yes; quite a real difference."

It is eventually brought out that "a projection shown on one side of the rim of a wheel" is a flange, and that without flanges on the wheels "the train could not have arrived at the spot where the accident happened. The jury therefore find the flanges responsible for the accident."—"North Eastern Railway Magazine."

PANEL SYSTEM OF COAL MINING

Under the present conditions when the demand for fuel is abnormally high, the extraction of the highest percentage of total coal in the progress of mining is a problem of vital importance. The Engineering Experiment Station, in cooperation with the Illinois State Geologica Survey and the United States Bureau of Mines, has undertaken an investigation of the subject and has made a somewhat elaborate study of the facts and of the compiled information. An investigation of the percentages of coal extracted and lost in Illinois and in other bituminous coal mining districts, showed that the percentage obtained is less than is commonly believed, averaging only about 50 per cent. This conclusion has led to the study of the panel system of coal mining in order to determine the greatest possible extraction with different dimensions of working. Previously other investigations of a similar nature have been made to determine the relation between dimensions of workings and amounts of extraction, but, so far as is known, no study of the panel system in general with regard to the percentage of extraction and the change of this percentage with the change of dimensions of workings has hitherto been made.

The results have been published by C. M. Young, Assistant Professor of Mining Research, in Bulletin No. 113 of the Engineering Experiment Station, Urbana, Illinois.

POWER PLANT RECORDS

One of the most essential things in power plants in the systematic record of operations by daily logs and recording apparatus, and when the results are published on engine room bulletin boards it creates a rivalry between the different shifts and promotes a desire among the men for higher efficiency. The importance cannot be overestimated. In this way affairs in the plant are lifted from the realms of guesswork to certainty. While the systems adopted for ordinary plants may be simple, the records should be arranged for convenient reference so that comparison of results with past performance may be made. Thus it is possible to note the effects of changes in equipment or improvements in economy, or the reverse, may be at once detected.

The General Fuel Situation in Canada

The Commission of Conservation, Ottawa, in Their Report on Pulverized Fuel, Gives Some Interesting Data Relative to the Fuel Situation in Canada. The Following Article Presents This Material in Abstract Form

IN a country of such enormous proportions as the Dominion of Canada, extending from the Atlantic to the Pacific, and northward to the Arctic, and with its severe winters, the question of an adequate fuel supply as a source of heat, light and power, and for use in the metallurgical industries, must always be of paramount importance. To a great extent the requisites of power and light can be supplied by the utilization of the numerous waterfalls with which the country is so abundantly supplied. Based upon investigations by the Commission of Conservation, the total water-power in Canada is estimated at 18,953,000 horse-power. Assuming that, under average conditions, one horse-power-hour can be produced in a steam plant from three pounds of coal, one-half of the 17,000,000 horse-power, if developed, would, on a basis of twelve hours a day, and a load factor of 50 per cent., represent a saving of nearly 24,000,000 tons of coal per year. Although hydro-electric energy will, where available, to a great extent replace the use of coal for light and power purposes and for certain metallurgical work, the necessary uses of coal will continue on a large scale.

The coal deposits of Canada, in respect of quality, quantity, and accessibility for mining purposes, compare favourably with those of other countries. About one-sixth of the coal resources of the world is possessed by Canada. The deposits are, however, confined to the eastern and western portions of the Dominion, the large central market being supplied by imported coal. Previous to the war, Nova Scotia bituminous coal was used as far west as Montreal, while United States bituminous was sold within the area extending from Montreal to Swift Current and Saskatoon, Sask., the railways being the principal users of this fuel. Portions of Manitoba and Saskatchewan are supplied with coal also from Crowsnest, Lethbridge, Canmore, Drumheller, Edmonton, Yellowhead Pass and Souris districts.

Eastern Canada possesses no deposits of anthracite, and, as this class of coal is suitable for heating and domestic purposes, considerable quantites are imported from the United States. Prior to the war, it was sold over an area extending from Nova Scotia to Battleford, Sask., in the west. In 1913, imports exceeded 4,640,000 tons, more than double those of 1906; thus it is apparent that the demand for anthracite is rapidly increasing, notwithstanding the upward tendency of prices. The supply of anthracite coal in the United States, also, is limited, and there is no assurance that its export to Canada will be long continued. If mined at the present rate, the anthracite coal reserves of United States will be exhausted in about 100 years. We may, therefore, expect the price to gradually increase, until only the wealthy can afford it. Coincidently with the rising price, production will decrease, thus prolonging the life of the mines. Thus, during the four-year period, 1913-16, production decreased from 91,524,922 tons in 1913 to 88,312,000 tons in 1916, or rather more than one per cent. per annum.

Of the total consumption during 1916, 45 per cent. was domestic coal and 55 per cent. imported coal, or, in other words, we imported more coal than we produced. The importance of this fact may be more fully recognized when it is realized that the value of the coal production, in 1916—$38,857,557—greatly exceeded that of any other mineral, and amounted to nearly 22 per cent. of the total mineral production of Canada during that year. Although we have over 17 per cent. of the world's reserve of coal, our production is small, and we import more than we produce.

From the above it is evident that, before many years, Canada may have difficulty in procuring supplies of anthracite coal from the United States, except at a greatly increased cost; also, as we have no supplies of this class of coal east of the Rocky mountains, we cannot supply the need from our own resources. We arrive at the conclusion, therefore, that, to take its place, some kind of substitute, of which we have large reserves, must be developed.

The following conditions have to be dealt with:

(1) Domestic fuel problem in Ontario and Quebec.
(2) Imported bituminous coal used as fuel on railways and as a source of power in Ontario, Manitoba and Saskatchewan.
(3) Domestic fuel problem in Prairie Provinces.
(4) Cheap power problem in Prairie Provinces.

(1) The following solutions of the domestic fuel problem in Ontario and Quebec are suggested: (*a*) By the installation of by-product coke-ovens at certain points on the St. Lawrence and Great Lakes system, the coke being used for domestic purposes in place of anthracite coal; (*b*) by the development of a peat industry, where peat deposits are near the market for such fuel; (*c*) eventually, electric energy will, to a limited extent, replace coal for heating and cooking purposes.

(2) The establishment of the distribution system of the Ontario Hydro-Electric Power Commission has been effective in largely replacing imported coal as a source of power in Ontario by electric energy derived from our water-powers. But for the work of this commission, many industrial plants in Ontario would have been hampered during the war, if not forced to shut down, for lack of power.

The economic solution of the railway fuel problem may be secured by the electrification of our railways which, for obvious reasons, would be undertaken step by step. So far as certain portions of the Prairie Provinces and Western Canada are concerned, the problem may be solved by the use of pulverized lignite or sub-bituminous coal, by the use of briquetted fuel made from lignite or bituminous coal, and by the increased use of our own bituminous coal, which is equal in every respect to that imported.

Consideration of this problem of importing coal requires that it be discussed under two headings, *viz.*: "Anthracite Coal" and "Bituminous Coal."

Anthracite Coal—This domestic fuel is a luxury, not a necessity; the higher grades of sub-bituminous and lignite coals can be used in its place, and have several advantages over hard coal. In 1918-19, for the first time, Winnipeg used western coal to a very considerable extent, and it gave good satisfaction, notwithstanding the fact that most people were not familiar with the manner in which it should be used.

Bituminous Coal—The imported bituminous coal is used largely for railway use, but a portion is also used for ordinary power purposes.

The value of the imports of coal into Fort William, Port Arthur, and Manitoba ports of entry amounts to from $14,000,000 to $18,000,000 annually. This figure represents actual money that goes out of the country. This money would otherwise be spent in developing Western Canadian industries.

The problem, which must be solved, is briefly this: How can Canadian coal be used in place of imported coal, without costing the consumer more, and at the same time solve the transportation problem? The answer to this problem and the putting of it into practice will mean twice the number of men employed in the coal mines in the west, and, at the same time, retaining in the country the large amount of money above mentioned.

The coal mines of Alberta and Saskatchewan have a capacity for producing some 15,000,000 tons of coal per annum. This fact is of importance when it is considered that the actual production of coal in these provinces in 1918 did not exceed 6,319,663 tons. There is no doubt, even under existing conditions, but that the production could be increased some 4,000,000 tons if the demand should warrant it.

The enlargement of the markets for western coal would also be the means of reducing the price of this coal to the consumer. For example, practically all the domestic coal-producing mines in Alberta are closed down from March 1 to August 15, which means that the fixed charges during this period must be borne by the coal produced during the autumn and winter.

Actual operation shows that, in the same time, operating at 50 per cent. capacity as against 85 per cent. capacity, the cost of production per ton of coal amounted to over $1.10.

This situation could be improved by the Government carrying out the recommendation made by the Conservation Commission that a supreme engineering authority be appointed, with full powers to prevent the use of wasteful methods in the mining of coal; also by the stocking of coal during the summer months.

Under present conditions dealers will not stock coal during these months, owing to additional costs necessary to cover carrying charges, etc. A dealer who stocks coal also has to compete with those who deliver direct from the cars during the winter. There are, therefore, no inducements offered for stocking coal.

In order to secure a more equable distribution during the entire year, and thus relieve the car shortage which occurs in winter, and at the same time permit of the working of the coal mines during the summer months, it appears desirable that special freight rates should be granted on coal shipped eastward during this period and also that the mines should give special summer prices for coal. The differential between the cost of summer and winter coal should be great enough to encourage not only the dealers to stock up, but also to induce consumers to lay in their winter supplies.

It is of first importance also that an investigation be carried out by the Government to determine what special processes could be applied to the more economical use of the low-grade fuels in Alberta and Saskatchewan.

In a report, *Conservation of Coal in Canada*, published by the Commission of Conservation, in 1911, the briquetting of the lignites of the west were advocated to obtain the above conditions. One of the first problems considered by the Honorary Advisory Council for Scientific Research was the possibility of the briquetting of carbonized lignite. Indications point towards the establishment by the Dominion Government, in conjunction with the Governments of Saskatchewan and Manitoba, of a commercial plant to demonstrate the practicability of the process. Should the result be satisfactory, it will not only provide a suitable fuel for the farmers in place of imported anthracite coal, but will cause a great development of the coal-mining industry of Saskatchewan.

Distribution of Imported Coal

As the coal-fields are situated in the eastern and western portions of Canada, the interior portion, from Cornwall, Ont., on the east, to Swift Current, Sask., on the west, is supplied by coal from the United States. The central and eastern portion, comprising central and eastern Ontario, is supplied *via* St. Lawrence, Lake Ontario and Niagara River ports; coal for the west is hauled by rail to Buffalo and Lake Erie ports, whence it is carried by water and rail to its destination. The bituminous coal is used principally for railway and the anthracite for domestic purposes.

The coal brought up the Great lakes is carried as return freight in ships engaged in the ore-carrying trade. Owing to the higher wages paid the miners and higher transportation charges, industries in Canada dependent on United States coal are handicapped. The increase of prices will tend to increase the distribution of Canadian coal farther east and make possible the development of uses for inferior coal.

The most important users of imported coal are the railways and transportation companies.

Railway Fuel

One of the most important factors in locomotive haulage is that of a suitable and economic fuel

The tonnage of coal used annually on railways in Canada is equivalent to nearly 58 per cent. of our total coal production for same period. In 1918 the coal production of Canada was 14,977,926 tons, while in the same year the railways consumed 10,173,344 tons of coal. In addition, 52,507,528 gallons of fuel-oil was used as locomotive fuel. The oil was imported from the United States and represented the equivalent of 312,545 tons of coal.

The development of fuel-oil, for use on railways and steamships, has resulted from the discovery of large oil-fields in California. Oil fuel has many advantages over coal, but its use or non-use will largely depend upon whether it is the most economical fuel under the circumstances. Railway companies have adopted it, not on account of any compulsion on the part of the Government, but from business considerations. On account of the ease with which it can be loaded into boats and fired, and because it occupies less space than coal, thereby giving greater freight-carrying capacity to steamships, it will be used on this class of traffic even after its price exceeds the price of its heat-equivalent in coal.

Fuel-oil has been used to a considerable extent on railways in the United States since its introduction in 1900. The partial exhaustion of adjacent oil-fields has caused some of these lines to revert to coal. The reversion will be still more evident as the increasing prices for oil offset its advantages. The use of fuel-oil in Western Canada will depend upon the low price of crude oil from California or other states bordering on the Pacific and Mexico. With regard to this subject, David T. Day, in *The Production of Petroleum in* 1913, states: "In California the railways were the first to absorb large quantities of California oils. This legitimate use has become permanent from lack of other fuel, and it has extended to other kinds of generation of power, including marine transportation for shipments coastwise and to foreign countries. A *serious menace to the continued use of oil for fuel in California* is the recent change in the character of the crude oils of that state. Many of the new pools yield oils suitable for refining and for the production of large quantities of gasolene and kerosene. Up to the beginning of 1913, about 30 per cent. of the oils of California was refined and the rest was sold for fuel, as crude, or after very slight distillation of the lighter products. This practice changed materially during 1913, so that the proportion of crude oil used direct as fuel became reversed, and, although no accurate figures are available, 70 per cent. is about the proportion of crude oil which was refined during that year, before the heavier portions were sold for fuel. The result of this, however, will be, not to decrease the use of oil for fuel, but to change the method of its application, particularly to the internal-combustion engine burning kerosene and heavier distillates". It is another significant fact that in 1915 the number of producing wells was increased, but the average yield per well per day dropped from 47 barrels in 1914 to 39 barrels in 1915. Although the petroleum business in California during 1915 was poor, and the price of oil one and one-half cents per barrel less, this was due largely to the effects of the war. The price, however, will increase for the above reasons, and there will be a greater demand for it for steamship use, incident to the placing in full operation of the Panama canal. The writer is of the opinion that, in so far as Canadian railways are concerned, the economic advantages of fuel-oil for locomotive use over that of Canadian coal is more favorable now than will be the case in the future. Should this prove to be the case the railways will, no doubt, for economic reasons, revert to the use of coal.

The coal reserves of Canada are considerable, but a large proportion is unsuitable for use in the ordinary way as locomotive fuel. The coals of Manitoba, Saskatchewan, and portions of Alberta are lignite or sub-bituminous, high in moisture, and cannot be used as locomotive fuel on account of the liability of setting out fires from excessive sparking.

In 1913, the Board of Railway Commissioners issued an order calling upon the railways to equip their locomotives with fire-preventive devices, to discontinue the use of certain grades of lignite coal on their locomotives, and to guard against outbreaks of fire along their rights-of-way.

In so far as supplies of fuel are concerned, the eastern portion of Saskatchewan forms the competitive area between the United States coal, on the one hand, and the high-grade bituminous coal of the Rocky mountains and adjacent region, on the other. It is evident, therefore, that the cost of fuel in this portion of the province is high. On account of our large imports of coal and fuel-oil, which, under these circumstances, are costly fuels, anything that can be done to increase the efficiency of generating power from coal or economically curtail the use of fuel-oil by the substitution of coal or lower-grade fuels which formerly could not be used on account of their liability of setting out fires from sparks, should be welcome.

Operating Features of Steam Turbines

The "Travellers' Standard" Publishes Some Interesting Data Relative to the Operation of Steam Turbines, Particularly From the Safety Standpoint

IT WAS only a few years ago that the steam turbine came into marked prominence, yet it is now one of the most important prime movers used in power plants and for the propulsion of steamships. Its rapid development and continued success have resulted from many causes, chief among which (as suggested in an earlier article in this series) are the economy of the machine in steam consumption, floor space, first cost, maintenance cost, and attention. Turbines are now built in sizes that would have appeared incredible ten or fifteen years ago, and advance in this direction has been paralleled, at the same time, by the adoption of much smaller units for minor purposes.

Although the turbine shows high efficiency and has a great many other advantages, it is by no means free from danger, and in consequence of the relatively small amount of experience that operating engineers have had with it (in comparison with the experience they have had with the reciprocating engine) the dangers that are peculiarly associated with the turbine are not always fully understood. The purpose of this article, therefore, is to point out some of the more important operating dangers that are present, and to indicate how these may be avoided.

The thing most to be feared in connection with a steam turbine is the rupture of the rotating part on account of centrifugal force or some other cause, and the bursting of the casing. In either case there will be a sudden liberation of vast quantities of steam. There is also an immense amount of mechanical energy stored up in the rotating parts, just as there is in the flywheel of a large reciprocating engine, and this must be expended in some way or other in case the rotor bursts.

An example taken from actual experience will serve to illustrate the amount of energy that is liberated even by the rupture of a rotor of small size. In the case we have in mind the disk, shaft flanges, bolts, and blades had an aggregate weight of about 300 pounds, and the normal speed of the disk was 10,820 revolutions per minute. While the machine was in operation a piece of the rotor, weighing about 60 pounds, broke off and was hurled through the casing. The linear speed of the centre of gravity of this piece was 656 feet per second, so that the amount of energy liberated when this piece broke away was approximately equal to that generated by a 730-horsepower engine in one second. It is easily imagined what serious damage such an amount of energy could do when once set free, and correspondingly easy to understand that in the case of the rupture of a rotor of large size the consequences might be almost incalculable. In this particular case two men were killed and two others were severely injured, and the property loss was also heavy.

In another accident the rotor of a small impulse turbine having a normal speed of 9,000 revolutions per minute, burst through the casing, broke off a 6-inch exhaust pipe, leaped over a small air compressor to the floor, and started to roll up a flight of cement stairs leading out of the engine room. Still whirling rapidly, it stopped at the third step, into which it ground a depression about five inches. It then turned back into the engine room and ran across the floor for a distance of 35 feet where it struck a foundation wall, after which it veered and crashed into another similar foundation ten feet away, and finally sped across the floor nearly to the starting point.

We might describe other turbine accidents in which both large and small machines figured, but the foregoing accounts are sufficient to emphasize the possibilities of danger, in case of defective material or parts, or if the operators or attendants fail in their duties in any respect. Serious disasters are becoming less frequent, however, and we believe that well-designed, modern turbines, when operated carefully and intelligently, present no greater hazard than reciprocating engines.

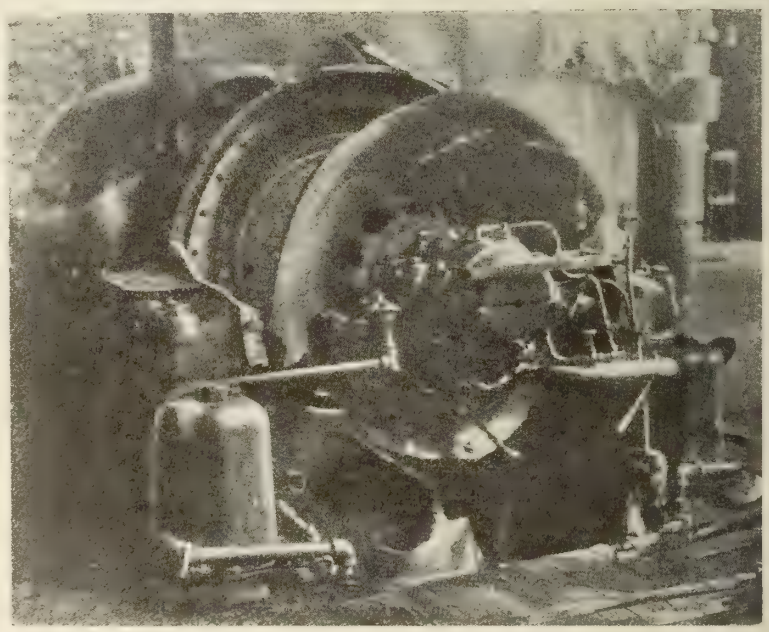


FIG. 1. ILLUSTRATING WRECK OF A SMALL TURBINE

Serious damage to steam turbines may arise from quite a number of causes, but the commonest immediate sources of trouble are: (1) rubbing between the revolving and stationary members, and (2) over-speed. As stated elsewhere in this article, the turbine should be shut down as soon as the first sign of rubbing is perceived, and the difficulty should be remedied before the machine is again put in operation. In case of over-speed it is also imperative to shut down the turbine immediately, and if trouble of this kind occurs the turbine mechanism ought to be capable of controlling the steam supply immediately, automatically and effectively.

Every turbine should have one main governing mechanism, competent to keep the machine running at designed speed under all conditions of load, and it should also have an emergency governor or control, which will promptly shut down the turbine whenever the regular governing device does not function. To safeguard both of these mechanisms it is necessary to have the governing apparatus in proper working order, and it should be maintained in this condition by frequent examinations and tests. It is equally important to ascertain, at short intervals, if the emergency control, and all the mechanism connected with it, is in good operating condition. Special attention in this respect should be given after either the controlling-valve stems or the throttle-valve have been repacked. Accidents have been known to occur on account of using packing containing a considerable amount of rubber, which would swell and render the mechanism inoperative as soon as the packing boxes became heated.

Failure of the regular governing apparatus may result from ordinary wear, or it may be brought about in other ways. If the load is suddenly thrown off the governor is supposed to cut off the steam supply promptly and prevent racing. Not infrequently, however, the governor valve becomes worn so that it admits a considerable quantity of steam, even when it is supposed to be closed; and if the turbine is doing little or no work it may speed up to the bursting-point in consequence. To guard against an accident of this kind the valve should be kept in first-class condition at all times. Attendants in charge of a steam turbine sometimes change the setting of the governor, and they occasionally take it upon themselves to disconnect the governor entirely for a time, in case it does not work satisfactorily. This practice is too evidently dangerous to require discussion. Even when the governor is not disconnected, the men in charge sometimes undertake to run the turbine at a higher speed than that for which it was designed. This should never be done, because an increase in speed corresponds to a decrease in the factor of safety under which the machine is operated, and is likely to lead to disastrous results. It is important to remember that the stress to which the rotating parts are subjected increases in proportion to the square of the speed, so that doubling the speed increases the stresses fourfold. The attendant will frequently re-adjust the governor so that its valve is allowed more travel than the governor can take care of. We do not need to point out the danger that an error of this kind involves.

To provide for emergencies and prevent racing in case of the failure of the main governing apparatus, upon which dependence is placed for the regulation of the speed, every steam turbine should be provided, as we have said, with a separate and wholly independent safety stop, in no way connected with the main governing mechanism. The safety stop should not merely reduce the steam supply, as the ordinary governor does, but should cut it off completely and quickly as soon as the speed reaches a certain definite limit. This limit may perhaps be ten per cent. in excess of the ordinary running speed, but the builder of the machine should be consulted on this point, and his counsel should be followed. It is specially important to see that the emergency stop is maintained in good condition at all times, because when a turbine starts to race there is usually a very small margin of time for action, if an accident is to be averted. The closing of a throttle-valve of the ordinary type requires more time than is safely available, after the turbine has begun to speed up toward a dangerous limit. The valve that is operated by the emergency stop should be of the quick-acting type, so that the steam will be shut off without a single second of needless delay. To test the emergency stop and insure that it is constantly in good working order, it is advisable to trip it every time the machine is shut down, instead of using the throttle-valve for this purpose, in the usual way. It is important to protect the emergency stop and all its connections in such a way that the stop cannot be rendered inoperative by accidents external to the turbine itself. For example, the turbine may be operating an electric generator, and the generator may burst and some of the fragments may wreck or incapacitate the governing apparatus and the emergency control connected with the turbine. In a case of this kind the load would be suddenly thrown off the turbine, and the most serious consequences would result. It is always possible to imagine unlikely things that would lead to accidents, but that is no good and sufficient reason why the emergency stop on a turbine or a reciprocating engine should not be reasonably protected against damage from external causes.

Many turbines have valves in the exhaust lines, or discharge their steam into main headers having no valves in them. The attendant sometimes forgets to open these valves, and when this occurs a dangerous condition is at once created, unless special provision is made for such a contingency. Every turbine that is installed in such a way that the exhaust line can be closed must be provided with a relief valve of sufficient capacity to discharge all the steam that can enter through the nozzles or other steam openings, without permitting the pressure inside the casing to rise higher than the limit that has been selected in advance as the limit of safety. In small machines the relief valve is commonly placed in the casing, so that it forms a part of the turbine itself; but in larger ones the relief valves are often installed separately, and connected with the casings by fittings or pipes of suitable size The relief valve should be installed so that it cannot be shut off from the turbine by means of a stop-valve. For example, when the turbine is run condensing and there is a stop-valve between the turbine and the condenser, the relief valve should be connected on the side of the stop valve that is next to the turbine. This point is sometimes overlooked by designers and erectors, and yet it is exceedingly important because serious accidents are likely to occur if it is neglected. A relief valve that is placed on the condenser side of the stop valve will operate properly if the stop-valve is open; but it is a mistake to install any safety device in such a way as to make its effectiveness depend needlessly upon the thoughtfulness of the attendant.

If the governor valve of a small turbine is operated directly by the governor without a relay, it is very important that the valve should rest on its seat before the governor has reached the limit of its travel. Unless this adjustment is properly made and maintained, there is danger of over-speeding to the bursting point. Turbine attendants are sometimes advised, therefore, to test this point by taking off the governor spring when the turbine is shut down, pulling out on the weights until the valve rests securely on its seat and then noting whether or not the governor is still within its limit of travel. This practice is itself dangerous, however, unless the examination is made by a specially trained expert, because it is hard to put the governor back in its original position and give the weights the proper attention. The governor should never be dismantled and taken apart by the attendant unless it is absolutely necessary to do so. Any desired verification of the kind suggested above should be made by somebody assigned by, or approved by, the builder of the machine.

Many other items connected with the operation of small turbines require careful attention, if hazardous conditions are to be avoided. Adjustment of the setting of the governor valve should never be attempted except when absolutely necessary, and then only by an experienced man who should make sure that the adjustment will not prevent the

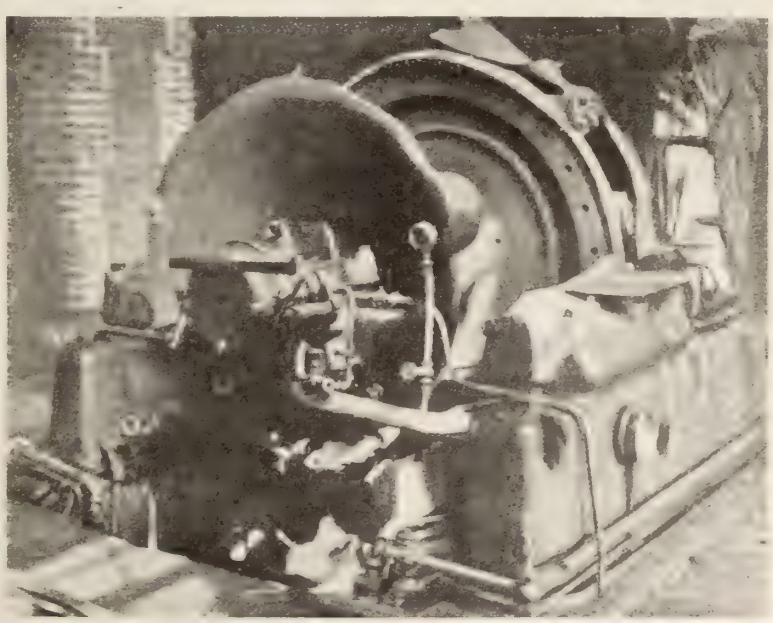


FIG. 2. ANOTHER VIEW OF THE TURBINE SHOWN IN FIG. 1

governor from closing the valve. The packing of the governor-valve stem should be attended to only when the turbine is shut down, and should be tested for sticking before the machine is put in service, and again (as indicated above) after the packing has become heated up. Governor valves are likely to become leaky in time, and hence they should be carefully watched. The governor-valve stems are usually made small in diameter to prevent leakage, and they may become bent quite easily from knocks or shocks, so that the governor will not operate properly.

Under ordinary circumstances the emergency valves of small turbines are seldom required to operate. There is therefore the likelihood that the automatic device, on account of long disuse, will fail to operate when an emergency arises. To guard against such a contingency these devices should be tested frequently, and any failure to function properly should be investigated and the trouble remedied before the turbine is restored to service. When an overspeed device operates without apparent cause, the reason should be sought, and located and remedied before the turbine is started again, even though an interruption in service is entailed thereby. These points, as well as others, are usually embodied in the instructions provided by the builders, and every man in the plant who is concerned in the care and operation of the turbine should have a copy of the instructions and become familiar with them. To emphasize the importance of this knowledge we may mention the fact that there are marked differences in the methods of lining-up and setting-up turbines of the various makes and types. For example, the same method cannot be employed for installing and lining up a rigid-frame turbine and one which has four bearings and is provided with a flexible coupling. There are also other more or less important dissimilarities in installation and operation. In our opinion each man should make just as serious a study of the particular turbine that he is to operate as he would of the various matters with which he must become familiar in order to obtain his license as stationary engineer.

Another prominent cause of trouble in connection with steam turbines is lack of balance of the rotating parts. This may arise in various ways. The rotor is supposed to be carefully balanced by the manufacturer of the turbine, but the balance may be disturbed by the making of repairs and in various other ways. Blades breaking off from the rotor will produce lack of balance to an extent corresponding to the number of blades that are lost, and masses of water entering the turbine from any cause may produce a very considerable lack of balance momentarily, or may give the shaft a fixed set, resulting in permanent unbalance.

The foundation for the turbine (especially if the machine is of large size) should be laid with extreme care, in order to insure absolute solidity. At certain speeds, called "critical speeds," vibration is specially likely to occur, even when none is noticeable above or below these critical speeds. In accelerating a turbine the critical speed should be passed as quickly as possible, especially if a flexible shaft is used, but except as this speed is approached the turbine should be accelerated slowly because otherwise the rotor is likely to become distorted and cause the blades to come in contact with the casing, and break. Whenever possible, the load should also be applied gradually after the turbine has been brought up to speed. Unless care is taken in these respects, troublesome vibrations may develop and persist for a long time. The present practice of nearly all steam-turbine makers, however, is to design their rotors so that the operating speeds are well below their critical speeds, and when it is known that this point has received attention by the builder, the turbine can be accelerated slowly throughout the entire range with entire safety.

Vibration is not always caused by lack of balance in the turbine itself. It may also be due to defective balancing in the electrical part of the unit, or to poor alignment of the shafting. Correct alignment is of extreme importance. Flexible couplings are sometimes employed to prevent trouble due to misalignment, but, contrary to general opinion, they do not entirely obviate it, and particularly when they are used with small high-speed turbines. Some small auxiliary turbines must be set a trifle low, because otherwise the expansion caused by the high temperature during operation with throw them out of line. Points of this kind are fully covered in the instructions furnished by the manufacturers, and these instructions should be followed absolutely.

Mis-alignment may also be caused by improper piping installations in which the piping is arranged in such a manner that an excessive load is imposed on the turbine and forces it out of line.

A large turbine should be started noncondensing, or with a low vacuum (not over 15 inches) in order that the large section of the rotor at the exhaust end may be properly warmed. At the outset a little steam should be admitted to blow out the drain water, then the throttle should be opened up further for a moment, until the rotor starts turning. The throttle should then be tightly closed and almost immediately opened again—juts enough to keep the rotor moving slowly. In this way the steam reaches all parts of the turbine, and the heating of the various sections or stages is approximately uniform, whereas, if steam is admitted in small quantities while the rotor is stationary some portions become hotter than the other portions, and this causes distortion and strain, and lays the foundation for excessive vibration later on.

In heating up a turbine the drain pipes should be left open until full speed is attained. Small turbines may require little or no preliminary warming up, and the tendency of builders is constantly in the direction of reducing the warming up period of the larger machines also, but the man in charge should never undertake to reduce the time on his own responsibility only, because he may do the turbine great harm in this way. It should be understood that these remarks about heating up are general. The builders of turbines give special directions for the warming up of each type and size of machine, and these directions must be faithfully followed in every particular.

A turbine running on a light load with the rotating parts rubbing against the stationary parts generates heat faster than steam flow can carry it away. This will cause distortion of the parts affected, and if continued for some time will seriously damage or even wreck the machine. Whenever rubbing is noticed, immediate steps should be taken to remedy it by finding the cause and removing it. Rubbing must never be permitted to go on under any circumstances.

A turbine that is out of service for some time, or that is used intermittently, is subject to corrosion from throttle leakage. It is hardly possible to emphasize the importance of this danger too strongly as it is specially harmful to a turbine to have small quantities of steam and water going through it when it is standing still, and the machine will deteriorate rapidly under such conditions.

The junctions of the blades with the disk are specially susceptible. When steam leaks in through the throttle of a large turbine it is also likely to cause distortion of the spindle on account of the uneven expansion that occurs when the steam blows in on one side. The use of brass lining strips helps to reduce corrosion from the throttle leakage, but the only right thing to do is to see that no leakage occurs. The throttle should receive careful attention, and should be kept in first class condition at all times. In the steam line of every large turbine there should be two valves with a good sized "leak-off" between them. By adopting an arrangement of this kind and closing both valves whenever the turbine is shut down, it is an easy matter to prevent damage from leakage.

Water is always likely to make serious trouble in a turbine, from whatever source it comes. (This is the case also with reciprocating engines.) It is likely to back up from the condenser unless special provision is made to prevent action of this kind. The impact due to a mass of water striking against the blades of a turbine may be very considerable if the machine is running at full speed, and it is quite likely to strip the blades or lead to vibration and other serious results. This source of trouble is pretty generally recognized, and turbines are usually guarded satisfactorily against flooding from the condenser.

Water is sometimes carried from the boilers over into the turbine through the steam supply line, and when this occurs the water is likely to do serious damage. The danger is specially great when the water comes in large quantities, as is likely to happen if the steam pipes contain pockets or loops, or are otherwise faulty in design. It is therefore advisable to install a separator of adequate

size in the steam main, just before it reaches the turbine, and special care should be taken to operate the boilers at a reasonable duty, and also to keep the steam main and all other parts of the supply system in good order. In these days of high superheating the damage to a turbine from the entrance of water through the steam main is likely to be materially greater than in the old days of saturated steam or slight superheat, because the temperature changes that are produced by the water in the turbine are far more severe, and the distortions of the revolving and stationary elements may be so bad that serious rubbing will take place. (Many engineers are of the opinion that superheated steam can never carry moisture, and hence that there can be no trouble from water in turbines using superheated steam. This is not the case, however.) In well-designed stations this can be overcome, but it is often due to permitting the water level to get too high in the boilers. In many stations automatic devices are employed to guard against this, but, like all other automatic devices, they occasionally go wrong. If a turbine is loaded too suddenly after it has come to speed, the governor will open quickly and admit a correspondingly large quantity of steam to take care of the increase in the work to be done, and when this occurs slugs of water are likely to be carried over by the steam.

Turbine accidents have occurred from leaving tools, fittings, or other objects inside the machine when closing it up after making repairs. In some machines the various parts could not be properly assembled if any sizable object were left inside, but in all of them there will be spaces in which small objects could be left with corresponding promise of trouble, and the possibility of this should be borne in mind whenever turbines are opened up for repairs or inspection.

It is extremely important in the operation of a turbine to apply constant lubrication to the bearings and to use oil of the best quality. An alarm or some other device might be used to advantage to give notice in case the supply in the oiling system falls below the point of safety. If a bearing becomes unduly heated the engineer in charge should immediately increase the supply of oil, and if this is not followed by marked improvement the turbine should be stopped and the cause of the trouble investigated. The oil wells should be cleaned out before starting the turbine, and care should be taken to see that they are kept clean. If sediment accumulates in the oil wells it is also likely to collect in the oil grooves where it may carbonize and eventually entirely fill the grooves.

It is of great importance to test carefully each and every part which runs at high speed during the operation of the turbine. The preliminary inspection of a new rotor should not consist merely of a careful examination, but a test run should also be included in the specifications. The test run should be continued for some time after the machine has become thoroughly warmed up, and the speed should be varied from ten to fifteen per cent. above the normal speed of operation. The importance of a test run of this kind, when a new machine or a new rotor is installed, cannot be emphasized too strongly.

When a turbine is opened up for inspection or repairs, the work should be supervised by a skilled man sent by the manufacturer of the turbine, until the operating engineer has become thoroughly familiar with it, and when the machine is large or complicated, the manufacturer should always be consulted before it is opened up. In removing and handling the rotor, special care should be taken to avoid injury to the blades and other delicate parts. At the time of such inspection the oiling system should be completely cleaned out and filled with new oil. After the parts have been assembled again, and before admitting steam to the machine, the rotor should be turned over by hand to see that it does not bind nor meet with serious resistance to rotataion. Inspections of the kind indicated should be made at least once a year, and every part of the turbine should be examined at such times, for defects of every kind.

In marine practice it is customary to make readings every four hours, for verifying the correctness of the position of the rotor so far as "fore-and-aft" displacements are concerned. Any error or departure from the standard position is then corrected by adjusting the nuts on the thrust bearing. Similar precautions should be taken on stationary turbines, if possible, when they are run under conditions analogous to those prevailing aboard ship—that is, when they are run with an end-thrust on the shaft, as in operating pumps of certain forms and other special machinery.

No person should undertake to operate a steam turbine until he has received thorough instruction with regard to the machine and the way it is to be used. All builders of turbines should furnish complete and detailed information on all essential points. This should be done not only by issuing printed circulars and booklets, but also, when the turbine is first installed, by supplying experienced men to give the necessary instruction, at first hand, directly to the employees who are to be responsible for the machine. These experts should remain at the plant until it is certain that the attendants are fully qualified to take charge.

The theoretical considerations involved in the operation of the turbine form a highly specialized branch of engineering, and a considerable amount of study of the subject is essential before innovations of any kind can be tried with prospects of success. For example, a turbine designed to run non-condensing should not be operated condensing except after consultation with some one qualified to express an intelligent opinion as to the practicability of the change, and a turbine designed for a constant pressure should not be used on what is called the "mixed pressure" system, unless similar care has been taken to ascertain that such change is advisable as well as satisfactory, and that suitable steps are taken to prevent a runaway. In general, the attendant should never undertake anything out of the ordinary with the machine, until he has taken counsel with somebody who has had considerable experience in such matters. Under all circumstances, he should be content to operate the turbine under regular routine conditions, which have been proved by experience to be safe.

ANCHOR ICE UPSETS CHICAGO'S WATER SUPPLY

On January 12 the water supply in the north and northwest districts of Chicago was almost completely paralyzed and a consequent suspension of industry was caused and domestic inconvenience took place. Anchor ice clogged the intakes to the water supply channels. Under tremendous handicap and danger, workmen resorted to the use of dynamite to force a pathway through the ice to affected points. The ice had blocked the water valves, cutting off almost completely the flow of water to the pumping stations. The Lakeview pumping station, with a daily capacity of 100,000,000 gallans, was crippled because three of its boilers were put out of commission.

"WHAT MAKES THE ENGINE GO"

Dear sirs, about the engine, well,
We write to let you know
We've waded through the booklet on
"What makes the engine go."
It took us close on half a day
To read through all the guff;
The engine goes alright, but don't
Keep goin' long enough.
It's very good to understand
What makes the engine go,
But why the deuce the ——— thing stops
Is what we want to know.
So now we're making this request,
While tears and curses drop:
Please send along a booklet on
What makes the engine stop.
The folks around here all await
With interest, your reply
To them the reasons why she goes
Don't seem to signify.
So while we wait and chew the cud
Don't let the matter flop;
For ———sake write and let us know
What makes the blighter stop.

—From a "Cocky" Customer.
(Censored.)

According to "Elektrotechnic und Maschinebau," special apparatus has recently been contrived to measure rapidly fluctuating temperatures such as an ordinary thermometer is too sluggish to record. At the point of measurement, wires of platino-iridium, 0.02 mm. diameter, are inserted and are connected to a galvanometer. The deflection varies with the resistance of the wires, and it is stated that variations in temperature with a frequency of ten per second may be noted. It is anticipated that the apparatus will be specially useful for studying cyclical variations in temperature in the cylinders of steam engines and combustion engines.

Electrical Energy Generating Stations---I

The Second of Several Articles Dealing With the Design of Power Plants, Both From the Electrical Standpoint and From That of the Prime Mover. Station Layout is Discussed

By TERRELL CROFT

(Copyright; all rights reserved by the author)

The Selection of the Capacities and Ratings of the Generators is a question which is always worthy of careful consideration. As a rule, in modern installations, each generator and its prime mover constitutes a complete unit. It is almost always the best practice to instal two or more such units in every plant so that it will be possible, under all ordinary operating conditions, to work at least one of the units at its most efficient load, hence, in determining capacities and ratings it is always desirable to base the determination upon the graph of the load to be imposed on the station. It is, however, seldom, possible to base the selection solely on the load graph because provision should be made for a certain growth in load.

Also the question of reserve capacity—that is, protection against accident and breakdown—should be considered.

The Rating of the Generator Should be Proportioned to the Characteristics of the Prime Mover. Both steam engine and water-wheel prime movers operate at maximum efficiency at certain definite loads. At loads greater or smaller than this maximum-efficiency load, there will be a material decrease in efficiency. With internal combustion engine prime movers (prime movers of this type have no overload capacity) the point of greatest efficiency is the maximum load which the prime mover will pull. These elements should be given due consideration.

In Providing Reserve Capacity in generating equipment, that is, capacity which may be utilized in case of a breakdown of some of the generating apparatus, there are two expedients which may be adopted. That is, reserve capacity may be provided by (1) installing an extra unit or extra units which may be operated when one of the regular units is inoperative, and (2) the overload capacity of the regular units.

*Note.**—With the method of rating engine-driven units which is generally used, which provides a liberal overload capacity for a few hours, the second expedient works out satisfactorily. For example, a plant of five units, each of which has an overload capacity of 25 per cent., can have one unit taken out of service when all of the units are operating at full load without placing an excessive load on the remaining units. It is now the almost standard practice of practically all steam-turbine manufacturers to rate their units on a maximum basis, that is, without any overload capacity. Under this method of rating it is necessary to utilize the first expedient noted above to provide reserve for emergencies. To maintain the reserve capacity at a minimum it may be desirable to have at least five or six units in the plant. With five units to carry the load and one reserve unit, there is, then, only 17 per cent. of the installation held in reserve. If one reserve unit is considered inadequate, the addition of another increases the reserve capacity to about 29 per cent. of the total.

*J. W. Shuster, "Tendencies in Central Station Practice," "Electrical Review," Mar. 3rd, 1917.

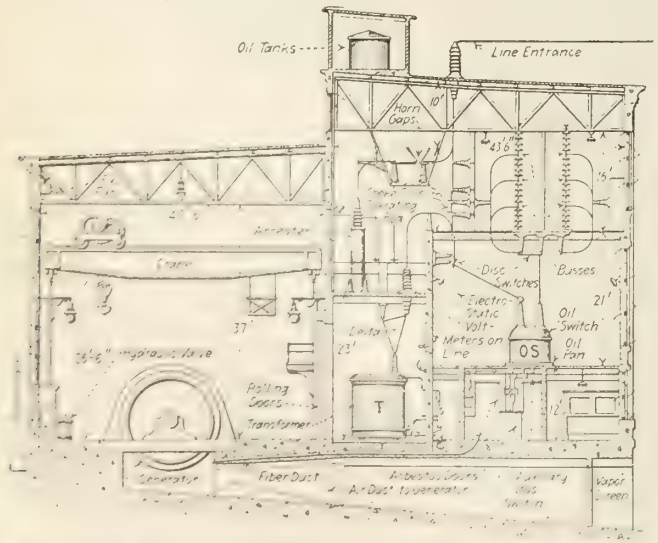


FIG. 8—SECTIONAL ELEVATION OF A TYPICAL 110,000 VOLT HYDRO-ELECTRIC GENERATING STATION.

Water-wheel and internal-combustion engine driven units have no overload capacity, hence in stations driven by prime movers of this type, reserve capacity must be provided as outlined in expedient (2) above. That is, additional units must be provided for reserve.

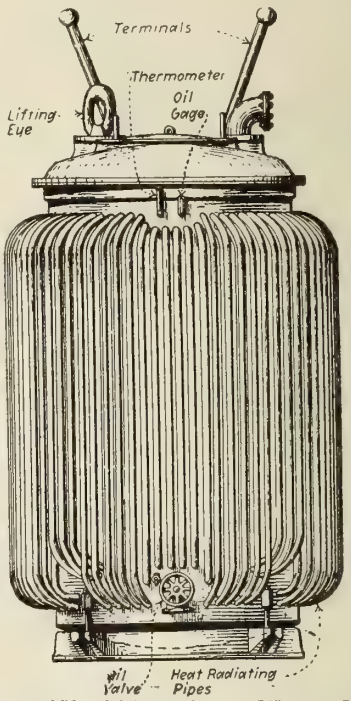


FIG. 9—OIL-COOLED OR SELF-COOLING TRANSFORMER. (This shows the tubular type.)

Low Power-factor Decreases the Effective Capacity of a Generator so that if a station is to operate at a power-factor other than 100 per cent. this should be recognized.

Example. If the power factor of a plant is 100 per cent. then for a 100 kva. generator, in such a plant, a prime mover capable of developing approximately 100 kw. output should be provided for the generator. However, if the power factor of the load which the plant serves is only 75 per cent. then to drive a 100-kva. generator a prime mover of only approximately 75 kw. output is necessary. If a 100-kw. prime mover were used approximately 25 per cent or one-fourth of its capacity would be unavailable. Furthermore the prime mover, instead of being fully loaded, that is, operating at high efficiency when the generator was fully loaded, would be operating at only three-fourths load with correspondingly low efficiency. (In the preceding example a generator efficiency of 100 per cent has been assumed.) Actually the efficiency of a generator is always less than 100 per cent., but the principle involved is evident from the above, even if the generator efficiency is not considered.

The Unit Principle should be Utilized wherever possible.

That is, all of the units in the plant should, insofar as feasible, be duplicates. The different essential elements of the installation, such as generating elements (comprising generator prime mover and its auxiliary apparatus) transformers, boilers, etc., should be arranged in groups or composite units. Each one of these groups should in essence be a complete central

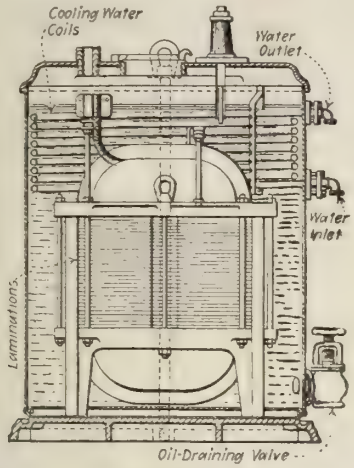


FIG. 10—THE WATER COOLED TRANSFORMER.

station installation in itself. Then, if this plan is followed, a breakdown in some component piece of apparatus should affect only the group of which that component forms a part. The other groups should be capable of uninterrupted operation.

The Factors Which Should Determine the Location of the Apparatus in a generating station are: (1) simplicity, (2) reliability of operation, and (3) extensions. Upon study, it will be evident that, in general, the unit system of arrangement described in the preceding Art. satisfies all of these requirements more completely than would any other arrangement.

In Locating the Prime Movers and Generators they should ordinarily be arranged on the main floor of the station. There should always be at least sufficient distance between units to admit a free passage around them and so that repairs can be effected without any unnecessary waste of time. In steam plants the condensers are usually located in the basement and the principal piping (Fig. 6) carried below the main floor.

The Exciters* should have a capacity sufficient for all of the synchronous apparatus in the station when all of the synchronous machines are operating at their maximum loads and at the operating power factor. It is not sufficient to provide only enough exciter capacity for excitation for the machines when they are running at unity power factor, The excitation required for power factors lower than unity is considerably higher than that required at unity.

The System of Excitation which is now considered good practice and which affords maximum reliability is that in which all of the exciting current is obtained from a common source. This common source should comprise as few units as possible. One or two units are generally provided for normal excitation

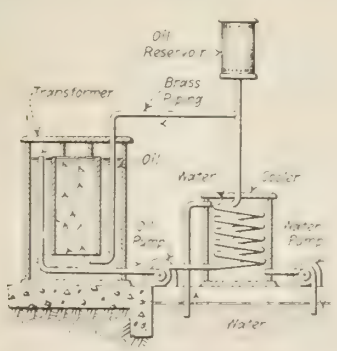


FIG. 12—THE CIRCULATING OIL-TYPE TRANSFORMER.

and a third is installed as reserve. It is always good practice to have the regular exciter driven by prime movers such as steam engines or water-wheels, while the reserve unit is motor-driven.

Note. Another system of excitation which is now being used frequently is to instal (for driving the exciters) low-voltage generators each of which is driven by a non-condensing steam turbine or a water-wheel. The exciters are then motor-driven, energy therefore being obtained from the low-voltage generator. The steam from the turbines exhausts into the feed water heaters. In addition to the exciters all of the other auxiliaries, such as circulating pumps, etc., are motor driven.

The Exciter Voltage is for small and medium sized plants 125 volts. For large installation 250-volt excitation is more economical.

In Locating the Exciters in a station it is, in general, desirable to place them near the centre of the generator room so that the excitation wiring will involve minimum cost.

Note. Where one exciter is furnished for each generator, it should be located as close as is feasible to its generator. Exciters direct-connected to their generators are often used.

Automatic Voltage Regulators are always installed in modern stations. These, by acting on the fields of the exciters, maintain the alternating-current voltage constant at the bus bars regardless of changes (within reasonable limits) of load on station or of changes in prime mover speed. Voltage regulators are usually located on or near the switchboard.

Transformers

The Number and the Capacities of the Transformers should be determined by the characteristics of the station and the load which it serves. In stations transmitting at medium or low

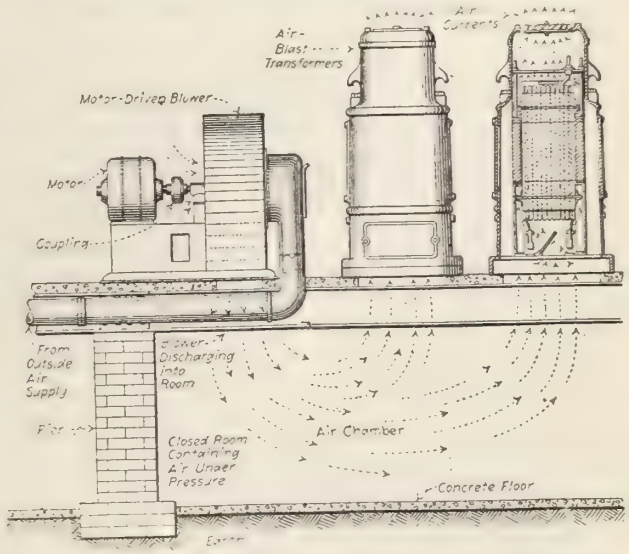


FIG. 11—AN AIR-BLAST TRANSFORMER INSTALLATION.

voltage it is usually considered best practice to instal one bank of transformers for each generating unit, following out the unit principle recommended above. However, where the transmission voltage is high, the transformer bank should form a unit with the transmission line, each of the transmission lines terminating in the station in one of these units. Where this arrangement is followed, switching on the high-tension side of the transformers is unnecessary, as all of the switching can then be effected on the low-tension side of the transformers. In locating the transformers in the station, they are usually placed (Figs. 6 and 8) on the main floor back of the generators. They are enclosed in suitable fire-proof compartments. A track is installed along in front of the tier of compartments so that the transformer may, when necessary, be readily removed for repairs.

Either Single-Phase or Three-Phase Transformers can be used. The modern tendency appears to be toward the utilization of three-phase transformers where the application of such is feasible.

Note. The conditions under which single-phase transformers are preferable are where only one group is installed or where the expense of a spare transformer is unwarranted. In such installations the burning out of one phase of a three-

phase unit involves considerable inconvenience, since the transformer would have to be disconnected before repairs could be made. If single-phase transformers are used and connected in delta (on both primary and secondary) the damaged unit can be readily cut out and the other two operated at normal temperature—58 per cent. of the rated

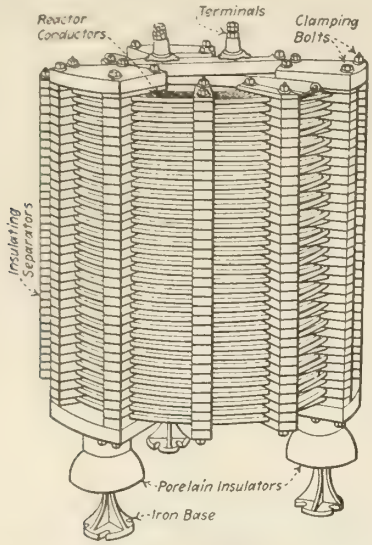


FIG. 13—A CURRENT LIMITING REACTOR.

normal capacity of the group—until the damaged unit can be replaced.

Note. With the three-phase, shell-type transformers both the primary and secondary windings are delta connected. Trouble in one phase will not prevent the use of the other two in open delta by short-circuiting both the primary and secondary of the damaged phase and cutting it out of the circuit. The magnetic flux in that section is entirely neutralized. Three-phase transformers may be used in moderate voltage installations having a large number of units. For high-voltage developments where each transformer bank should be of a capacity equal to that of the line, which it serves it is usually necessary to select single-phase transformers so as to obtain the required capacity and minimize the cost of the spare unit.

Transformers May be Either of the Oil-Cooled, Water-Cooled or the Air-Blast Type. In the oil-cooled (Fig. 9) or self-cooled type the oil, heated by contact with the transformer core and winding, rises to the top in the transformer case, from which the heat is radiated into the air. The tanks of self-cooling transformers are, therefore, usually made of corrugated sheet steel to provide maximum radiating surface. The self-cooled transformers are the most frequently used. Where water for cooling purposes is available, the water-cooled

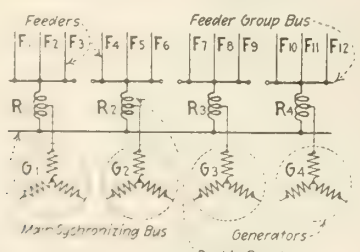


FIG. 14—SINGLE LINE DIAGRAM OF COMBINED GENERATOR, BUS AND FEEDER FROUP REACTANCE COIL.

transformer (Fig. 10) is the most economical in first cost. In a transformer of this type, the oil circulates in a manner similar to that in a self-cooled unit. However, the greater proportion of the heat is carried away by the water forced through a pipe coil which is submerged in the hottest oil in the top of the transformer. Ordinarily the water rate is approximately one-half gallon per minute per kw. loss, the temperature of the incoming water being 59 deg. Fahr. In the air-blast transformer (Fig. 11), the cooling is effected by forcing a blast of air through ducts or spaces provided in the transformer structure. Transformers of this type are applicable for voltages

*I. E. E., "Standardization Rules."

up to about 33,000 but they are being rapidly superseded by those of the self-cooling type.

Note. Circulating-oil-type transformers (Fig. 12) may be adopted where the only water available for cooling is hard or contains sediment. Such sediment might deposit on the insides of the coils of water-cooled transformer. But with the arrangement shown in the illustration, the deposit would be on the outside of the oil coils, hence read ly removed.

External Reactances or Reactors* (Fig. 13) are now used in many stations of large capacity to limit the excessive current which would flow, if these reactors were not inserted, in the case of a short-circuit on the system. It is not feasible to incorporate sufficient reactance in high-voltage turbo-generators,

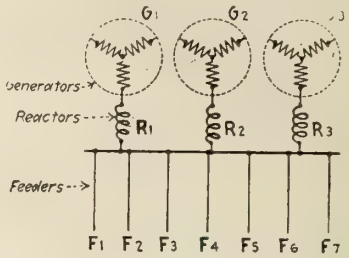


FIG. 15—SINGLE LINE DIAGRAM SHOWING REACTORS INSTALLED ON FEEDER GROUPS.

hence, with generators of large capacity of this type, current-limiting reactances may be inserted in the generator lead or between the bus sections (Figs. 14, 15 and 16) or in the outgoing feeders.

The Percentage Reactance of a Reactor** is the ratio (expressed in per cent.) of the voltage drop across it, when full-load current flows to the voltage of the system.

Example. If the full-load current is 100 amp. (on a 10,000-volt, single-phase system or on a three-phase system with 10,000 volts to neutral) the drop across a coil having a reactance of 5 ohms will be : $100 \times 5 = 500$ volts. The percentage reactance of the coil will be $100 \times 500 \div 10{,}000 = 5$ per cent. Or, if the full load current is 100 amp. on a three-phase system, with 10,000 volts between phases, then the percentage reactance of the coil having a reactance of 5 ohms will be: $100 \times 500 \div (10{,}000 \times 0.577) = 8.66$ per cent.

The short-circuit current which will flow is: 100 ÷ (the percentage reactance of the coil + the percentage reactance of the generator) × (full load current.) In the above case, if the generator reactance is also 5 per cent., the short-circuit current will be 10 × full-load current. On short circuit, the reactance will, in this case, have one-half the no-load voltage impressed across it.

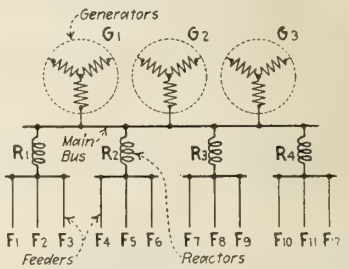


FIG. 16—REACTORS INSERTED IN GENERATOR LEADS.

The Location of the Switchboard and Switchgear should be determined by the capacity, voltage and general arrangement of the plant. In low-voltage, small-capacity plants where self-contained switchboards are used, all of the switchgear is mounted directly on or adjacent to the switchboard. The switchboard is installed in a convenient central location near one of the walls on the main floor of the station. Where the switchboard is of the remote-control type there are many different arrangements which may be used. It is usually considered desirable to so locate the control board that an unobstructed view of the station may be had from it. However, in certain very large installations, the control board is in a room entirely separate from the generating room. The bus bars and oil switches are located on the various floors of the switch house.* See Figs. 6 and 8.

THE METERING OF STEAM DESIRABLE IN POWER PLANT OPERATION

It is only within a comparatively few years that engineers have interested themselves in the metering of steam, but the attention now devoted to the efficiency of operation of industrial plants has created a demand for apparatus which will provide definite information as to the quantity of steam flowing through a pipe.

The question of steam measurement first came into prominence in connection with tests of steam engine efficiency, and the general practice was to condense the steam and to measure or weigh the resulting water. The measurement of steam—as steam— is a different matter altogether, and a far more difficult one.

Field for Steam Measurement

The most obvious field for steam measurement is when steam is sold to an outside purchaser or supplied to some department of a factory which has to keep separate costs. The power plant, as the producers, are not concerned with the efficiency with which such steam may be used, but have to be paid for what they supply. On the other hand, the consumers of steam may rightly demand that they should be charged for steam only and not for water of condensation entrained with the steam which might otherwise be debited to them. Again, in these days of large boiler plants, the engineer in charge should know how much steam each boiler, or at least each battery of boilers, produces in order to have a check upon their evaporative efficiency as affected by the kind of coal burnt, the method of firing, or the condition of the boilers. Individual water-meters on the feed lines of each boiler, even when fitted, as they very rarely are, do not adequately meet the case, for they register all water entering the boilers, including much that is not turned into steam at all but expended in blowing down, etc. Moreover, the ordinary water-meter merely counts the number of pounds or gallons which have passed and gives no indication of the rate of flow at any time. Hence there is an increasing tendency for the provision of steam flow meters in boiler houses where a high efficiency of operation is aimed at.

Numerous other cases in which the direct measurement of steam is desirable or necessary will at once occur to the mind. The steam supplied to gas producers, for example, must be measured as steam or not at all, and a large number of industrial or chemical processes use steam, the amount of which must be known by the management if the best results are to be obtained either from the process or from the steam generating plant.

Principles

Most practical steam meters are based upon one or other of two principles. Either there is a slight constriction inserted on the steam pipe so as to cause a small pressure difference on the two sides, which will vary with the amount of steam passing, or the velocity of the flowing steam is measured by a sort of Pitot tube. The actual measuring instrument can be placed at any convenient distance from the steam pipe and is connected to it by means of two small copper tubes filled with water of condensation, which transmit the differential pressure to the instrument. The latter may be constructed either simply to indicate on a dial or scale the rate of flow of the steam at any instant, or to record the rate of flow graphically on a diagram, or to integrate numerically by means of a counting mechanism the quantity which has passed in any given time. Indeed all these functions can be combined in one instrument if desired.

When the principle of the constricted pipe is employed the quantity of steam passing per unit time is taken as being directly proportional to the square root of the difference of pressure on the two sides of the constriction. This statement, however, is strictly true, only if the pressure and the superheat of the steam are constant.

The principle of the Pitot tube has found favor with perhaps the majority of inventors. In its simplest form the apparatus for determining the rate of flow comprises two tubes inserted through the side of the steam pipe, one being cut off flush with the inner wall of the pipe and the other bent so that its open end faces the flowing steam. Both tubes are equally submitted to the static pressure of the steam, but the bent one measures also the dynamic pressure due to the velocity. The difference in pressure in the two tubes is therefore a measure of the rate of flow and may be employed to operate an appropriate instrument. Several variants of this arrangement have been adopted, usually with the idea of taking into account the fact that the rate of flow is not uniform over the section of the pipe, being fastest at the centre, and slower nearer the walls. The disturbance of the flow due to the presence of the Pitot tube itself is also a factor to be reckoned with.

An alternative to the principle of the fixed orifice across which the drop of pressure is measured, consists of a variable orifice designed to create a constant pressure drop. The steam is arranged to pass upwards through the seat of an automatically lifting valve, which is therefore held in a higher or lower position according to the rate of flow. A suitable lever mechanism connects the valve with the pointer of the instrument.

Each of these methods has its advantages and its defects. A defect of the Pitot tube principle is that no convenient adjustment can be made to render the instrument suitable for the measurement of rate of flow very much less than the maximum. The reading of the instrument will be proportional to the square of the velocity of the steam in the pipe, and for low velocities the forces acting are so small that the readings are unreliable. The corresponding difficulty, in the case of the instruments depending upon the pressure-drop across an orifice, can be overcome either by inserting a smaller orifice, for which a simple provision is usually made, or by the following method. The constriction causing the pressure drop which has to be measured, consists not of a fixed orifice, but of a kind of butterfly valve which may be locked in either of several positions, according to the rate of flow. The valve is accurately made and carefully calibrated. Thus the instrument is provided with a very simple and effective means of altering its range without the necessity of interfering with the steam pipe in any way. In every type of instrument referred to, however, there is the difficulty of accurate metering when the density of the steam varies, and in all but the best instruments no provision is made for dealing with this condition.

Degree of Accuracy

Although the average steam meter at the present time can hardly be classed with instruments of the highest precision, it must be remembered that measurements of steam in ordinary industrial practice need be no finer than is possible in the case of coal or water. If, what is called "commercial accuracy" can be obtained in the metering of steam, it is as much as the ordinary engineer will demand. Given fairly steady conditions of pressure and superheat, and not too great a variation in the rate of flow, several types of meter will record the quantity of steam passing with an error of about 2 per cent., which is sufficiently accurate for most practical purposes. In the steam meters of foreign design which are now on the market, little attempt seems to have been made to compensate for the errors which must occur if there is any considerable variation in the pressure of the steam. Messrs. George Kent, however, the principal British makers, employ an ingenious automatic correction for this error, and their meters are, in consequence, highly accurate over a considerable range of pressure. The same firm issue with their meters a table by which the readings may be corrected for the density error arising from variations in superheat, but no automatic correction for this error has yet been embodied in commercial instruments. It may be taken that the best steam meters working under commercial conditions will give results correct within plus or minus 2 per cent. at loads ranging from three-quarters to full load. At half load the accuracy will be within 2½ per cent., and from one-quarter load to one-sixth load it will be within 4 per cent. Such accuracy can be obtained only by calibrating each instrument under conditions similar to those under which it will have to work, and this practice is followed by the best makers.

Mechanism of the Instruments

The mechanical methods adopted to

translate the difference of pressure due to the flowing steam, whether determined by a constriction in the pipe or by a Pitot tube, into the actual readings of an instrument differ widely. The simplest instruments of all—namely, those which merely indicate the rate of flow at an instant, sometimes do so by allowing the differential pressure to act upon liquid in one limb of a U-tube, thus causing the liquid to rise in the other limb and to indicate by its height the rate of flow which is read off a suitably graduated scale placed alongside the liquid column. Water is sometimes used as the indicating liquid, partly on account of the ease with which it is automatically supplied by condensation and partly because of the open scale obtained with very small pressures. Mercury, however, is frequently adopted. For equal pressure differences the height of the mercury column is only about one-thirteenth that of a water column, so that it is usual to magnify the motion of the mercury by a float and pulley mechanism, thus giving a large motion of a pointer exactly as in the case of the ordinary type of "weather glass." Another device consists in arranging that the column of mercury as it rises shall successively short-circuit a number of resistances through which a current of constant voltage is flowing. By suitably proportioning the resistances it is possible to arrange that the quantity of current flowing at any time is directly proportioned to the quantity of steam flowing. Thus an ordinary ammeter will serve as an indicating instrument, and a wattmeter similarly can be used for recording the total flow. The use of mercury, however, has certain disadvantages, so that other makers cause the differential pressure to act upon a spring-controlled diaphragm, the movement of which is magnified and transmitted to the pointer by means of a series of levers.

In the Kent steam meters, diaphragms similar to those used in aneroid barometers are employed, and the pressure correction device to which reference has been made above consists of another set of spring-controlled diaphragms subjected to the total steam pressure. The motion of these latter diaphragms is made to alter the leverage with which the differential pressure diaphragms act upon the pointer. The combined action of the two sets of diaphragms therefore causes the pointer to indicate the true quantity of steam which is passing, independently of changes which may take place on its pressure. In addition to recording the rate of flow on a chart these meters may be caused to integrate the quantity of steam which has passed, so that it may be read directly on counting dials. The clockwork mechanism which drives the chart also causes the periodical rotation of a spindle, which is held in gear with the counting mechanism during a part of the revolution, greater or less according to the rate of flow at the time. Other methods of integrating the flow comprise a friction wheel driven by a disc. The disc is rotated uniformly, but the revolutions of the wheel, and therefore of the counting mechanism, depend upon the radial position of the wheel on the disc. This position is controlled by the rate of flow of the steam.—The Engineering Supplement of "The London Times."

FOREWORD OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

After almost three years of painstaking investigation and discussion by the engineering fraternity, and under the guidance of Professor Comfort A. Adams as chairman, the revised constitution of the American Engineering Standards Committee, along with the by-laws and rules of procedure, has been adopted, and has been ratified by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, and the three Government departments of Commerce Navy and War. Each of these interests have three representatives, and although the committee as it exists to-day consists of twenty-four members, the new committee is of very wide scope and allows the direct or indirect participation of any one interested in standardization.

The American Engineering Standards Committee makes it possible to give an international status to approved American engineering standards and to co-operate with similar organizations in other countries. Similar organizations are now functioning in Great Britain, France, Switzerland, Holland and Canada.

Through the new committee the methods of arriving at engineering standards will be unified and simplified, and, by co-operation, the duplication of standardization work will be prevented. Standards will not be created without giving all interested an opportunity to participate.

The approval of a standard by the American Engineering Standards Committee does not mean that the committee has itself worked over and approved each detail, but rather that the work has been carried out by a sectional committee adequately representing the industry concerned and sponsored by one or more bodies of ability, experience and standing, so that the result may stand for what is best in American engineering practice.

What the Committee is Doing

The American Engineering Standards Committee is not only ready for business but it has made considerable practical headway. It has approved specifications for standard pipe threads, for which the American Society of Mechanical Engineers and the American Gas Association are sponsors, and are representing America on this subject at an international conference in Paris. Co-operation is in progress with the National Screw Thread Commission authorized by Congress and composed of representatives of the various technical societies, looking forward to standard screw threads. Through this agreement direct co-operative work with the British, which is not possible by the official commission, is being carried out. The committee is also in active co-operation with the Canadians on bridge specifications, with the British on specifications for machine tools, and with the Swiss on specifications for ball bearings. In each case the detailed work is being carried out by sponsor bodies by means of sectional committees.

A large conference, in which practically all national organizations interested in industrial safety, has unanimously voted that all industrial safety codes should be prepared under the auspices of the American Engineering Standards Committee.

Now that the organization of the committee has assumed such definite and precise form, no doubt its activities will be greatly extended and accelerated.

How the Committee Operates

Any organization may request the committee to approve standards which it has formulated or to approve committees that it has appointed, and by so doing becomes a sponsor society. Two or more organizations may act as joint sponsors. Approval of a standard is given when it is the substantially unanimous conclusion of a section committee made up of representatives of producers, consumers and general interests, and so selected that all interests concerned have adequate representation on the section committee.

It is understood that a standard must be referred to as that of the sponsor, using whatever title the sponsor has given it, followed by the statement: "Approved by the American Engineering Standards Committee." The approval may be given in one of three ways: Recommended practice, tentative standard, or American standard.

Any standard or group of standards adopted by any organization or in process of preparation prior to January 1, 1920, may be approved by the committee, if in the opinion of the committee it has either been developed by a properly constituted committee, or has, by actual practice, proven its right to become a standard.

In addition to the work of assistant in the selection of committees and certifying that their work has been done under proper conditions, the committee will act as a bureau of information regarding standardization. It will collect information regarding existing standards and as to the bodies that have formulated or adopted them. This will enable it to properly give the data to those who select a committee to formulate a new standard or revise an old one.

Provision is made for direct representation on the American Engineering Standards Committee, of additional organizations (or groups of organizations) interested in engineering standardization. Already several important additional organizations of national standing have applied for membership on the committee.

The Operation of Pump and Injectors

The Following Article Gives Information Regarding Pump Principles and Operation Which Should Prove to be of Interest to the Tyro Desiring a Knowledge of the Subject

By LLEWELYN

PUMPS may be divided into several classes, reciprocating, rotary, and centrifugal. Those of the reciprocating class which have one or, more cylinders are named simple, duplex, triplex, etc., according to the number of cylinders. Some are single acting, others double, that is, they either force water into the boiler or discharge pipe during one or, both strokes. They may be horizontal, or vertical, belt driven, gear driven or connected direct to a steam cylinder. Some pumps have pistons, others plungers.

Our young men who are preparing themselves for their examination, to obtain a certificate, will do well to get all the information they can on pumps. The boiler feed pump is one of the most important things in the boiler room, and

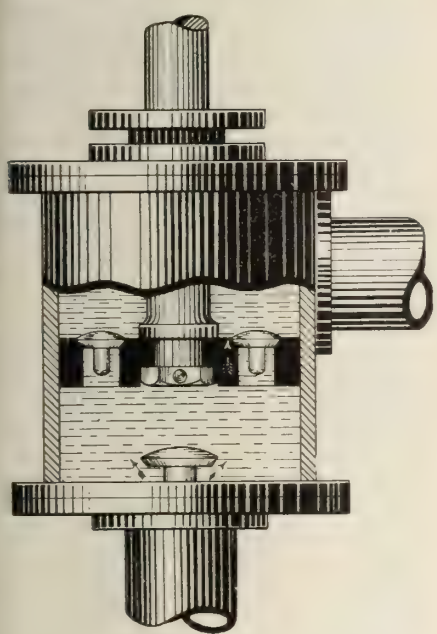


Fig 1

should be thoroughly understood, not only boiler feed pumps but every kind, suction, lifting, force pumps, etc. Examiners, as a rule, shoot over quite a number of interesting questions in regard to pumps in general.

A suction pump is shown in Fig. 1. You will notice that it has a valve of the non-return type in the suction pipe, and one or more similar valves in the piston, or bucket as it is sometimes called.

Do not tell the examiner that a suction pump works by suction unless you understand just what is meant by suction. Webster, in the Collegiate Dictionary, says. "Suction is drawing by exhausting the air."

In the type of pump shown in Fig. 1., the piston with the valves closed on the suction stroke forms a partial vacuum behind it in the cylinder and the pressure of the atmosphere causes the water to rise in the suction pipe through the suction valve into the cylinder. At the end of the stroke the piston starts to descend, closing the suction valve, and forcing the water through the valves in the piston. On the next stroke the water that has passed through the piston is discharged through the discharge pipe, the piston at the same time is now making its second suction stroke, and so on.

An important point to bear in mind is that the pressure of the atmosphere will only sustain a column of water a certain height, hence, it follows that the greatest distance that the piston should be (when at the top of its stroke) from the surface of the water is about 28 feet, though the atmosphere is said to balance a column of water some 33 feet in height, allowance must be made for any air leaking through the valves, the weight of the suction valve, etc.

If it is necessary to raise water from a greater distance, a lifting pump is used, the action of which is the same as the suction pump, with the addition of a non-return valve in the discharge pipe, to prevent the return of the water. The pump itself is located within the 28 feet from the water and the delivery pipe brought up to the height where the water is to be discharged.

The action of a suction pump and lifting pump are practically the same and are generally considered separate simply because the suction pump discharges at the pump level, and the lifting pump above the level of the pump.

Another form of pump is the force pump, Fig. 2 and 3, which has no valves in the piston but on the suction and delivery. A plunger instead of a piston or bucket is used when it is necessary to force water against heavy pressure, this obviates the necessity of keeping a water-tight piston which is difficult to do against high pressure.

The number of different designs and size of pumps on the market are legion and a description of each is not at all necessary as it is the principal upon which they are all based is the important point, and though simple, quite a number of important points occur when in operation.

Boiler feed pumps, in the majority of cases, are direct driven, that is the plunger or piston rod from the pump is connected on the opposite end to a piston working in a steam cylinder, and may be single cylinder, duplex or multiplex. A duplex pump which is used extensively consists of two steam cylinders and two water cylinders. The steam valves on the one side are operated from the opposite side and vice versa. The suction and delivery pipes are common to both pumps.

The chief points in considering a boiler feed pump are, that they should be large enough, having a capacity of at least 1 cub. foot of water per horsepower per hour, should be quiet in operation, economical in steam consumption, have no dead centres, and as few parts as possible.

If the suction pipe is long it should be provided with a foot valve on the end just above the strainer. Both suction and delivery pipes should be kept as large as the openings in the pump permit, should be free as possible from bends, and all joints well made, especially on the suction pipe, for if these are not air tight, trouble will be the result.

In fact, providing there is a good

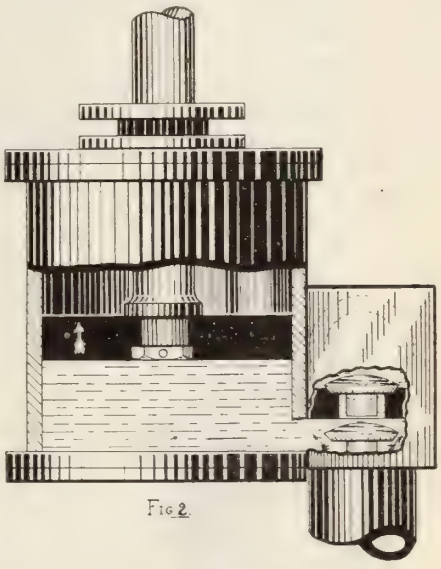


Fig 2

supply of water and sufficient power to move the plunger a pump fails because of one thing only, and that is, there is a leak somewhere, either in the suction pipe, in one or more of the valves, or the piston, etc. It is very important that you locate the trouble quickly when your pump fails. By opening the petcock on the side near the bottom of the pump and noticing if water is discharged through it on the discharge stroke only, or both suction and discharge strokes, or on neither suction and discharge. If on neither stroke your pump is not getting water, either through a leaky suction pipe, leaky piston, suction valves may be stuck, or the supply shut off, or water too low in the well. Again, if you get a good force of water at both strokes your check valve and discharge valve may be leaking or prevented from returning to their seats for some reasons,

perhaps some foreign substance is lodged on the seat, such as a match stem, chip of wood, piece of old packing, etc. If your water is too hot your pump is almost sure to give trouble, if not fail altogether by becoming steam bound, as a pump will not lift hot water but generally pounds badly, and the partial vacuum formed by the plunger is immediately destroyed by the vapor occupying the space.

If it is necessary to pump hot water then have the pump so located that the water will flow into the valve chamber, that is, put the pump below the source of supply.

A suction air chamber is a useful addition if the suction pipe is long or the pump is running at high speed, as it not only prevents pounding but assists in enabling the pump barrel to fill up when running at high speed.

A suction air chamber can easily be made with a piece of pipe the same size as the suction pipe, about two or three feet long, with a cap on top, attached in an upright position to the suction pipe close to the pump.

The delivery air chamber, which should not be less than about five times the area of the water cylinder, also assists the pump by virtue of the air compressed there in forming a cushion, which acts on the delivery valves and also causes a more steady flow in the discharge.

For good results the velocity of flow in the suction pipes of boiler feed pumps should not exceed about 200 feet per minute for small pumps. 400 feet per

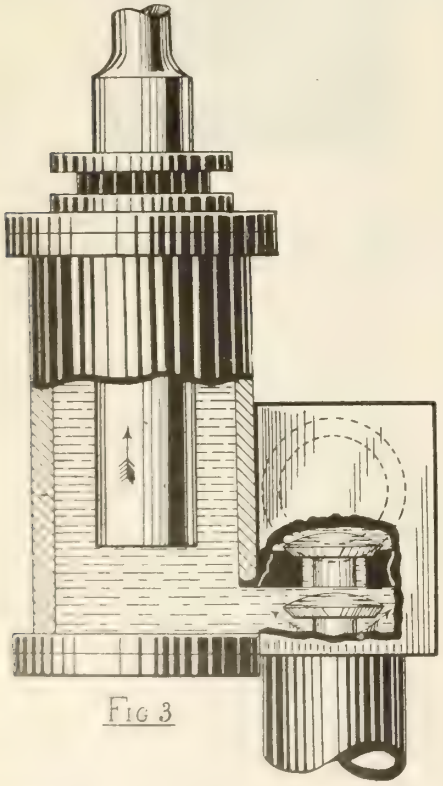


FIG 3

minute for a single cylinder, and 500 feet per minute for a duplex pump.

In calculating the power for a pump the number of foot pounds of work to be done by the pump must be considered, the boiler pressure it has to work against, the suction lift, and an allowance made for friction, etc. The suction lift being known, convert the boiler pressure into its equivalent head of water in feet by multiplying it by 2.31 and add to the suction lift, then, with the weight of water to be pumped, the foot pounds of work to be done can easily be calculated. As an example, a boiler has a pressure of 100 pounds per square inch, and the suction lift is 15 feet; you wish to find what horsepower it will take to put in 625 gallons. Then $2.31 \times 100 + 20 = 251$ feet head; 625 Imperial gallons weigh 6,250 pounds, and $251 \times 6{,}250 = 1{,}568{,}750$ foot pounds. One horsepower = 33,000 foot pounds; $1{,}568{,}750 \div 33{,}000 = 47.54$ horsepower nearly; allowing 25 per cent. for friction, etc., $47.54 + 25$ per cent. $= 59.425$ horsepower. That is to do the work in one minute. If one hour is taken to do the work it will require $\frac{1}{60}$ the power, or about 1 horsepower.

Again, if you wish to find the size of feed pipe required for a boiler when a duplex pump is used, allowing a velocity of 500 feet per minute, divide the velocity, viz., 500 into 19.25 times the number of gallons per minute for U. S. gallons, or 23.1 for Imperial gallons. Thus, to pump 50 U. S. gallons into a boiler a minute, $19.25 \times 50 \div 500 = 1.925$ sq. inches area of pipe.

And further, to find the number of gallons passing through a pipe in one minute, multiply the velocity in feet per minute by the area of the pipe in square miles and divide by 19.25 or 23.1 as the case may be.

The velocity of flow may be found by multiplying the area of the water piston by its speed and divide this by the area of pipe.

In the Province of Ontario it is necessary to have two separate means of supplying feed water (Sec. 121), and the injector is used to such an extent that the student should be cognizant of its general principles. Fig. 4 shows one form which will serve our purpose for the present.

The action of the injector is based on the fact that the amount of work a moving body can do in being brought to rest varies as the square of the velocity.

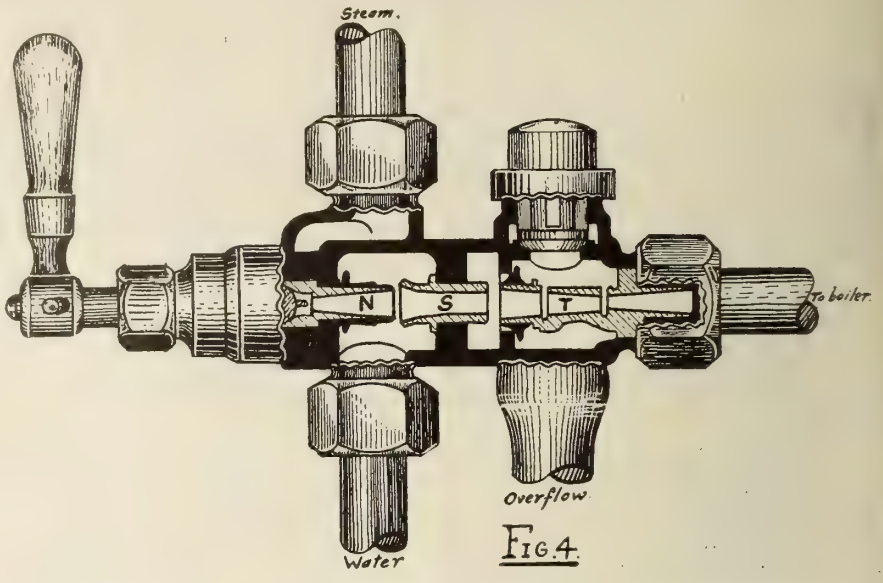


FIG 4

The steam from the boiler in passing through the steam nozzle N has its pressure reduced, first owing to the shape of the nozzle and second by coming in contact with water of a low temperature. This immediately gives the steam a high velocity and great kinetic energy, which creates a partial vacuum in the water space, inducing the water to pass through the suction jet S on to the delivery tube T with sufficient force to overcome the resistance of the boiler pressure in the feed pipe.

It is evident that unless the steam is condensed the injector will not work, and much trouble with injectors is caused either by giving the injectors too much steam, especially if the pressure and consequent temperature is high, or, if the feedwater is too hot, unless you throttle the steam a little.

Like pumps, injectors are affected in various ways—a leaky suction, too hot feed water, or the flow retarded by an accumulation of mineral deposit from the feed water.

It is important in the operation of an injector that the size of jet remains unaltered, this size is determined in the first place by the manufacturer, and much trouble has been caused by carelessly reaming or scraping the jet to remove the scale deposit, making the jet much too large, thus reducing the efficiency. It is far better to use a solvent to remove the scale such as dilute muriatic acid or some other scale remover.

An injector is a good way of feeding a boiler providing that a suitable one is selected for the condition under which it has to work, and care is exercised not to subject it to careless treatment.

Injectors are also used for many purposes beside feeding boilers, such as raising water from excavations during construction work and in mines for draining certain places, etc.

The Stationary Engineer, His Position and Future

The Following Article Gives a Clear Resume of the Present Trend of Engineering Practice and of Future Developments. The Various Means by Which the Engineer Can Keep Abreast of the Changing Knowledge Required of Him Are Also Indicated

By M. B. WATSON, M.E., Director of Engineering, Toronto Technical Schools

THE progressive advertising and educational campaign of the Electrical interests in this country, and especially in Ontario, has resulted in the scrapping of many of the stationary steam plants during the past decade. If this electrical replacement of steam power continues for the next decade, as it seems likely to do, it would appear that a large number of the steam engines now operating will be lying idle or sold for scrap, while their boilers may be used to a limited capacity for heating in the winter season. When this condition comes how are the large number of stationary engineers, now operating engines going to be employed? The positions to which they are promoted, or drift back, are dependent in each case on the individual characteristics and capabilities of the engineer.

The engineer, or more properly engine driver, who can not take charge of responsible work other than in connection with his steam plant, will naturally be left in charge of the boilers as far as they are used, and as they will likely be used only for heating purposes, he will probably have charge of the radiators, ventilating fans, etc., but is this the kind of work an engineer wants? This amounts to becoming an assistant janitor, and naturally is not as important a position as he holds at present and consequently will not demand as high a salary. No. The real engineer does not want this kind of a position. He wants a real job with big responsibilities; not helping out with any sort of odd job except in the heating season.

The reasons for the imminent replacement of a large amount of steam power are obvious. Some of them are: The relative cost, especially in the small and medium sized plants, is greatly in favour of electricity in most localities. The uncertainty of adequate fuel supplies and the instability of its cost. The cleanliness, convenience and sightliness of electrical distribution systems and individual drives for machines, as compared with the mechanical distribution of power, and the saving of power incidental thereto. The immediate availability of any part or the whole of the load capacity, independent of conditions in the boiler room or other parts of the factory .

The above advantages can not be disputed, but many of them may be qualified to a certain extent as follows: In the matter of cost it may be shown that where low pressure steam is required for heating or manufacturing purposes, power can be generated by steam, using the exhaust for the above purposes, at a lower cost than it can be purchased in most districts. As to the uncertainty of fuel supply, fuel must be used for heating in any case. With exhaust steam heating systems, less than five per cent. of the heat value of the steam is used in the generation of power, thus if this system is used less than five per cent. extra fuel will be required than will have to be purchased in any case. The cleanliness etc. of electrical systems can be retained where the steam engines are used to drive electric generators, and the electrical distribution and individual drive be used. As to availability, during the heating season steam must be kept up in any case thus having the power instantaneously available besides, power companies cannot guarantee an absolutely constant supply of power on account of accidents, storms, etc. However, let us leave the advantage with the electrical system. How can the present engineer be employed to escape becoming a janitor or handy-man-about-the-place? The supplanting of many steam plants may be inevitable, but the scrapping of engineers is not.

The word ENGINEER is derived from the latin word ingenium meaning ability and skill in invention or production. From the same source comes the word ingenious. Thus a real engineer must have ability, skill and ingenuity. If he has these qualities when his steam plant is closed down he will be able to take charge of any or all of the following work. The complete charge of the heating system and the ventilation, this requires a complete knowledge of the principles upon which the complete systems and each part work. Having this knowledge, he can at once locate and remedy trouble, or could design and install correctly a similar system. This means that he will be in a position to take charge of extensions or changes for his employers, instead of calling in outside experts, as probably would have been done if he were still occupied operating engines. He should also be competent to take complete charge of the electrical system in the plant, to repair same or install additional equipment, and be able to advise his employers intelligently regarding requirements, sizes etc. of equipment. This requires a fair knowledge of electrical construction and electrical machinery, also any government or underwriter's regulations under which same may be operated. In refrigerating plants, he must understand their principle as well as their operation to efficiently take charge of their repair, extension or alteration etc., without outside expert assistance. He should be able to calculate their capacities and give reliable advice regarding extensions etc. to architects, employers, etc. He should have a good understanding of general machinery and machine work, that he may be able to look after the operation and maintenance of any types of machinery used in his plant. He should as well be able to estimate closely the labor and materials required for extensions or alterations in his part of the plant, and to offer sound advice on the selection and purchase of further equipment. If the engineer can prove to his employers that they might save a great deal of power and money by continuing to operate the steam plant, especially in the winter, he is not only saving money for the firm, but assisting in the conservation of the country's resources, and strengthening his own position with his employers as well as helping the power companies over their peak load season which is caused in the winter by the overlapping of the lighting and power loads, and the large amount of electric heating employed.

Thus it appears that the engineer who anticipates this change or power conditions, and who prepares himself to handle expeditiously duties such as those mentioned above, will be given more authority, responsibility and salary, instead of drifting into a mere coal heaver and handy-man.

In the Province of Ontario, in view of the recently enforced Regulations respecting the grading of Stationary Engineers, many of these engineers must do considerable studying to retain as good or better positions as they now hold. While doing this it would be folly to overlook the prospects for the future, and do only sufficient studying to pass the examinations. Engineers must keep it up in order to progress and become a recognized standard among engineers of the world.

To accomplish this result it is up to each individual engineer to get out after the required education and training. There are numerous ways of doing this. The practical work required can be got on your own job or in your own factory; but to understand the principles and apply them scientifically to your work, a certain amount of technical information is necessary. This technical knowledge can be got privately from books, or much more easily at one of the Technical schools of night classes throughout the country, or by correspondence courses from the better Engineering colleges. The technical press is also one of the

greatest aids the engineer can have in the educating of himself for better things.

It can be seen from the above that to get along an engineer must have a complete fund of engineering knowledge at hand and the power to apply this knowledge to his own problems. How many of the stationary engineers in this country could successfully carry out work as suggested above? The answer would be a very small proportion. This condition can only be remedied by a comprehensive scheme of practical and technical education, but the engineers must come after it. It will not hunt them out and force itself on them. It is generally understood that the authorities controlling the above conditions and preparing for it by requiring a more general and diversified knowledge of engineering and a larger amount of business ability and technical training. It is thus those who apply themselves, and do more work than they are actually paid for in so many hours in the engine room, who will progress when the number of qualified steam engine operators is in excess of the demand.

Reader's Query

WE have received a request for information concerning the horsepower of an engine flywheel. Before entering into the mathematical side of the question it may be well to define the two terms horsepower and energy, for they are not synonymous, and the use of the term horsepower in speaking of a flywheel, except in a very restricted sense, is not strictly accurate.

Consider energy first. Energy may be defined as the capacity for doing work, and in speaking of material objects this energy is inherent in the object by reason of its position in space or by virtue of its velocity. Intimately associated with energy is also the idea of force. Force in some cases may be due to the weight of an object as when we say a pound weight exerts a force of one pound on a table or other support, or force may mean the stress in a body as when we say a belt has a tension of so many pounds.

It is now possible to examine what is meant by the term energy, and when energy is considered it may also be well to consider the term work. Let us suppose we have a weight of one pound resting on the floor and that we raise this weight three feet and place it on a table. We have done two things: first of all we have done some work on the object in raising it the three feet. The work done is simply defined by the product of the amount of weight lifted and the distance through which it has been raised in this case the work done will be three foot-pounds, a compound unit.

We have also increased the available energy of the weight for we have placed it in a position where it is capable of doing more work. If it were pushed off the table it would do work on the floor, denting it and making a noise. The amount of energy we have added to the weight equals the work done, or three foot-pounds. To this type of energy the name potential energy is given, since it has a capacity for doing work when conditions are right for the release of the energy.

Other forms of potential energy will occur to the reader: explosives, a steam boiler under pressure, a lake at a considerable elevation, etc.

Another form of energy is possessed by a moving body, since by reason of its weight and velocity it is capable of doing work. Our one pound weight will here again serve as an example. At the instant of starting to fall off the three-foot table it possesses three foot-pounds of potential energy and no kinetic energy. When it has fallen one foot it only possesses two foot-pounds of potential energy (since it has two more feet to fall) and one foot-pound of kinetic energy. At the instant of striking the floor and before its velocity is destroyed it possesses no potential energy and three foot-pounds of kinetic energy. When it has hit the floor no energy of any kind remains, and work to the extent of three foot-pounds has been done.

Work may be defined as force through distance, since if a piston works through three feet against a pressure of 1,000 pounds, work to the extent of 1,000 x 3 = 3,000 foot-pounds has been done. So far we have only considered two things, force and distance, and when we speak of power we must take heed of a third—time.

We might do 3,000 foot-pounds of work in sixty minutes, or it might take us just one. In the latter case the power exerted would be just sixty times that in the former.

Power is time rate of working and always includes the idea of work (foot-pounds) and time. When we speak of horsepower we are speaking of a particular unit devised by Watt for power measurement. One horsepower simply means the doing of 33,000 foot-pounds of work in one minute, or 550 foot-pounds in one second.

A fly-wheel acts as a store house of energy, and in doing so, serves to smooth out the speed of an engine. During a certain portion of the stroke, in passing the dead centres, the flywheel uses some of its energy in doing work and maintaining the speed of the engine nearly constant. This work is done at the expense of its own speed and it slows down slightly. When the expansive force of the steam comes into play, the flywheel is speeded up, work is done upon it and energy is stored up in it.

It would be quite possible to say that the flywheel has a certain horsepower which is exerted at some parts of its revolution but the term would have little meaning and calculations as to the weight necessary are more simply made without the definite use of the term horsepower.

It would also be quite correct to say that the flywheel would have a certain horsepower if the steam were cut off and the engine allowed to slow down under the action of the flywheel. But under running conditions the flywheel is not an instrument or mechanism for supplying power beyond the engine. Its only use is to smooth out the fluctuations in the power supplied by the piston and to make operation possible and the speed more uniform.

The stored energy of a flywheel is a perfectly definite quantity and depends upon its weight, speed and the disposition of the weight in the flywheel. Heretofore we have been dealing with height or distance fallen through instead of velocity when speaking of energy and the introduction of velocity complicates matters somewhat.

A falling body under the influence of gravity always has a certain velocity at each instant through its flight and this velocity varies continuously, increasing all the time. This is due to the force of gravity which accelerates the velocity according to a definite law. The relations between the different properties of a falling body are all expressed by means of a few simple equations and in these the weight of the body has no influence whatever.

If we know the velocity which a body has at any instant we can easily find out the distance it must have fallen through to attain that velocity. In the case of a rotating body it is also possible to figure out by the same equation what distance a portion of the flywheel or other body would have to fall to attain the same velocity.

The equation referred to is:

$$h = \frac{v^2}{2g}$$

where h = the height in feet fallen through
v = the velocity in feet per second
g = the acceleration due to gravity = a constant which may be taken as 32.2.

To find the energy stored in a moving body it is only necessary to multiply the value for (h) found above by the weight in pounds and the result will be expressed in foot pounds or

$$E = \frac{wv^2}{2g}$$

where E = energy in foot pounds
W = weight in pounds
and the other units are as before.

This formulae applies without change to the case of a body moving in a straight line but when applied to a flywheel certain reservations are necessary.

These have to do with the velocity v^2. It might be asked where this velocity were to be taken—whether at the face of the wheel, the average radius of the rim or elsewhere, for all points on any radius are moving at different velocities. Again the disposition of the weight affects the problem somewhat, since the same weight concentrated in a heavy rim would be of more value than if distributed throughout a lighter rim and heavier arms. This is

the case and to enable these factors to be taken into account formulae are derived which take these factors into consideration (see Kent, 9th Edition, page 529)

As an approximation, we may take the formulae given above and may assume W = to the weight of the rim; $\sqrt{}$ = to the velocity of the flywheel at its mean radius and the remaining symbols as before. Their own result will be fairly close to the correct result for the stored-up energy in a flywheel.

Operating Features of Carbon Dioxide Recorders

THE most insidious and possibly the greatest single cause of waste of fuel in the ordinary boiler plant is the excessive amount of air which usually finds its way into the furnaces and other parts of the boiler setting. The reduction of pressure inside the setting due to the chimney draught causes the cold air to rush in through every crack and crevice it can find, and it even filters through ordinary brickwork in appreciable quantity. The consequence is that far more enters than is necessary for the proper combustion of the fuel, and this excess air lowers the furnace temperature, absorbs heat which should be given up to the boiler, and goes up the chimney, carrying away this heat to waste. Further than this, it spoils the draught both by cooling the flue gases and increasing the chimney resistance. Its harmful effects upon economy are frequently overlooked because its presence is invisible, yet so serious are they that in most boiler plants a very material saving of fuel might be effected by a proper attention to the exclusion of superfluous air.

While much may be done by the exercise of common sense, in filling up cracks in the boiler setting, making air-tight joints between the brickwork and the boiler drums, seeing that inspection doors are tight, that excess air cannot get in around mechanical stokers, and in the numerous other ways which will occur to everyone familiar with boilers, experience shows that the best results cannot be obtained without some means of determining whether the efforts made are really adequate. The crucial test is the composition of the flue gases leaving the boiler. If these are diluted with air, it is clear that excess air is entering the setting, and many an engineer who prides himself upon the condition of his boiler plant has been disagreeably surprised at the unsuspected air leakages which a test of his flue gases has disclosed.

Composition of Flue Gases

If the combustible portion of coal consisted of carbon only, and if exactly the proper amount of air were supplied for combustion, it is obvious that the flue gases would contain 21 per cent. by volume of carbon dioxide, as this is the percentage volume of oxygen contained in the air. But account must be taken of the hydrogen contained in the hydro carbons, which also requires oxygen for its combustion. If the hydrogen content is taken at 5 per cent., which is about the figure for bituminous coals, we shall have oxygen equivalent to only about 18 per cent. of the air available for the burning of carbon, so that 18 per cent. may be considered as the maximum possible percentage of carbon dioxide which can be obtained with ordinary coal. The remaining 82 per cent. of the flue gases would be composed of nitrogen and water vapor.

Combustion as efficient as this is, however, impossible of attainment in practice because owing to the physical nature of the fuel-bed, a certain excess of oxygen is necessary to prevent some of the carbon dioxide from being reduced to monoxide in its passage through the bed and passing away as such in the flue gases. This incomplete combustion must be avoided because it involves a very serious waste of fuel, a pound of carbon producing only about 4.350 B.t.u. when burnt to monoxide, as compared with 14,540 B.t.u. when burnt to dioxide. The problem before the engineer is to limit his air supply to the smallest amount compatible with the absence of carbon monoxide from the flue gases, as every cubic foot of air more than is absolutely necessary serves only to cool the boiler and to spoil the draught.

The Orsat Apparatus

There has been on the market for many years an apparatus by which a simultaneous determination of the principal constituents of the flue gas may be readily made. The Orsat apparatus, as it is called, consists of three glass vessels containing solutions which will absorb respectively carbon dioxide, oxygen and carbon monoxide. A sample of the flue gas is brought into contact with the various solutions, and the percentage of each of the constituents named can be read from the height of liquid in a graduated tube. This apparatus gives invaluable quantitative information as to what the conditions are when the test is taken. The presence of carbon monoxide indicates too little air for proper combustion, while that of free oxygen denotes that more air than necessary is passing through the furnace. The highest percentage of dioxide which is consistent wtih the absence of monoxide is the ideal to be aimed at, and when once this is determined the conditions which provide it should be maintained continuously as far as is possible. The state of the fire and the quantity of air passing through it, are, however, changing constantly, and it would be quite impracticable to keep a continuous check upon efficiency by means of an Orsat apparatus. Something much simpler is necessary for practical use, and a large number of instruments have been developed which will automatically test the quality of the flue gases and make a continuous graphic record of the percentage of carbon dioxide they contain.

All the instruments on the market depend for their operation upon the principle of absorbing the dioxide from a sample of the flue gas, usually by means of a solution of caustic potash, which has a great affinity for carbonic acid. Sometimes the caustic potash is used in the solid form, while in one instrument its place is taken by ordinary quicklime, which has similar absorbent properties. The methods by which the sample of gas is measured and brought into contact with the absorbent vary considerably. A common device is to allow a flow of water to trickle continuously into the instrument. When a container becomes full it is suddenly emptied by a siphon action, and draws in a measured sample of the flue gas. This is then automatically put into communication with the chamber containing the caustic solution, and the sudden diminution of its volume, due to the absorption of the dioxide, is measured by the descent of a kind of gas-holder in which it is contained. The motion of the gas-holder causes a pen to draw a line on a chart, the length of the line being proportioned to the percentage of dioxide. This cycle of operations takes place every few minutes, according to the rate of the flow of water.

Instead of measuring the diminution in volume corresponding to the dioxide which is absorbed, some inventors have utilized the reduction of pressure caused by the absorption to indicate the percentage present. A small current of flue gas is continuously drawn through a chamber containing the absorbent by means of a steam jet aspirator. The elimination of dioxide causes a reduction of pressure in the chamber, which is measured by a manometer or any suitable form of pressure gauge. This method provides a continuous record, and has also the advantage that the recording instrument may be situated at any reasonable distance from the boiler-room if desired. An alternative plan is to draw the flue gases through a chamber in which the absorbent is covered by a porous pot. The reduction of pressure inside the porous pot is then utilized to work the manometer. In both these types, however, the consumption of the absorbent is greater than when an intermittent test only is made, and the use of a steam jet is also regarded as wasteful.

Yet a third principle of determining the carbon dioxide contents has been developed, which is attractive in some respects. In place of measuring either the shrinkage of volume, at constant pressure, of the drop of pressure at constant volume when the dioxide is removed, the flue gas is passed through two ordinary gas meters, one before absorption and one after. The second one will work more slowly as it has naturally less to measure. The difference in their speed is recorded by a differential gear which operates the pen producing the record. In this type of instrument dry calcium hydrate forms the absorbent, and the gases are drawn through the meters by a water jet.

It is by no means unusual to find a boiler plant being operated with not

Continued on page 99

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII. TORONTO, Feb. 20, 1920 No. 4

PRINCIPAL CONTENTS

A Direct Acting Explosion Pump 73
The General Fuel Situation in Canada 76
Operating Features of Steam Turbines 78
Energy Generating Stations 82
The Metering of Steam 85
The Operation of Pumps and Injectors 87
The Stationary Engineer, His Position and Future 89
Carbon Dioxide Recorders 91
Editorial 92
New Equipment 94
Operators' Point of View 96
Selected Market Quotations 44

Fuel Alcohol

IT has been said that the fuel resources of the world both as regards coal and oil are sufficient unto the present day and that regard for the comfort and convenience of future generations is a bit too altruistic. In other words we should trust to a kind Providence or to man's ingenuity and inventiveness for the circumventing of a future shortage of coal. While this is true and while it is also true that the present known resources in the way of coal and oil will last for some little time to come it is also true that long before exhaustion takes place, prices will have advanced to such a point as to render conservation in the strictest sense advisable.

To-day even coal and oil are far more expensive than anyone thought possible a few years ago and increasing attention is being given to other forms of fuel.

Low grade lignites and other material formerly of little value are now being used and industrial alcohol is being recognized as a cheap and valuable fuel for the internal combustion engine. The Advisory Research Council in Canada published a report on the use of industrial alcohol some little time ago and a recent report states that the Dominion Government is contemplating the removal of restrictions on its manufacture and will free it from excise duties.

The importance of this step can scarcely be overestimated, for the production of alcohol may be likened to the use of our waterpowers—water over the dam is lost forever and undeveloped waterpowers have to be paid for in the use of fuels which when once mined can never be replaced. In like manner the raw materials from which the alcohol can be obtained are now wasted, wood waste is allowed to rot or is burned, vegetable waste of the farm or city garbage is treated similarly and the sulphite liquor of the pulp mill is turned into the nearest stream to the pollution of the waters and the injury of all aqueous life. This latter source of alcohol, in passing, would provide an enormous quantity of alcohol for industrial purposes at a very reasonable price.

Probably the greatest immediate use for alcohol would be in the form of motor spirit and in this alone its use would render Canada more self contained, rendering her independent of foreign sources of supply, incidentally to the material benefit of the exchange situation. Tests have shown that alcohol is an admirable source of heat energy and any engine at present using gasoline may be run equally well on alcohol, although an increase in power of about 20 per cent. can be obtained by redesigning.

An interesting feature in connection with the world-wide shortage of fuel is the appointment in England of Sir Frederic Nathan as power alcohol investigation officer under the Fuel Research Board.

Suggestions For Improvements

From the suggestions sent us in response to the request for constructive criticisms of the Act, several facts stand out very clearly. No objection is made to the first class certificate requirements insofar as technical knowledge is concerned but some adverse comment has been made regarding the length of service necessary. This might be shortened possibly to the advantage of all concerned but it at least assumes the attainment of practical knowledge of sufficient extent to balance the technical knowledge required.

The greater objection to the Act seems to be in connection with the requirements for first class engineers, the size of plant operated by the second class man and other relationships between these two grades. That is to say, the practical engineer, up in years, argues with every appearance of right that he will be unable to operate a plant of any size since he has not the technical training to pass the first class examinations.

A remedy has been suggested, the lowering of the first class requirements. This is objectionable and is a course that meets with the approval of few engineers. Another suggestion, and one which we think has a lot to commend it, proposes that the plant size be raised for the second class engineer. In this case he would be able to take charge of power plants up to say, for a guess, 2,000 boiler horsepower. This would do justice to the engineer, maintain the high standard of the first class certificate and would be the best all round solution.

In any case changes and improvements of this nature can only come after the Act has been in force for some time and experience has been gained as to its effectiveness.

"CAN any of you tell me what the late ruler of Russia was called?" asked the teacher. "The Czar!" roared the class. "And what was the Czar's wife known as?" Only two voices answered this time: "The Czarina." "Ah!" said the teacher eyeing his flock fondly. "That is very good. Now, who will tell me what the Czar's children were called?" "Czardines!" yelled one little boy.

How the Locomotive Whistle Came to Life

A Musical Instrument Maker Solved the Problem—Horseback Rider Used to Precede the Locomotive

By F. A. McLEAN

SURROUNDED on every side by wonders of the mechanical and electrical world, the majority of people are disposed to take them for granted and regard them more or less as if they had always been. As a matter of fact, there is usually an interesting story behind the invention of most of the things that are now considered essential to our everyday life.

How many people, for instance, could tell offhand who invented the locomotive whistle or know that it came into being like many other epoch-making inventions and discoveries as the result of an accident. An apple falling on the head of Sir Isaac Newton, as he lay under a tree, is said to have started the train of thought which led to the promulgation of Newton's law. Bell stumbled onto the telephone accidentally while working on an apparatus to improve the hearing of the deaf. The phonograph was born while Edison was working on an entirely different invention. A lazy boy gave us the first automatic valve motion for a steam engine, while Elias Howe is said to have conceived the sewing machine needle in a dream, so that it is not at all strange that the invention of the locomotive whistle was also brought about by an accident.

On May 4th, in the year 1833, Stephenson's locomotive the "Samson"—a successor of the famous "Rocket"—ran into a farmer's wagon containing fifty pounds of butter and eighty dozen eggs, on a level crossing between Thornton and Bagworth, England. Had the high cost of living been a topic of discussion at that time, or had butter and eggs been worth as much in those days as they are now, perhaps Stephenson's career as a railroad builder would have been cut short.

At any rate, as a result of this spreading of butter and eggs around the landscape (and perhaps as an aftermath of the death of William Huskisson, a Cabinet Minister, who was killed by Stephenson's Rocket on September 15th, 1830, and thus had the unfortunate record of being the first man ever killed by a locomotive) a meeting of the directors of the railroad was called to see what steps could be taken to prevent accidents in the future.

In 1825, when the Stockton and Darlington Railway was opened, for the first part of the trip, a man on horseback had preceded the locomotive, warning people to get out of the way, but during the latter portion of the trip Stephenson ordered him out of the way and speeded his engine up to fifteen miles an hour. The Samson being a heavier and more powerful locomotive than the famous Rocket and other earlier models, sending a mounted man ahead of it was now out of the question, so Stephenson's suggestion that a whistle blown by steam could be used, was welcomed by the directors.

Acting on Stephenson's advice, a musical instrument-maker in the town of Leicester produced a steam trumpet which was about eighteen inches long and about six inches across the bell, and resembled a huntsman's horn. This horn was tried out before the board of directors and accepted. It must have had a weird sound, and no doubt was effective, as we are told that the Reverend Sydney Smith, a witty divine, was wont to say that "Stephenson's whistle always reminded him of the squeal of a lawyer when the De'il first got hold of him."

The Tunnel Will Be Built

FOR years engineers have talked of the day when the tunnel would be completed between England and France. The world in general has not been much interested, probably because the world in general never thought such a thing practicable.

But work is going to start—start from both sides, the French and English Governments to find an equal share of the money and provide an equal share of the men.

Then it will be possible to take a train at London for Constantinople, for any European capital. Through the tunnel the line will be run by electric power. This will prevent trouble with engine fumes, which was one of the serious objections to the long tunnel through the Alps.

Forty-five minutes will be occupied in going through the Channel tunnel. Passengers, in fact, will pass through the tunnel almost without realizing they are passing under stormy Straits.

The tunnel will be about thirty miles long. It will not be exactly in a straight line. Beginning at a spot two or three miles on the island side of Dover, it will follow the gray chalk bed of the Channel, which is impervious to water and suitable for tunnel construction, and come out at a point between Calais and Boulogne, near the village of Marquise.

There will be, as on the London underground railways, two distinct tubes. Below them, about nine feet in diameter, will be a drainage tunnel. The whole work will take five years to complete and will employ 1,200 men on each side.

The French, who are proud of their share in the tunnel, will do half the work and find half the money. There is bound to be much friendly rivalry between the two sections of workers as to which will go ahead the faster.

According to exact calculations of the engineers, the French and British workers, who will begin construction of the tunnel thirty miles apart, will meet within an inch or two of the centre of the tunnel.

THE QUESTION IS—"WHEN WILL THEY GET DIZZY?"

Progress in New Equipment

NEW ELECTRIC RIVET HEATER

THE ordinary method of heating rivets in the rivet forge is open to several serious objections, and has disadvantages which can't be very well overcome. These objections to the old heating methods with the attendant expense of handling fuels or installation and maintenance of piping, together with the problem of waste gases, cinders and dust are eliminated in a new electric rivet heater recently developed by the Canadian General Electric Co.

No time is lost in starting production, since the first rivet is heated in a few seconds after throwing the switch. In ordinary methods of heating rivets the heat is applied from the outside, and the rivet may in consequence be cooler in the interior than good driving would allow. In the new electric heater the rivet is heated from the inside, which gives uniformity of heat and the best upsetting conditions in the shank.

The even quality of the heat produces a minimum amount of scale, and the absence of products of combustion further eliminates scale, etc. The wastage of rivets is reduced to a minimum, and a further economy is apparent in the high efficiency obtained through the localizing of heat in the rivet. Close heat regulation is also obtained, and power is used only when heating rivets.

Rivets from ⅞ in. to 5 in. in length are heated without adjustment. The mechanism is air-cooled and thus is extremely portable. It may readily be mounted on wheels when desirable.

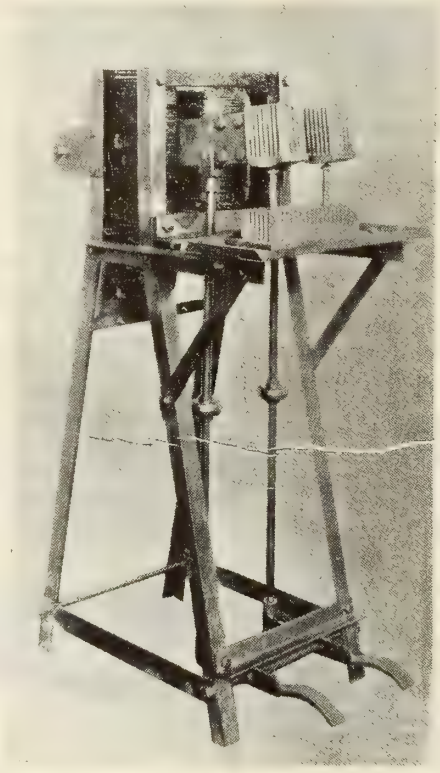
In operation the heater is cleanly, and no smoke results from its use, nor are contaminating gases produced. The heat radiated is also a minimum. The accompanying table gives a fair idea of performance under actual working conditions.

Approximate Maximum Production in Rivets Per Hour on 15 K.W. Machine.

Length under head to point in inches	Diameter in Inches							
	¼	⅜	½	⅝	¾	⅞	1	1¼
1	800	650	550	350	280	190	120	80
2	650	500	400	275	190	130	80	60
3	500	400	300	160	150	100	65	35
4	400	300	250	100	120	90	40	25
5	300	250	200	140	90	60	25	15

Two rivets are heated at one time. The heater will handle rivets up to 1 inch in diameter, and from ½ to 5 inches long. The General Electric Company at Schenectady have heated 500 ½ inch by 1¼ inch rivets with a power consumption of 10 k.w. hours.

It is estimated that this equipment will handle 5 pounds of rivets per k.w. hour. The heater is self-contained and self-cooled, holding two rivets at a time. The rivets are held by placing them in sockets with the transformer, which is a part of the equipment. The wastage of rivets can be reduced to a minimum, for if the machines be left in operation with the rivets in place, it is only necessary to



ELECTRIC RIVET HEATER

burn out one rivet to open the circuit and so prevent further damage. The current consumption is limited strictly to the time the rivets are placed between the electrodes of the heater as the contact is broken as soon as the rivets are removed. Two points worth mentioning are: (1) That the operator might become somewhat alarmed when placing the rivets between the jaws of the heater, because when the heater is closed considerable sparking takes place at the point of contact. This sparking, however, is harmless; (2) the advisability of cleaning the jaws of the heater. Cleaning these off twice a day with an ordinary file is quite sufficient.

Some of the advantages of the heater are that it is noiseless in operation, it is clean, there being no smoke or gases as is present with other methods of heating, no time is lost on operation; after closing the switch it takes but a very few minutes to start work; the voltage across the rivets is but 5 or 6 volts, and therefore harmless to the operator.

Specifications

Height, 4 ft.; space occupied at top, 18 in. square; space occupied at bottom, 24 in. square. Weight approximately, 300 lbs. This equipment can be furnished in 110, 220, 440, 550 volts, 25 and 60 cycle.

Rivet heater will actually heat considerably more than 800 rivets per hour, but this is about the maximum number an operator can handle.

RESEARCH IS BENEFITED

The Carnegie Corporation of New York has announced its purpose to give $5,000,000 for the use of the National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organizations. The remainder will be placed in the hands of the academy, which enjoys a federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry.

The council is a democratic organization based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the Government, differing in this respect from other similar organizations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. It intends, if possible, to achieve in a democracy and by democratic methods, the great scientific results which the Germans achieved by autocratic methods in an autocracy while avoiding the obnoxious features of the autocratic regime.

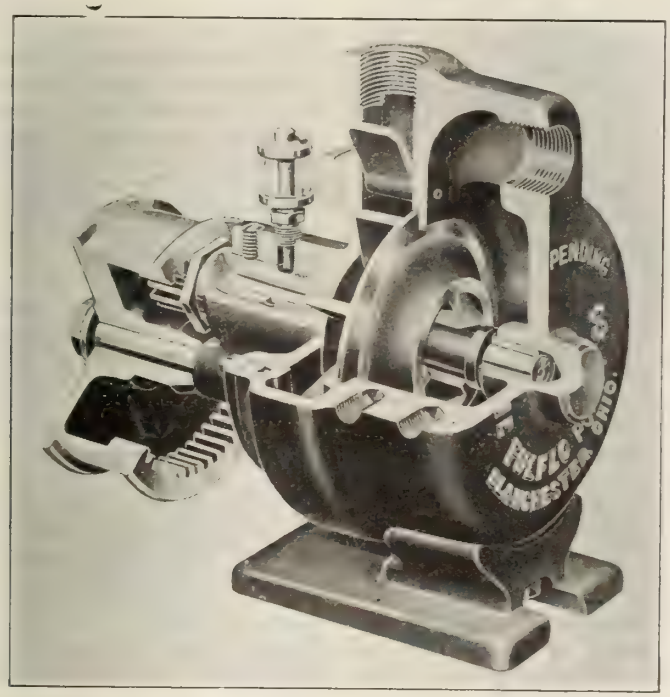
The council was organized in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation.

Reorganized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

"FULFLO" REVERSING PUMP

The Fulflo Pump Co., Blanchester, Ohio, has just placed on the market the reversing centrifugal pump illustrated. Its design includes the prime-retaining, non-clogging features of the other pumps of this line with the reversing feature in addition.

The ability to reverse the flow of water or coolant through the pump is obtained through the design of the impeller blades and the introduction of a bronze deflecting gate in the discharge passage. As both openings are at the top of the pump it is always primed and will immediately start the flow of the liquid in either direction, depending on the direction of rotation of the driving pulley.



SECTION VIEW OF THE FULFLO REVERSING PUMP.

The pad for mounting the pump is detachable and may be located in any one of three positions at 90 deg. to each other. It is fastened by two flush-head screws.

As regularly furnished with ¾-in. pipe, the pump has a capacity of 15 gal. per minute with a 15-in. suction lift against a 4-ft. head at a pulley speed of 450 r.p.m. When equipped with 1-in. piping the discharge can be easily increased. Variation of the pulley speed naturally varies the output of the pump.

ORGANIZING TO BRING NIAGARA PENINSULA TO ATTENTION OF WORLD

THE municipalities of the Niagara district have organized the Niagara District Industrial Association, with the object of holding, during the present year, an industrial congress. By this means they will endeavor to attract responsible people who may be interested in the power shipping and industrial facilities of the district, and also in the fruit and farm areas. Plans will be made to have their guests visit the power development at Niagara Falls, the Chippawa Power Development, now under way; the Welland Canal enlargement, and the fruit belt. Literature will be prepared describing these outstanding features of the district, and each municipality will also give wide publication to its advantages from an industrial viewpoint. Lists of representative men will be prepared, with the object of inviting them to the congress as the guests of the association.

The officers are:—

President, W. M. German, K.C., Welland.

1st vice-president, H. P. Stephens, Mayor Niagara Falls.

2nd vice-president, E. J. Lovelace, Mayor St. Catharines.

3rd vice-president, George W. Sutherland, Mayor Welland.

Secretary, Louis Blake Duff, Welland.

Treasurer, E. C. Graves, St. Catharines.

Publicity Committee:—W. B. Burgoyne, St. Catharines; F. H. Leslie, Niagara Falls; J. H. Thompson and J. E. Carpenter, Thorold; B. J. McCormick, Welland; P. B. Yates, St. Catharines; H. W. Shore, Port Colborne.

The members of the association are the representatives of the municipal councils of :—

(a) St. Catharines, Niagara Falls, Welland.

(b) Thorold, Merritton, Port Colborne, Bridgeburg, Niagara-on-the-Lake.

(c) Port Dalhousie, Fort Erie, Hubberstone Village, Chippawa.

(d) Crowland, Thorold Tp., Stamford, Bertie, Grantham, Niagara, Louth.

The representatives of the following Trade Boards:

(a) The Niagara Falls Chamber of Commerce.

(b) The St. Catharines, Merritton, Thorold, Welland, Port Colborne, Ridgeway, Fort Erie, Port Robinson and Stamford Boards of Trade.

TRADE OPPORTUNITY IN CUBA

The old-established British firm of Albert Moloney and Co., 12 Amargura St., Havana, Cuba, is anxious to obtain sole agencies in Cuba for the following heavy machinery manufactured in Canada: Return tubular boilers, water-tube boilers, condensers, surface, jet, and barometric, power pumps of all types, steam driven, motor and belted, vacuum pumps, steam engines, valves and fittings, electrical generators and motors.

Canadian manufacturers might bear in mind that Americans enjoy a preferential tariff in Cuba, but that this is more than offset at the present time by the discount on the Canadian dollar. Another substantial assistance to Canadian trade with Cuba is the recent establishment of a direct line of the Canadian Government Merchant Marine between Canadian ports and Havana.

At a recent meeting of the Montreal branch of the Engineering Institute of Canada, an address, illustrated by motion pictures, was given by John Murphy, M.E.I.C., electrical engineer of the Department of Railways and Canals, Ottawa. The subject, "Ice Formation," was ably dealt with by the speaker, and the pictures showed the audience the actual formation of frazil and anchor ice and the manner in which submerged machinery at temperatures below the freezing point attracted the spicules of ice and invited disaster to the equipment.

W. H. Rose, formerly with G. W. Cole, Ltd., has been appointed general manager of the Canadian Farnsworth Company. This company has been organized in Canada to operate the Farnsworth Canadian patents. Active manufacturing has been started in their plant on Hillington Ave., Toronto. The Farnsworth patents cover duplex automatic boiler feeders, condensation pumps and return steam traps.

The Operators' Point of View

Correspondence Re Graded Certificates

A CONCRETE SUGGESTION FOR IMPROVEMENT

The Editor:—Your editorial on page 70, THE POWER HOUSE, noted. The new license law has many good points. Any man who does not understand the technical or theoretical side of engineering is not an engineer, he is simply a laborer, what is called a "wop." However, there is a limit to everything and it is quite possible to go beyond the proper limit in technical requirements to secure a license to operate power plants, although it is not possible that any one man can have too much technical knowledge.

Personally I believe that the size of the power plant operated by second and third class license holders should be larger than the new law allows, 300 B.H.P. for the third class and 800 B.H.P. plans for the second class men would be about right.

This would allow the men of ordinary intelligence and experience to earn a fair living. Under the present law, it appears to the writer that only the exceptionally clever man can pass a highly technical examination if he is not allowed to use books of reference. I have had brought to my notice many illustrations of the foregoing fact. The late Mr. M. L. Smith, ex-associate editor of THE POWER HOUSE, and engineering instructor at the Toronto Technical School, was a personal friend of mine. Several times Mr. Smith asked me for answers to some practical power plant problem which was bothering him. He was a technical expert of high ability, but he informed me that often he would be engaged until midnight, and later, searching through textbooks to find the answer to some question asked by a reader. When I attended the meetings of the C.A.S.E. in Toronto, some years ago, I have seen question slips brought out which none of the members could give detailed answers to from memory. Engineers all over the province of Ontario are delighted to have a graded license law, but from my conversations with different men the one big kick seems to be dissatisfaction with the smallness of the plants allotted to the second and third grade license holders. Like myself the majority of the engineers I have talked to are positive they can not pass a highly technical examination from memory, even when they are, like myself again, graduates of the I.C.S. or A.C.S. holding their engineering disploma. It would be quite all right to leave the first class examination as it is, then the exceptionally clever men could have the high class, big paying positions, which is only right and proper. If this is so, the other fellows, who are only moderately clever, or simply first class mechanics and second class engineers and technical men, should be allowed the priviledge of earning a fair living in a moderate sized power plant.

I believe if the change suggested in this letter were put through, there would be little or no objection to leaving the act as it is written.

JAMES E. NOBLE,
First Engineer,
Ontario Hospital,
Kingston, Ont.

ANOTHER GOOD SUGGESTION

It has been with much interest I have read the correspondence on this subject, and when Chief, Justice I, II, and An Old Engineer, get their first-class certificate (which I have not the least doubt they eventually will), I wish they would tell us about it.

But in the meantime I would like to put another phase of the subject on record. Those holding second and third papers and wishing, by study and labor to advance themselves in their positions, deserve some consideration.

Mr. D. F. Campbell promises to help. Arthur Smith offers a solution to the problem, but could the average engineer give the correct answer to the formula.

When I say average I mean 50 per cent. of the engineers. When I obtained my certificate I had to prove that I knew my business, but I saw nothing of square roots.

I have a good library on engineering subjects by several authors, but in many things, particularly mathematics, I find the rules are not given clearly, and it is often necessary to check one book against another.

I would suggest that all readers who are interested in their own advancement ask POWER HOUSE to give one page (or more if it is possible) to help those who would help themselves.

In the December 20, 1919 issue we had a clear and concise explanation of several rules of mathematics. I would suggest a portion of the space to mathematics, chiefly because they are so necessary for all other problems—the balance to electricity, air, water, refrigeration, usages, breakdowns, repairs, etc.

Also a department where anyone, wishing to obtain advice on technical books, libraries, and courses, could do so. I for one am glad of the graded certificate; it will mean study for many, but good for the largest number.

I hope I have started the ball rolling another way, and hope to hear more good-natured grumbling.

A. O. STONE.

Editor's Note.—The suggestion contained in the above letter quite meets with the approval of the editors, and we are glad indeed to devote whatever space is necessary to these subjects. In fact a rather extensive series of educational articles is in the course of preparation, and in addition we would request the cooperation of our readers to the extent of their sending in concrete suggestions, especially questions concerning any particular portion of engineering, theory or practice, which may not be clear to them. Questions actually sent in by readers are of more value than those otherwise prepared, since they are apt to come more closely to the engineers own requirements.

A Letter from Justice the Second

The Editor:—"Chief," in replying to my letter of December 5th, which appeared in your issue of that date, states that his plea was and is for the man who, by perseverance and determination based on an ambition that any man should be proud of, have overcome all obstacles and attained a position in charge of a large plant. He then goes on to state that he has a very intelligent engineer in mind, one who is in charge of a large plant, but yet could not even pass a second-class examination, is having very good results from his plant. How can this be possible? Is it not the case that to be an economical operator, one must have a fairly good theoretical

understanding of engineering? And this combined with his practical knowledge should produce efficiency. If "Chief" can prove to me that economy and efficiency of a power plant can be got otherwise, I will be more than obliged to him for the formulae, thus saving me further time and study of engineering books.

Yes, we all know that the much-coveted paper will not make the man but now that "Chief" as one of the agitators of graded certificates has persuaded the Government of Ontario to adopt same, surely he thought that the paper would be of some benefit to the engineer of to-day and more especially of to-morrow. If that be the case, what other fair and square means can be adopted but by the examining of each and every individual engineer to test his true knowledge of the questions that shall be of a highly practical and theoretical nature as the small handbook issued on the subject of graded certificates by the Stationary Engineers' Board hath set forth.

Perhaps it may be of interest to "Chief" that very recently an important position was to be filled by an engineer, and after being duly advertised some 60 applicants entered the field for same. It was no simple matter to discriminate the winner, as all had first-class references and knew engineering from A to Z. A test examination was to be the deciding factor, then, alas what happened? Seven out of the sixty appeared for examination and only five attempted it. Doubtful if any ever reached the goal. Approximately 90 per cent. of the highly referable applicants' bluff was called.

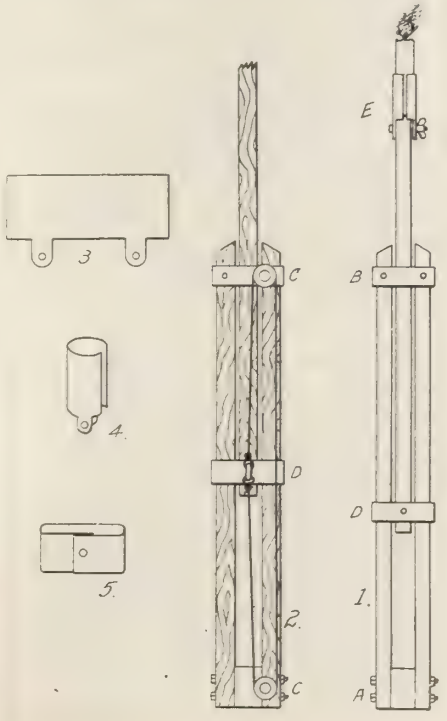
Will the grading of certificates not place the majority of the self-estimated, first-class, economical and efficient chief engineers of to-day in such a position?

JUSTICE II.

TELESCOPIC CANDLESTICK

By J. O. McDONNELL

The accompanying sketch shows a telescopic device for carrying a torch or candle for use in the boiler room where it is frequently necessary to examine the inside of the boiler when cleaning, or in such places about the boiler room where it would be very difficult to reach without an apparatus of this description. It is sometimes the practice to use a long pole for this purpose but this method is often awkard owing to the confined space available. The simple and cheap extension here shown can be made in a very short time by any handy man about the plant and adjusted to any desired length to suit the working conditions. The use of such a device will often save the crawling into difficult and dirty places for inspecting and repairing. The frame is constructed of light strips of wood about ¾ inch square and of a length suitable to the class of work for which it is to be used. The base is secured by a small block of wood bolted by a small block of wood by a couple of small bolts as shown at A. The upper end is fastened as shown at B with a short piece of band iron. The centre extension piece is also made of a strip of wood ¾ inch square with a clamp secured to the bottom that keeps it in place while in use permitting of free movement when travelling along the supporting frame. When an extremely long extension is required it is advisable to use a cord that passes around two pulleys, one at the base and the other at the top of the frame, the ends of the cord being secured to the clamp that is fastened to the bottom of the movable centre piece. The holder for the candle which is fastened to the top end of the centre piece, is made of a small piece of tin of a shape shown in Fig. 3, and bent into the shape shown at Fig. 4. The candle holder is so made that the candle may be placed in any desired position by swinging on the small swivel bolt that holds it to the stick. Fig. 5 is a view of the clamp that is fastened to the base of the centre stick. The cord and pulley is not always necessary but is very convenient when a long extension is required.



THE NEEDS OF PRACTICE

There is one feature which is common to all the infinite varieties of mechanism with which the engineer has to deal—namely, the necessity for lubrication. Yet, in spite of the fundamental importance of the subject, the principles of lubrication have, until recently, received but scanty attention at the hands of scientific men.

It is true that Beauchamp Tower studied the action of oil in a bearing and Osborne Reynolds developed a mathematical theory based upon his experimental results, but it is not derogatory to the work of these and other investigators to say that the present state of the art of lubrication is far in advance of any scientific theory. The engineer has found out by experiment what kinds of oil or other lubricant give the best results under various conditions of use, and in what circumstances satisfactory lubrication is possible; yet as to what constitute the determining factors in these cases he is almost entirely in the dark. Enlightenment as to the nature of these factors is required not merely for intellectual gratification, but for the severely practical purpose of improving our machinery. If we knew upon what lubrication ultimately depends and understood the molecular mechanism by which it is accomplished, it might be possible to devise lubricants or bearing surfaces which would permit of vastly greater working pressures than are now permissible, with a consequent revolution in the design of machinery. A wide and almost untouched field of research lies open to the physicist and the chemist, the exploration of which would benefit the engineer in a very direct and practical manner. The work has been taken up by the Research Committee on Lubrication, and it is sincerely to be hoped that the outcome of their labors will be to place the whole matter upon the scientific basis which its importance deserves.

Function of a Lubricant

The primary function of a lubricant is to make surfaces slippery, so that they may slide over each other with the least amount of frictional resistance. The usual lubricants are, of course, oils of various kinds, and Mr. R. M. Deeley, in a communication read at a recent meeting of the Physical Society, refers to the specific property of liquids, in virtue of which they reduce friction as "oiliness." This hardly seems more illuminating than the definition of an archdeacon as a man who exercises "archdeaconal functions." Moreover it appears either to beg the question or to be misleading. For example, one of the slipperiest substances known, and one which is always associated with ease of sliding, is ice. It is generally assumed that the "lubrication" which makes ice so slippery is a minute film of water caused by the momentary liquefaction of the ice under the pressure of the sliding body. At any rate, whether this is so or not, there is nothing about the phenomenon which would justify such a word as "oiliness" being used in connection with it. Water is said also to make a good lubricant for surfaces of ebonite, and it serves to lubricate the sterntubes of steamships. It is, however, quite inadequate for ordinary metallic surfaces for which universal experience indicates some sort of oil or grease to be the only practical lubricant.

Why oils possess the property of lubrication in so marked a degree, as compared with other liquids, is something about which we are still awaiting an explanation from the physicist. Moreover, oils which are for all practical purposes identical in viscosity and other characteristics prove to be of very varying merit as lubricants. It has been suggested that to be a good lubricant, any oil, whether of organic or mineral

origin, must contain a number of unsaturated molecules which attach themselves to the metallic surfaces by their residual affinities. Thus the interface between the solid metal and the oil film is looked upon as being composed of a sort of alloy or amalgam of oil and metal, which prevents the oil film from being rubbed away. The necessity for unsaturated molecules is, however, denied by other authorities, and there the matter rests. What does seem to be certain is that good lubricants appear to have the power of attaching themselves strongly to the rubbing surfaces, and of retaining their adhesion under very considerable shear stresses.

What the Engineer Wants to Know

The engineer is quite content to wait until the physicist and chemist have come to some agreement with regard to the molecular explanation of lubrication, but he is pressing them for some practical guidance which will help him to decide upon the suitability of an untried sample of oil for some particular purpose. To make an actual test of a new kind of oil upon an important machine, such as a large gas engine or turbine, is an expensive matter, and is not without a certain risk of injury to the machine. The engineer consequently is tempted to bear those ills he has rather than to risk incurring others that he knows not of, and he therefore often continues to use a high-priced oil for fear of experimenting with a cheaper one. To add to his difficulties the salesman of the new oil may claim that it is identical in character with that which he desires to supplant, and may point to the fact that as regards viscosity, flash point, fire point, and other features the two oils are indistinguishable. Every engineer who has purchased oil on a large scale must have had experience of this kind, and many a one has found that the cheaper substitute fails in just the feature which is essential—namely, the power to lubricate efficiently.

When oil has to be purchased by tender this ignorance of the factor upon which lubricating power depends is a serious matter. The buyer cannot protect himself by requiring bidders to conform to any specification, however rigid, because in the present state of our knowledge it does not appear to be possible to draw up a specification which will ensure that every oil which conforms with it shall be a good lubricating oil. In more than one case an oil company has been asked to furnish a specification of some of its oils which have proved satisfactory, the specification to be so rigid that none but oils absolutely identical with its own could satisfy it. In spite of a promise to the company that tenders would be called on such a specification, thus practically throwing a valuable contract directly into its hands, the specification was never forthcoming. It appears that all the engineer can do at present to ensure uniformity of quality of his lubricating oil is to purchase some brand under a trade name, and trust to the honesty of the sellers that the name shall always connote the same quality. This is unsatisfactory in the last degree, and matters cannot be improved until those who preach to him the duty of conducting his business along scientific lines will furnish him with specifications and methods of testing which will place the purchasing of oil on a more scientific footing.

Oil-Testing Machines

There have been on the market for many years various machines designed to test the lubricating qualities of oil under conditions comparable with those under which it is to be used. In the more elaborate of the machines tests may be made of the friction occurring at various speeds, temperatures, and pressures, and autographic records may be obtained of the variation of friction with time. These testing machines do not, however, command the general confidence of engineers as a guide to the merits of an oil. None of them, so far as we know, can provide conditions even approximately resembling those which obtain in a gas engine cylinder, steam cylinder, or turbine bearing. Moreover, the results obtained by different machines are not comparable, so that oil cannot be bought on the guarantee that it will give certain results in a testing machine. The utility of the machines really consists in enabling the engineer to test different samples of oil for similarity of behaviour under similar conditions, or to compare periodical tests of the same brand of oil with one another. They have a certain scope for these purposes, but the relationship between the figure of merit they would award any particular oil and its real merit in practical use is by no means definite.

What an engineer usually wants to find out is whether a new sample of oil offered him is better or worse than that which he is using. There would, therefore, seem to be room for a simple machine which would indicate the differential friction between two similar pairs of surfaces working at precisely the same pressure and temperature, and lubricated, one with the sample of oil to be tested and the other with the oil in ordinary use. It is true that it would not be possible to imitate the actual factors which influence the life of an oil, such as the presence of steam or flaming gas, but nevertheless the ease of making a simultaneous comparative test of two oils under necessarily identical conditions would be worth something.

Work Waiting to be Done

Without minimizing for a moment the scientific interest, and no doubt also the ultimate practical use of the investigations now being carried out by the Committee on Lubrication, as to the real explanation of lubrication, it may be suggested that work of a more immediately useful nature lies ready to their hand. If, without interrupting the researches they are now making into the physical basis of lubrication generally, they could spare the time to draw up specifications for oils suitable for certain difficult conditions, they would confer an immediate benefit upon engineers. In the case of the lubrication of the cylinders and glands of large

To The Stationary Engineer

A number of engineering correspondents have written us respecting various phases of the Graded Certificate Act now in force in Ontario. Many of these letters have been more or less severe in their criticism of the Act, and while the pointing out of defects, real or fancied, is important and of value towards their betterment, little has been given in the way of constructive criticism.

No one is better able than the engineer himself to give suggestions as to improvements to be effected either in the Act or in the Regulations under which it will be carried out, and since each engineer has, or should have by this time, his copy of the Act and its Regulations, he should be in a good position to form his own opinions. Not only so, every engineer has no doubt given the matter considerable thought, and, having read both the Act and Regulations carefully, has his own ideas as to both, and can suggest improvements.

We are, then, asking that the stationary engineer send us a letter in which improvements and suggestions are embodied. No matter what your opinions are, send them in for publication and discussion. The requirements for examination, the type of questions which you think should be asked, the length of service, the size of plants for each certificate, and similar matters are all suitable subjects for discussion.

It is only by free discussion that any legitimate change can ever be brought about, and the columns of POWER HOUSE offer an ideal medium for the freest discussion, leading eventually to a crystallization of the general thought of the engineers of the Province.

One thing more, and equally important—the education of the engineer should be an important feature of the educational system of Ontario. The Department of Education has taken a long step forward by establishing night classes for the engineer throughout the Province. Since these have only been functioning since the late fall, in most cases, it is possible that the subjects taught might not be just what you require, or the courses in other ways could be bettered. Let us have your thoughts regarding this, and send in your suggestions as to what you would like to see taught, and how.

double-acting gas engines, for example, the Committee might obtain samples of the oils used in various plants with success, and from the practical knowledge so acquired draw up specifications defining the kinds of oil most suitable for various conditions of temperature, pressure, and rubbing speed. In this instance, of course, the tendency of certain oils to form hard carbon deposits in the glands and cylinder heads is a point which has to be noted. Should the Committee not be able to draw up any specification of practical use, possibly they could indicate simple tests, chemical or mechanical, which would serve to differentiate good from bad oils. Again, a standard specification for turbine oils suitable for various conditions would be useful. A note as to the permissible rise of temperature without risk of injury to the oil, the question of the "life" of a turbine oil, and the conditions which render an oil useless on account of what has been explained as polymerization, are all subjects on which guidance might be looked for from the Committee.—Engineering Supplement the London Times.

CARBON DIOXIDE RECORDERS

Continued from page 91

more than five or six per cent. of carbon dioxide in the flue gases, although until the test was made there was no suspicion that anything needed improvement. By careful attention to the settings, the grates and the method of firing, this can always be raised to an average of 12 per cent., and even 15 per cent. can be reached, although this is about the practical limit, having regard to the necessity of avoiding the production of carbon monoxide. To show the importance of proper attention to the dioxide percentage, we will suppose that the introduction of a recorder has resulted in the average percentage of that gas being raised from 5 to 12 per cent., and we calculate the saving resulting from the change. It has been mentioned that if perfect combustion could be obtained with no excess of air, the proportion of dioxide in the flue gases would be about 18 per cent. The quantity of air necessary to give this result would be about 144.5 cu. ft. per lb. of coal, supposing the latter to contain 87 per cent. of carbon and five per cent. of hydrogen. If, therefore, the percentage of dioxide were reduced from 18 to 5 by the dilution of the flue gases with air, it is clear that the total volume of air passing through the furnace would be $(144.5 \times 18) \div 5 =$ 520 cu. ft. per lb. of coal burnt. The excess air is therefore $(520 - 144.5) =$ 375.5 cu. ft. per lb. coal, and supposing the flue gases to leave the boiler at a temperature of 500 deg. Fahr., this excess air will carry away about 3,000 B.t.u. to waste, or more than 20 per cent. of the heat of the coal.

A similar calculation shows that if the dioxide in the flue gases amounted to 12 per cent. the excess air would be 72.25 cu. ft. per lb. of coal. This quantity of air would carry away nearly 600 B. Th. U., or less than 4 per cent. of the heat of the fuel. The effect, therefore, of increasing the percentage of dioxide from 5 to 12 would be to effect a direct saving of something like 16 per cent. of the fuel. This is a saving quite within the reach of hundreds of plants throughout the country, and apart from the national importance of conserving our fuel supplies, it is a material consideration with the present price of fuel. Many an engineer regards the low flue-gas temperatures which he is getting as a proof of the efficiency of his boiler-plant, whereas if the temperature is low merely on account of the furnaces and settings being flooded with cold air entering where it should not, he is living in a fool's paradise.

Choice of an Instrument

With so many thoroughly serviceable types of automatic recorders on the market, it would be invidious to recommend any particular design. The engineer, however, may be counselled to select a thoroughly simple and mechanical type, and particularly one which can easily be taken apart and cleaned when necessary. The first cost of any of the commercial types is inconsiderable in comparison with the savings resulting from attention to their indications, so that the choice should be determined more by the mechanical qualities of the instrument and its suitability to boiler-house conditions than by its price. Furthermore when instruments have been installed, it is worse than folly to neglect them, as soon as their novelty has worn off, because of the very slight amount of attention required to maintain them in efficient working condition. One is sometimes tempted to think that it is not their trouble which is the real reason for their neglect, but rather the fact that their records are inexorable witnesses to conditions of inefficiency which otherwise would pass unnoticed. —"Times Engineering Supplement."

PRODUCTION OF ASBESTOS INCREASING

The asbestos industry of the United States is in better condition now than ever before, especially as to the quantity and the grade produced, and the outlook is encouraging. Most of the asbestos used in the large asbestos factories of the United States comes from Canada, but the growing appreciation of the high quality American fiber, especially that from Arizona, is a welcome feature of the industry.

The total quantity of domestic asbestos sold in 1917, according to J. S. Diller, of the United States Geological Survey, Department of the Interior, was 1,683 short tons, valued at $506,056, an increase of about 13 per cent. in both quantity and value over 1916. Most of the domestic asbestos comes from Arizona, where the proportion of crude spinning fiber to that of lower grades is much larger than in Canada, so that the average price of American fiber in 1917 was $301 a ton, whereas the average price of that in Canada was only about $50.

Some years ago the opinion was expressed that as the Arizona fiber contains less iron than that mined in Canada, it is therefore better adapted to use for electrical insulation than the Canadian fiber. This opinion has lately been confirmed by analyses made by R. E. Zimmerman, of Pittsburgh, whose investigations also indicate that the harshness of certain parts of the Arizona asbestos is due to thin films of calcite among the fibers.

A small amount of spinning fiber was mined in Fremont County, Wyoming, from a contact deposit of remarkable interest.

The increased demands for asbestos due to the war have been met largely by increased imports from Canada. The imports of asbestos from South Africa and Italy have been largely cut off. The demand for imported asbestos for use in filters is being supplied by amphibole asbestos obtained from residual deposits of the crystalline rocks of Maryland.

TENDERS

The city of Brantford requires tenders for cement, sewer pipe and crushed stone. Tenders addressed to Ald. Harry Simpson, chairman of the Board of Works, will be received until Feb. 19. Specifications may be obtained from the city engineer, T. Harry Jones.

The secretary of the town of Ingersoll will receive tenders until February 28 for the erection and completion of a sixteen-room public school, of tile and concrete construction, fireproof. Plans can be obtained from the architect's office.

The Lignite Utilization Board, 2 Youville Square, Montreal, are calling for sealed tenders for the supply of material and erection of buildings at the plant in Estevan, Sask. The work includes the construction of industrial buildings and a concrete reservoir, and the erection of a water tank on a 70-foot tower. Complete plans and specifications can be obtained from the Board's offices in Montreal, or at the office of Mr. J. M. Leamy, Power Commissioner of the Province of Manitoba, Winnipeg. Tenders must be in by March 6.

The Department of Public Highways are calling for tenders for the supply of and erecting field painting of the steel superstructure for a 170-foot steel bridge over the River Aux Raisin in the vicinity of Lancaster. Plans and specifications can be obtained from the office of the Resident Engineer, Cornwall, and at the Department, Toronto. Tenders will be received till March 9, 1920.

To Manufacture Oxygen.—The Dominion Oxygen Co., a subsidiary of the Union Carbide and Carbon Corporation has been organized and will build five plants in the Dominion. Toronto will have one of these plants, and there will be in addition service stations and warehouses for supplying the small cities. The headquarters of the new company will be in Toronto, and work will be started almost immediately.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Add 5% to list above.

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1916.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 75
Steel bars, base, Toronto....	4 75
Steel bars, 2" to ¾" base.....	6 00
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 75
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$7 00	$6 75
Sheets, Black, No. 10..	6 50	6 50
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.		9 25
Premier, 10¾ oz.....		9 65

PROOF COIL CHAIN

¼ in.	$13 00
5-16 in.	11 00
⅜ in.	10 00
7-16 in.	9 80
½ in.	.....
9-16 in.	.....
⅝ in.	.....
¾ in.	.....
⅞ in.	9 20
1 in.	9 10
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ i.n	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.....	....
Royalite, per gal., bulk.....	22½
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.....	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	30½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$2	20
Leather in sides 1	75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and leg screws.....	30
Stove bolts	50
Plate washers	50
Machine bolts, 7-16 and over	10
Machine bolts, ⅜ and less..	20
Blank bolts	25
Bolt ends	10
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex., blank.....add	1 75
Nuts, hex., tapped.....add	2 00
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	43
Emery Cloth .....list plus	37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.....	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon...	2 00
Whiting, plain, per 100 lbs..	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$	0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	16½
Ideal	16
K press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

METALS

Lake copper .....$	24 25	$25 00
Electro copper	24 00	25 00
Castings, copper....	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

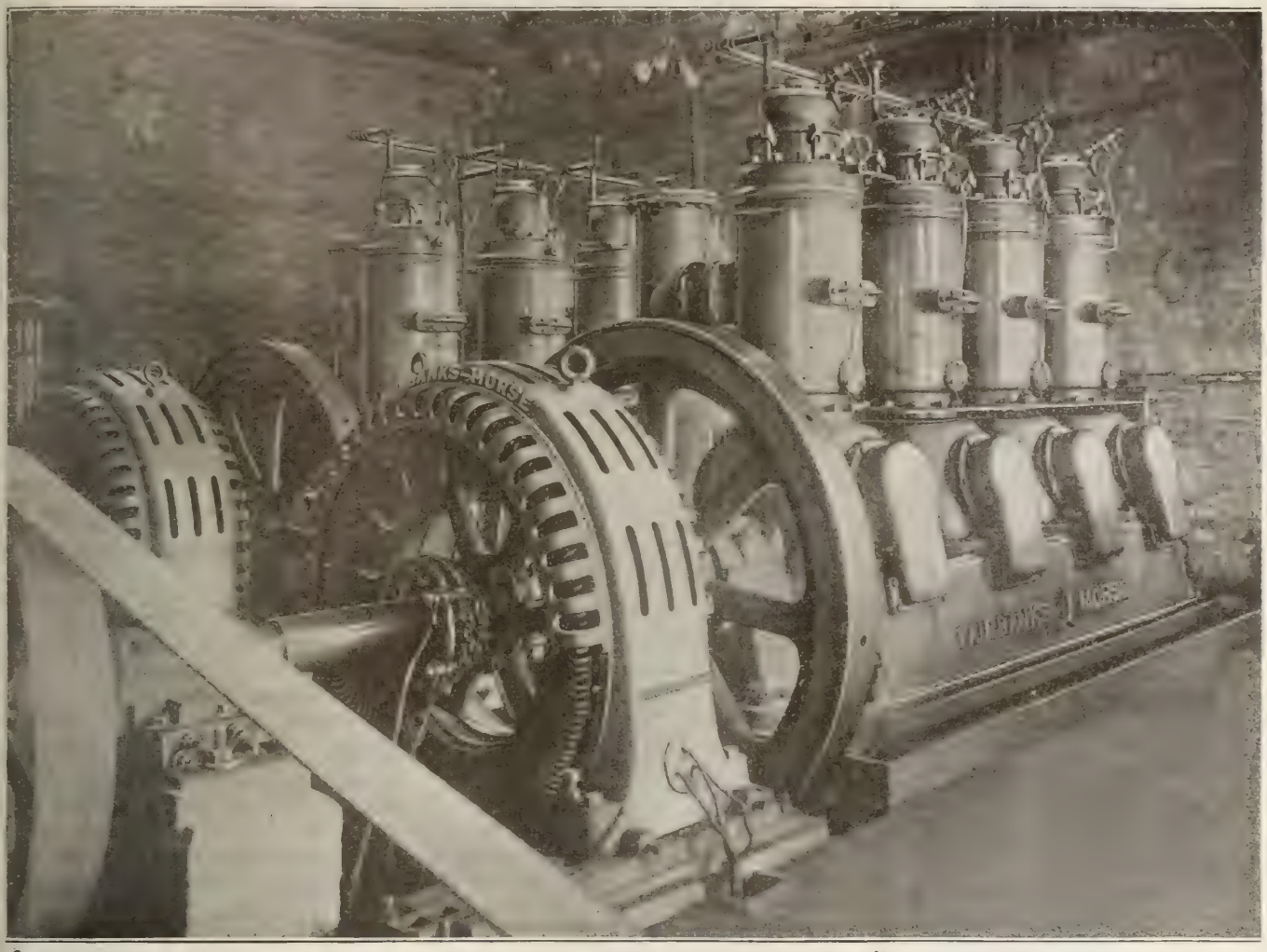
ROPES AND PACKING

Packing, square braided .....$	0 69
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 27
Transmission rope, Manila....	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.



FAIRBANKS-MORSE
ELECTRIC POWER MACHINERY

Each of the units shown above consists of a 200 H.P. Semi-Diesel Oil Engine and a 170 K.V.A. Generator.

Our smallest plant is a 1½ H.P. 9 K.W. Automatic Suburban Lighting Outfit.

Fairbanks-Morse Electrical Machinery covers the entire range between the above sizes.

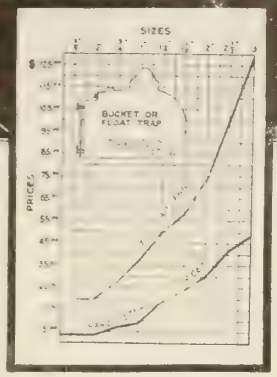
Our experience is at your service.

The Canadian Fairbanks-Morse Co. Limited

"CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS"

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON
WINDSOR WINNIPEG SASKATOON CALGARY
VANCOUVER VICTORIA

See What You Save on Steam trap SARCO



This diagram shows at a glance the big difference between the size and the price of the clumsy, cumbersome bucket trap and the simple, compact Steam Trap SARCO.

The difference in size and the difference in price are, as a matter of fact, cause and effect. For it is the larger size of the bucket trap—with its extra superfluous parts such as floats, levers, valves, water gauges, bowls, toggles and packing—that you have to pay the larger price for. It is the compactness and simplicity of Steam Trap Sarco that makes it possible for you to buy it for one-third the price of the bucket trap.

Rated size for size, Sarco has the same capacity as the big float trap. Its efficiency is greater. It discharges condensate as rapidly as it collects, consequently doesn't need to be large. It closes promptly and prevents all loss of live steam. Its compactness permits it to be installed in many places where there would not be room for a cumbersome bucket trap.

Why, therefore, pay the **larger price** for a bucket trap when it gets you neither increased capacity nor increased efficiency?

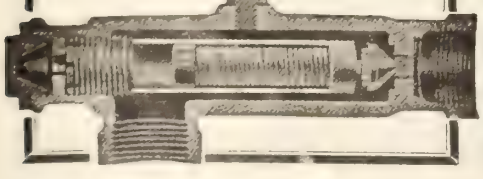
Use Steam Trap Sarco and save two-thirds of your Steam Trap Costs. Will send it on thirty days' free trial and let it convince you in your own plant, away from the influence of salesmen, that the Sarco is all we claim, and more.

Write for Booklet J 6.

SARCO CO., INC.

239 Broadway
NEW YORK CITY

Buffalo *Detroit*
Chicago *Philadelphia*
Cleveland *Peacock Bros, Montreal*



TRADE GOSSIP

Engineers' Club Closes Year.—The Engineers' Club of Toronto has just completed its 20th year, which has been the most successful in its history. Owing to the fact that their premises are not capable of accommodating any large number of new members, it was decided to raise the entrance fee 100 per cent.

New Brantford Industry.—S. C. Johnson & Co., of Racine, Wis., have purchased a portion of the Waterworks property in the neighborhood of the Robbins & Myers plant. The firm are manufacturers of prepared wax and wood stains, and they will erect a factory early this spring and employ 100 hands before the end of the year.

The Oil Engine Works of Canada, operating for the past few months at 29 Prince Street, Montreal, will shortly move their plant to Iberville, Quebec, taking over a portion of the plant now occupied by the Rapid Tool and Machine Company. They are building the Hvid line of oil engine in 6 and 8 h.p., principally for the farm trade. M. L. G. Vincent is the managing director.

Canadian Nathan Co. for Hamilton.—The Canadian Nathan Co., which will be closely allied to the Nathan Manufacturing Co., of New York, will shortly be established in Hamilton. The new company has arranged to take over the plant of the Canadian Chadwick Metal Co., and the premises will be remodelled and fitted with the necessary machinery to manufacture the Nathan line of valves, injectors, lubricators, etc.

N. B. Timber Transaction—The lumber lands and two mills on the Tobique river, owned by the Upham Lumber Co., Ltd., have been sold to the Fraser Companies, Ltd., for a sum reported to be $100,000. The purchasers will take this season's cut of six million feet. The principal stockholder in the Upham Company is George W. Upham, ex-M.L.A., of Woodstock, and the stock is held entirely in his family.

Dominion Foundries Extends.—The mills of the Dominion Foundries at Hamilton are undergoing large extensions, the cost of which will be in the neighborhood of $1,000,000. The plate mill is expected to be put in operation within the next two months. There are orders on hand for plates enough to keep the new mill busy for the rest of this year and well into next. All the other departments are booked up for some time.

T. W. Rogers has joined the staff of the St. Lawrence Welding Company of Montreal, and will have the position of general sales manager of the company. Prior to his recent appointment Mr. Rogers was eight years with Darling Bros., four years as a travelling salesman and the last four as purchasing agent. He was formerly with the heating division of Taylor Forbes Co. The tank development of the St. Lawrence Welding Company will necessitate additional selling organization and Mr. Rogers will have full charge of this department.

New Company in Welland.—The Marvel Company of Welland has been incorporated and will carry on the business of manufacturing and dealing in automobiles and accessories of every description. They will manufacture the "Marvel" steering device for Ford cars and deal in light, heat and power.

Briquette Plant Being Pushed.—The briquette manufacturing plant which is being constructed by the Lignite Utilization Board of Canada, at Bienfait, Sask., will be actively proceeded with as soon as the season opens. Some of the machinery contracts have already been let. The capacity of the plant will be 30,000 tons per annum, and production should start in August next.

The Annual Refrigeration Number of Power House

will be issued on April 20th. This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the REFRIGERATION NUMBER

OPPORTUNITIES

SEALED tenders will be received up to and including March 1st, 1920, to cover the installation of a distribution system of electric lighting in the town of Capreol, Ontario. Plan and specifications on request.

W. H. MATHEWS,
Town Clerk.

STATIONARY ENGINEERS

Those who wish some practical tuition for their Graded Certificates from a practical power house engineer holding highest certificates are invited to communicate with T.H.F., Box 208, Power House.

Stopping an ad to save
money is like stopping
a clock to save time

Where Do You Live?

We are going to put a representative in every town in Canada. Be the one in your territory.

We teach you how to build a permanent, substantial business. Whole or spare time. Write for particulars to-day.

Dept. B., Agency Division
153 University Ave., Toronto, Ont.

LIKE EATING, ADVERTISING SHOULD BE CONTINUOUS. WHEN TO-DAY'S BREAKFAST WILL ANSWER FOR TOMORROW'S YOU CAN ADVERTISE ON THE SAME PRINCIPLE.

Manager wanted, for Canadian National Newspapers & Periodicals Association. To act also as Secretary-Treasurer, and carry on the Association's general work, under the direction of the President and the Board of Directors, study the interests of the various classes of publications in the Association, and plan and carry on promotion work in their interests. Applicants should understand advertising and merchandising. Apply in writing only, stating age, full details of experience, and salary expected. Applications will be treated as confidential. Address Acton Burrows, President, Canadian National Newspapers & Periodicals Association, 70 Bond Street, Toronto.

Instructive Advertisements

"I think the advertisements are good and I read them all the time. If it was not for the ads. an engineer would not be able to keep up-to-date on new eqiupment. It is the only way we learn about anything new, as circulars are mostly kept in the offices," writes a Hamilton reader.

Double Moral—Read the Advertisements. Use Power House for Advertising.

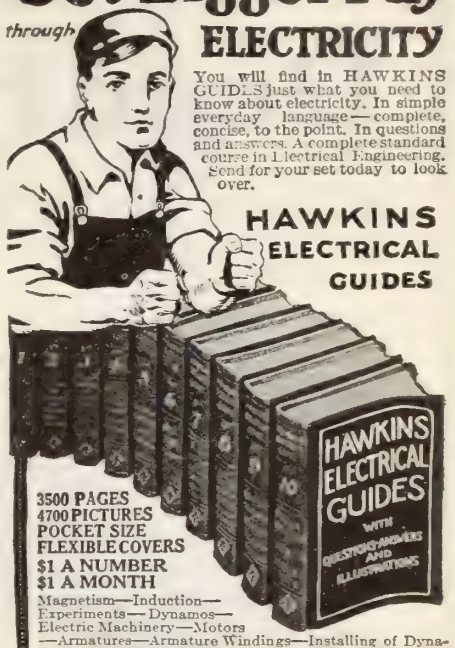
SPLENDID OPPORTUNITY

Engineer or **Steam Specialty Salesman wanted** to handle a high grade Canadian-made return steam trap. District, Quebec. Headquarters, Montreal. A good proposition to the right man. All inquiries confidential.

Apply to Box 210,
POWER HOUSE

The advertiser would like to know where you saw his ad.---tell him.

Get Bigger Pay through ELECTRICITY



You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination **Hawkins Electrical Guides** (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____
Occupation_____
Employed by_____
Residence_____
Reference_____

CRANE MALLEABLE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver
Sales Offices: Halifax, Quebec, Ottawa, Calgary

The Growth of the Deadly Drug Habit

IN the year 1912 only 35 ounces of Cocoaine was imported into Canada. Last year the imports had jumped to 12,333 ounces. In 1907 Canadians imported 1,523 ounces of Morphine. Last year we imported 30,000 ounces.

These figures tell a grim story. The drug habit is growing in Canada—growing so fast that it has become a national menace. The war, by teaching the use of opiates, has stimulated the habit and to-day the insidious disease is creeping into our homes and spreading its coils around countless victims. No class is exempt. It strikes everywhere.

Mrs. Murphy (Janey Canuck), police magistrate of Edmonton, has been engaged by MACLEAN'S MAGAZINE to write a series of articles on the danger and the means of checking it. The first article of this series appears in the February 15th issue (now on sale) and it is a powerful appeal for action against "the human canker-worms and caterpillars who fatten and batten on the unfortunate drug addicts"—the men and women who smuggle and sell the drugs. No better person could have been secured to handle this subject, for Mrs. Murphy is not only a powerful writer, but in her official capacity she has had an opportunity to see all phases of the drug traffic. What she writes has the ring of absolute authority.

Other Readable Features of a Strong Number

This, the first number of MACLEAN'S to appear on the semi-monthly basis, is a particularly interesting one. Here are some of the features:—

THE STORY OF THE ALLENS
By Floyd S. Chalmers

How Jule and Jay J. Allen built up their business from a two-by-four theatorium in Brantford, Ontario, to a twenty million dollar string of theatres—the story, in fact, of a business miracle.

THE BLOOD BROTHER
By W. A. Fraser

A strong, short story by the author of "Bulldog Carney" and "Thorobreds."

THE LAND OF NANNABIJOU
By Charles Christopher Jenkins

There's a huge part of Canada that has tremendous possibilities and yet has been neglected, overlooked. Mr. Jenkins tells about it.

THE MANTLE OF ELIJAH
By J. L. Rutledge

An unusual sketch of a politician, Ernest Lapointe, who is regarded as the successor of Laurier as leader of the Quebec wing of the Liberal party—a fascinating bit of inside political gossip.

THE DIAMOND HUNTERS
By Henry P. Holt

An exciting story of two Canadian sailors in the South Seas.

THE THREAD OF FLAME
By Basil King

A powerful serial story by this famous Canadian author.

And a score of other features—stories, articles and reviews.

Over 80,000 Canadian Families Read

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

FEBRUARY 15th ISSUE *Now on Sale At All News Dealers* **20c**

Jenkins Bros. Valves

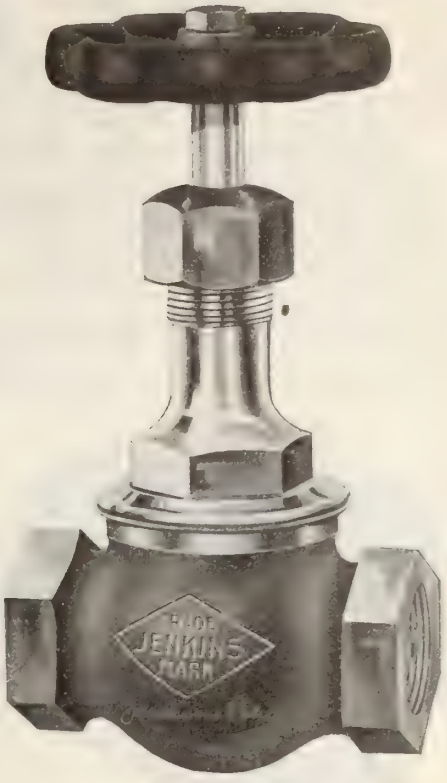


Fig. 106

JENKINS' Valves are recognized as the Standard in all parts of the World and wherever there are supply houses—Jenkins' Valves will be found. The standard of quality never changes except to improve, and while to-day there are hundreds of imitators, the sales of genuine Jenkins' Valves are constantly increasing.

A Fair Offer

If you will put a Jenkins' Valve on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight or does not hold steam, oils, acids, water or other fluids longer than any other Valve—

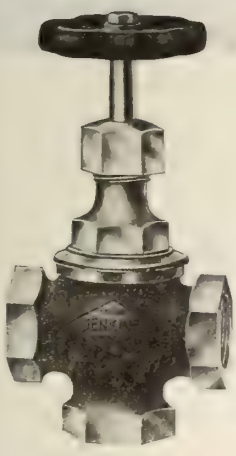


Fig. 110

YOU MAY RETURN IT AND YOUR MONEY WILL BE REFUNDED.

For Every Purpose

There's a Jenkins' Valve for every purpose. You will know the genuine by the Diamond Trade-Mark with the signature Jenkins Bros., cast on the body. Never fail to look for it. It means service and economy to you.

Jenkins' Valves are approved by Department of Public Works in Ontario and Western Provinces. Stocked by first-class dealers everywhere. Catalogue No. 8 free on request.

Fig. 141

TRADE JENKINS MARK
Jenkins Bros

Jenkins Bros. LIMITED

Head Office and Works:
103 St. Remi Street
Montreal, Canada

Agencies in all the
Principal Countries
of the World

European Branch:
6 Great Queen St., Kingsway
London, W.C. 2, England

TRADE JENKINS MARK
Jenkins Bros

Carling BLOWERS SUPERIOR

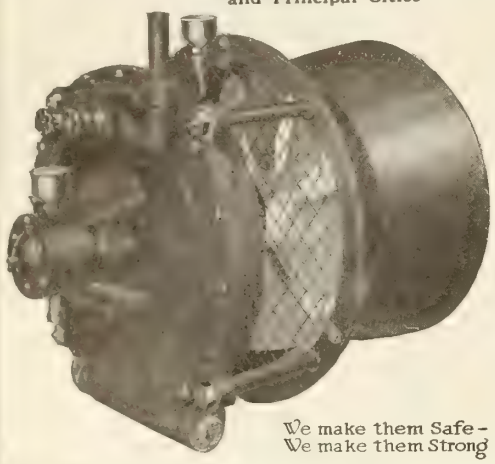
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

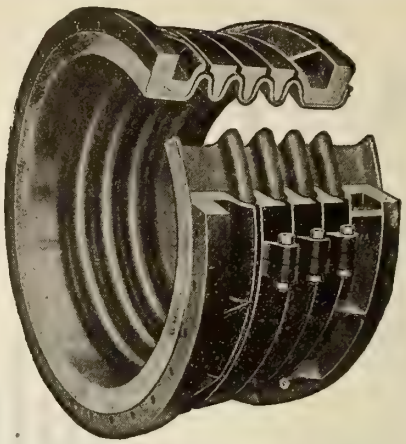
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong



BADGER

SELF - EQUALIZING EXPANSION JOINTS

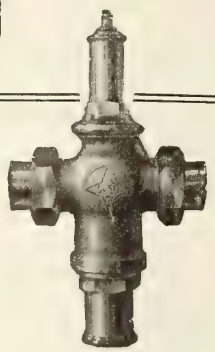
are the best joints for absorbing pipe expansion—Note the corrugations that expand and contract, thus preventing leakage.

Write for our new book today

E. B. BADGER & SONS CO.
75 PITTS ST., BOSTON, MASS.

Canadian Agents
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

MASON SPECIALTIES STEAM



Mason Reducing Valve

Quality!
Reliability!
Service!

The Mason line of steam Specialties meet all requirements of the engine room. Every Mason Specialty represents high-grade construction. Engineers and power house superintendents who have had experience with the Mason line never fail to vouch for their reliability under severe strains, as well as their long and satisfactory service with minimum upkeep cost.

THE MASON LINE

Mason Reducing Valves (Genuine)
Mason Pump Governors
Mason Pressure Controllers
Bundy Steam Traps for every service
Coppus Turbine-driven Blowers
Sims Hot Water Generators
Sims Storage Heaters
Sims Open Feed Water Heaters
Bundy Oil Separators
Ashton Gauges and Safety Valves
Everlasting Blow-off Valves
Babbitt Sprocket Rims
Stratton Steam Separators
Reilly Multi-coil Feed Water Heaters
Reilly Evaporators and Distillers
Reilly Multi-screen Feed Water Filters

Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.

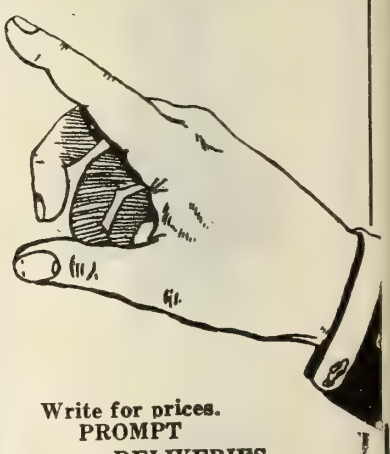
The Mason Regulator & Engineering Co., Limited
Formerly to H. L. Peiler & Co.
Montreal Office and Factory
135-153 Dagenais St.
Toronto Representative:
The Arthur S. Leitch Co., 1002 Kent Building

Structural Steel and Steel Plate Work

of every Description

Penstocks
Thimbles
Draft Tubes
Wheel Cases
Steel Gates
Racks
Gate Steelwork
Power House

MacKinnon Steel Co. Limited



Write for prices.
PROMPT DELIVERIES

Sherbrooke, Que.

Montreal Office:
404 New Birks Building

Protect your small motors with——

CONDIT

Type I Oil Starters

Safety

All mechanism and live parts are entirely enclosed — fuses are dead when switch is in open position — may be locked in open position. This means absolute safety.

Motor Protection

Starters are of **Oil switch construction,** equipped with enclosed fuses for overload and short circuit protection.

Special design enables fuses of approximately full load running current to be used, **which will not blow during starting period.**

It is equipped with low voltage release which immediately disconnects the motor on power interruption or any considerable drop in voltage.

Handle cannot be left in starting position.

Installation and Maintenance

The Conduit Type I Motor Starter is compact and easily mounted on any flat surface.

It is equipped with interchangeable knock-out plates arranged to receive 1½", 1", ¾" or ½" Conduit.

Both movable and stationary members are identical, interchangeable and reversible, reducing maintenance work to a minimum.

The liberal design of conducting parts insures long life.

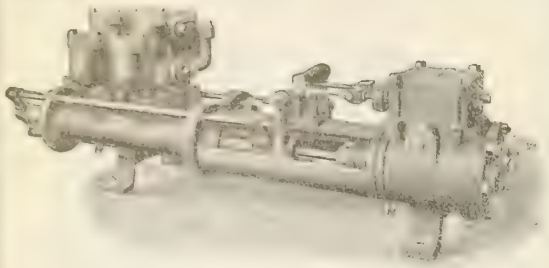
Ample space in the case for making connections.

Our nearest house can supply you.

Northern Electric Company
LIMITED

Montreal Quebec Toronto Winnipeg Calgary Edmonton
Halifax Ottawa London Regina Vancouver

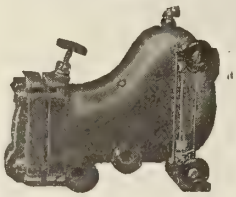
HINTS TO BUYERS



PUMPS that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada



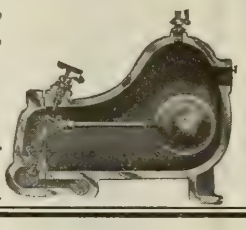
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



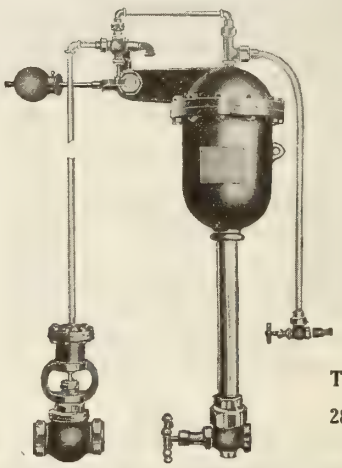
THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

WE WELD
EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300



Safety or Worry?
CHOOSE

Would you rather worry about your fireman's inattention to the boiler feed water, or be absolutely assured of continuous middle gauge lever control by VIGILANT FEED WATER REGULATORS?

We will gladly furnish full information

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor

LANCO BALATA BELTING
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO
SCANDINAVIA BELTING

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE
Put Your Water Wheel Proposition Up To Us

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. Write for our latest catalogue.
Patterns *Machine Work*

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

DEPARTMENT OF LABOUR

Ontario Government

Minister:
Hon. W. R. Rollo.

Deputy Minister:
W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a STATIONARY steam plant of 60 B.H.P. or over, in the Province of Ontario, must hold a Stationary Engineer's certificate from the Board of Stationary & Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers.

After January 1st, 1920, the Certificate issued by the Board will be of four grades, viz., First, Second, Third, and Fourth. Application forms for graded certificates will be mailed upon request after the above-mentioned date. The certificates now issued by the Board will be graded into Third and Second-Class upon renewal, same being classified from the information contained in the renewal application which will be sent to each certificate holder.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse-power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating **such a plant without a certificate is liable** to the penalties set forth in the Act respecting Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1st, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request. The B.H.P. and other information contained in these forms is to be used for statistical purposes. A Registration Certificate will be issued to each applicant. All applications, or requests for same, should be mailed to the Chairman.

W. C. MCGHIE, CHAIRMAN OF BOARD

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

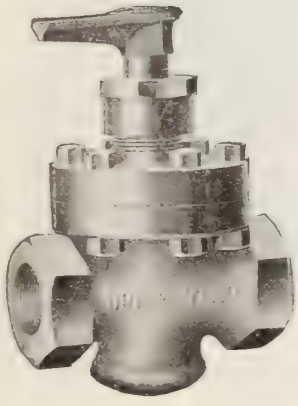
All steam boilers built in, or entering the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., c. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, Parliament Buildings, Toronto.

D. M. MEDCALF, CHIEF INSPECTOR OF STEAM BOILERS

HOMESTEAD
Quarter-Turn Valves



Give Better Service Than Globes and Gates

Homestead Valves provide full pipe area and give straightway, unobstructed flow.

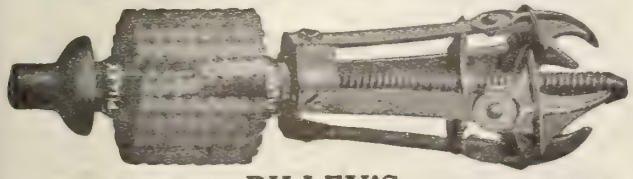
A quarter-turn opens a Homestead Valve — a quarter-turn closes it. Adopt the Homestead in place of your globe and gate valves; better service is assured.

Used for every service —air, steam, oil, water, acids, etc. Made for any pressure up to 3,000 lbs.

All Homestead Valves are constructed with the patented Homestead principle which makes them seatless while the pressure is passing through.

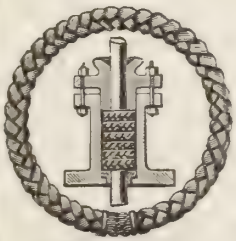
HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over.
A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



DUVAL'S
METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.
SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal

Leonard

UPRIGHT BOILER WITH EXTENSION SHELL

We also sell the following types of Leonard Boilers:—

Return Tubular
Locomotive
Firebox
Upright

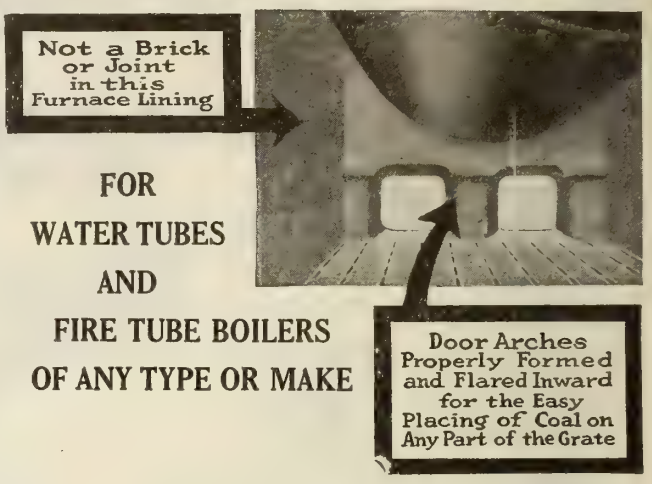
Connelly Vertical Water Tube (Patented)

E. Leonard & Sons
Toronto District Office.

E. J. PHILIP & SONS

57 West Queen Street
TORONTO

DURABLE FURNACE LININGS


Not a Brick or Joint in this Furnace Lining
Door Arches Properly Formed and Flared Inward for the Easy Placing of Coal on Any Part of the Grate

FOR WATER TUBES AND FIRE TUBE BOILERS OF ANY TYPE OR MAKE

A FURNACE lining that is gas-tight and remains gastight in service is easy to build with

BETSON'S REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

It comes in yellow-top barrels ready for use. Anyone can do the job. Experts not necessary. A mallet and trowel are the only tools required.

There is no mystery about Betson's. It is the pioneer and proven Plastic Fire Brick that has made practical the one-piece furnace lining without joints, and is not affected by expansion and contraction. It has a record of 20 years' experience and satisfactory service under all sorts of trying conditions.

Write for booklet that tells of its uses in the boiler room

Canadian Distributors:

International Chemical Co.

44-46 Lombard Street
TORONTO, ONT., CANADA

9-42

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Northern Electric Co., Ltd., Montreal.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Iriam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd. Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
[illegible]

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
[illegible]

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton, Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto., Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto., Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS

MacLean Publishing Co., Toronto.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

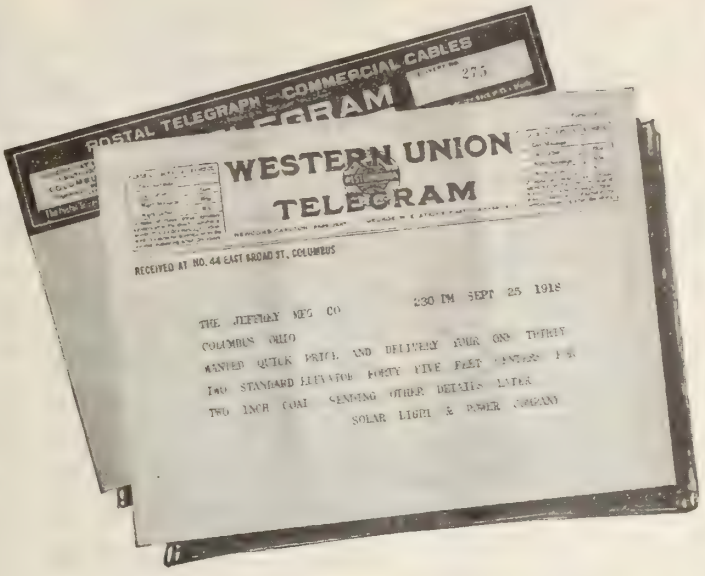
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORKS

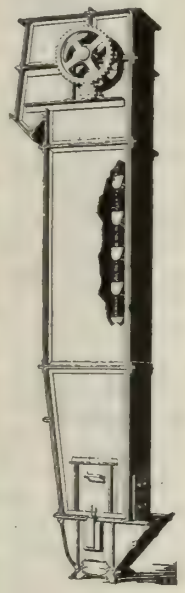
Norwalk Iron Works Co., South Norwalk, Con.

SERVICE?

Just Telegraph Jeffrey


POSTAL TELEGRAPH — COMMERCIAL CABLES
WESTERN UNION
TELEGRAM
RECEIVED AT NO. 44 EAST BROAD ST. COLUMBUS
THE JEFFREY MFG CO
COLUMBUS OHIO
WANTED QUICK PRICE AND DELIVERY FOUR ONE THIRTY
TWO STANDARD ELEVATOR FORTY FIVE FEET CENTERS
TWO INCH COAL SENDING OTHER DETAILS LATER
SOLAR LIGHT & POWER COMPANY

From your Jeffrey Catalog on Standard Bucket Elevators select the number and feet centers, and the information as to price and delivery will be wired back to you at once.

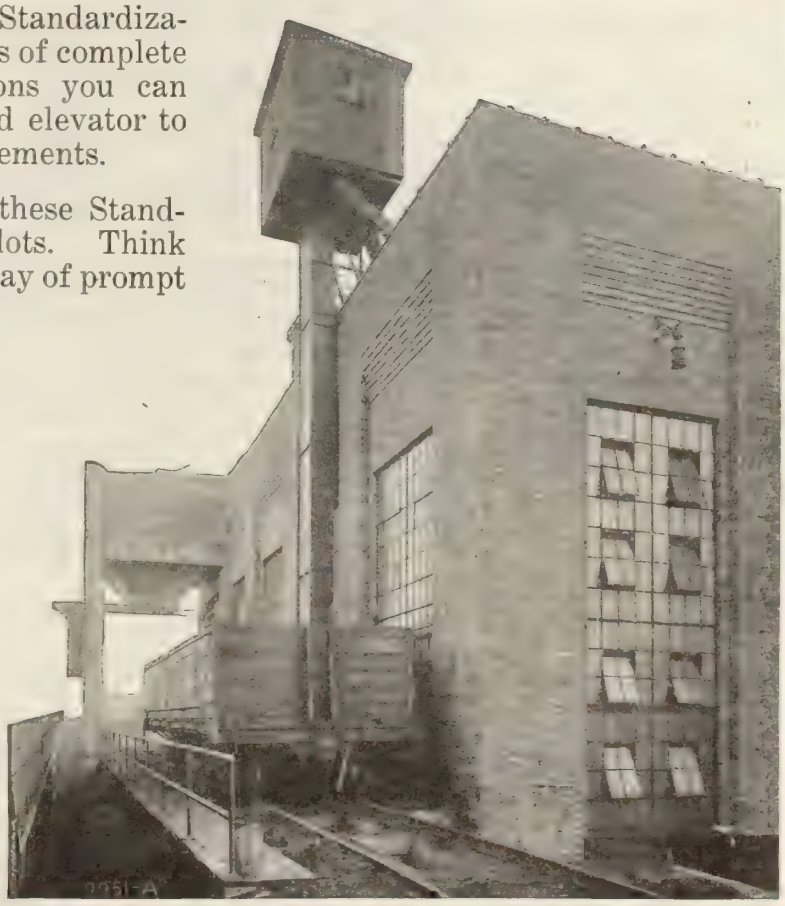


Quite an improvement over the old, endless corresponding, when it was necessary to make special layout before work on your order could be begun, isn't it?

That's the advantage of Standardization. Now from 40 pages of complete layouts and specifications you can select a tried-and-proved elevator to exactly meet your requirements.

We are manufacturing these Standard elevators in stock lots. Think what that means in the way of prompt shipment and low cost.

If you haven't Jeffrey Catalog 244 already, send for it to-day. Besides simple directions for ordering an elevator from the specifications given it contains many interesting installation views, with detailed descriptions of results had from "handling it mechanically."



At the power plant of a large implement manufacturer. Coal is fed from hack-hopper to Jeffrey Single Rollcrusher and through plate feeder to Jeffrey Standard Bucket Elevator.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jeffrey Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal. Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equip. Co., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubriciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STEEL
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

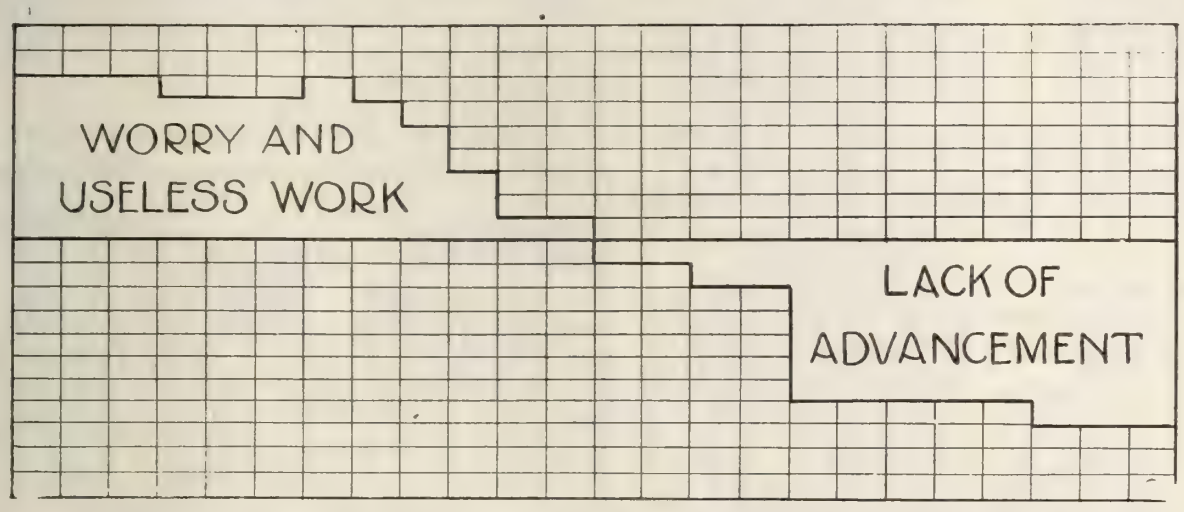
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the *C.A.S.E.* Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithaca, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Leonard & Sons, E., London, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

Showing ease with which Plibrico is laid in place.

PLIBRICO Increases Boiler Efficiency

PLIBRICO is a plastic refractory that makes a solid one-piece furnace lining without joints. PLIBRICO also is unexcelled for baffle construction and repairs.

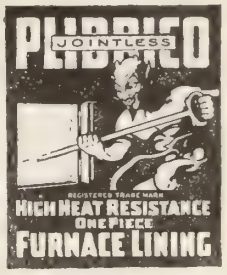
It will increase the efficiency of your boiler 15 per cent. It will make your furnaces gas and air tight and greatly reduce the cost of upkeep. Can be used wherever fire brick is used. Will outwear any fire brick made.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.



Reg. U.S. Pat. Office Trade Mark

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adam ite Gauge Glass Rings. **Glass Tubes and Rod**

S. & C. BISHOP & CO., St. Helens, Lancashire

LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

GEORGE T. LADD COMPANY

Farmers Bank Building

PITTSBURGH - - PENN., U.S.A.

Make it Easier- -

ALL-WAY

Flexible Spout Grease and Oil Guns

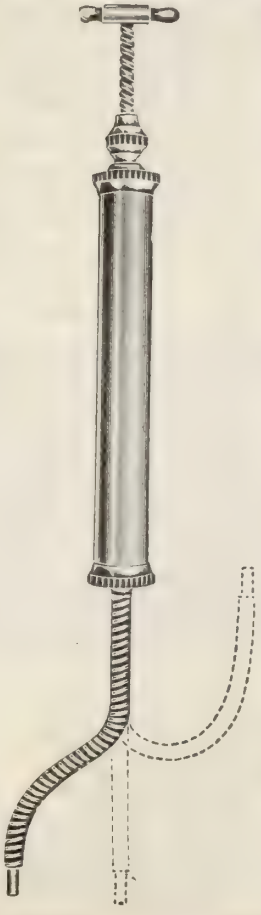
Make it easy to refill the most out-of-the-way gear cases or transmission as the flexible spout can be bent to any desired angle. The Cleaning Device at the end of the **"ALL-WAY"** spout reduces cleaning time and oil wastage to a minimum.

The **"ALL-WAY"** gun is especially useful and handy in filling lineshaft hanger reservoirs.

If your dealer cannot supply you, write us.

We also manufacture the well-known "ALL-WAY" Oil Can. Saves you 50% of your oil bill.

The Allway Oiler Mfg. Co.
196 KING STREET WEST
TORONTO, ONT.



FOR REMOVING SCALE

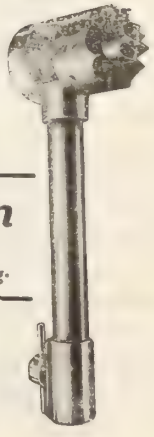
from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★



Frank Gilman

(SOLE MAKER)
9, Westfield Road Birmingham Eng.

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Co., Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
Defender Automatic Reg. Co., St. Louis.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
Leonard & Sons, E., London, Ont.
W. S. Sexton Boiler Setting Co Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
E. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PACKING F. J. A. B.
Lincoln Electric Co. of Can., Ltd., Toronto

CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING SERVICE
Electric Welding Co., Montreal

WELDING SUPPLIES
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

We want your Order

We are in a good position now to give you service on Horizontal and Vertical Tubular Boilers. That means much, considering the quality of work we turn out.

Horizontal Tubular
Vertical Tubular
Locomotive
Marine

Write for Prices, etc.

Engineering & Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Hand Frame	No. of Blade for Power Machine			
		Light Machine	Medium Machine	Heavy Machine	Extra Heavy Machine
Light Angles					
Channels			262		
Tee Iron					
Ornament					
Heavy A					
Channe			255		
Tee Iro					
Light S			5	254	256
Heavy			5-B	2	256-B
Steela					
Condu			2	25	
Brass					
Solid S				B	B
Cold R					
Machin					
Tool Ste					
Cast Iron					
Brass					
Sheet Metal a					
Tubing					
Less than 18 gage,	295	298			
Over 18 gage	102	252			

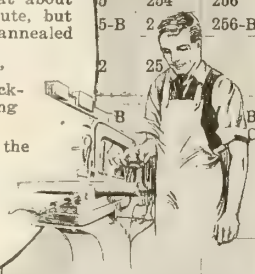
Get the S. P. M. Right

Don't run blades too fast in power machines. You can cut soft steel, if you use compound, at about 100 strokes per minute, but don't try it on unannealed tool steel.

"Haste makes waste" just as much in hack-sawing as in anything else.

Send for a copy of the Starrett Catalog No. 21 "CD" and Chart "CD"

42-983



Numbers above are those given in the Starrett General Catalog and on boxes containing the blades

Get the Starrett Hack Saw Booklet Sent Free

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.

THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS

Tycos TEMPERATURE INSTRUMENTS

INDICATING RECORDING CONTROLLING

No matter how rigorous the application, *Tycos* instruments will not fail you.

Unhesitatingly the Chemist, the Engineer, the Superintendent of Power—men that shoulder great responsibilities, put their trust in *Tycos* instruments. 8000 types for every industry, every walk of life.

If to-day's mail carries your request for *Tycos* catalogs and other literature you will be a day nearer the solution of your temperature problems.

(388)

Taylor Instrument Companies
ROCHESTER, N Y

THERE'S A *Tycos* OR *Taylor* THERMOMETER FOR EVERY PURPOSE

110-112 Church Street, Toronto, Canada

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

INDEX TO ADVERTISERS

Allway Oiler Mfg. Co. 61
Audel Co., Theo. 47

Badger & Sons Co., E. B. 50
Betson Plastic Fire Brick Co. 54
Bishop & Co., S. & C. 61
Busch-Sulzer Bros.— Diesel Engine Works 53

Can. Assoc. Stationary Engrs. 59
Can. Fairbanks-Morse Co. 45
Can. Farnsworth Company..... Inside back cover
Can. Graton & Knight Co. 8
Can. Mead-Morrison Co. 15
Carling Turbine Blower Co. 50
Chaplin-Fulton Mfg. Co. 52
Crane, Ltd. 47
Coppus Engr. & Equipment Co. .. 1

Darling Bros. 52
Dart Union Co. 3
Dept. of Labor 53
D'Este Co., Julian 9
Dominion Belting Co. 11
Durabla Mfg. Co. 5

Electric Welding Co., The 52
Engineering & Mach. Works of Canada, Ltd. 63

Federal Engineering Co. 52

Gates Refractories, Ltd. 2
Gilman, Frank 61
Goldie & McCulloch Co. 16
Graton & Knight Mfg. Co. 8
Green's Economizer, Limited 8

Hays School of Combustion 13
Hints to Buyers 52
Homestead Valve Mfg. Co. 53
Hoyt Metal Co. 2

Imperial Oil Co. 3

Jeffrey Mfg. Co. 57
Jenkins Bros. 49
Jointless Fire Brick Co. 63

Ladd Co., The Geo. T. 61
Laurie & Lamb 53
Leonard & Sons, E. 8
Lunkenheimer Co. 7

MacKinnon Steel Co. 50
Mason Regulator & Engr. Co..... 50
MacLean's Magazine 48
Morrison Brass Mfg. Co., Jas. ..... Outside back cover
Murphy Iron Works 7

Norwalk Iron Works 5
Northern Electric Co. 57

Pilley Packing & Flue Brush Mfg. Co. 53
Penberthy Injector Co., Limited ... Front cover
Philip & Sons, E. J. 64
Pyro Products Co.....Inside front cover

Refrigeration Dept. 10
Royles, Ltd. 14
Robb Engineering Works 4

Sarco Co., Inc. 46
Sexton Boiler Setting Co. 12
Shell-Bar Boico Supply, Ltd. 12
Smart-Turner Mach. Co. 52
Standard Mach. & Supplies, Ltd... 14
Starrett Co., L. S. 64
Sterling Engine Co. 9
Steel Mill Packing Co. 10
Sturtevant Co., B. F. 6
Scaife, Wm. B., & Sons Co. 64

Taylor Instrument Co. 64
Tagliabue Co., C. J. 9

Victoria Foundry Co. 52

Watson & McDaniel Co. 52
Wilson Mfg. Co., J. C. 52
Williams Co., J. H. 11

York Mfg. Co. 10

Announcement

The Canadian Farnsworth Company, Engineers and Manufacturers of Condensation Pumps, Automatic Boiler Feeders, Return Steam Traps, all of the Duplex Type, and General Steam Utilities, have opened and are now operating their new factory, at 1-24 Hillingdon Avenue, Toronto. These lines formerly manufactured by the Canadian Fairbanks-Morse Company.

This new organization is under the management of Mr. W. H. Rose, who was well known to engineers as General Manager and Chief Engineer of the Geo. W. Cole, Limited, Toronto.

The Farnsworth line is thoroughly well known, having a world-wide reputation for efficiency in manufacture.

The largest order for Condensation Appliances ever placed is now in process of manufacture by this Canadian Company, for use in a Canadian plant, and consists of a number of Automatic Boiler Feeders of 1000 h.p. each, and a quantity of Lifting, Separating, Condensing Types of Machines. Photos of this installation will appear in later issues of Power House.

The Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

MORRISON'S

Morrison
Reducing Valve

Steam Specialties

Engine Supplies

Morrison
Improved
Injector

Boiler Mountings

"Beaver" Globe Valve
Bronze

A complete line of Guaranteed Steam Goods of the finest quality to meet every Power House requirement

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

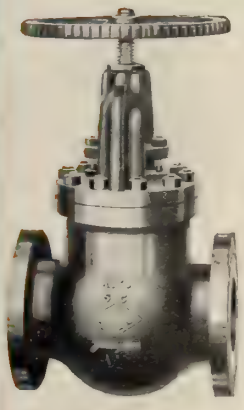
A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

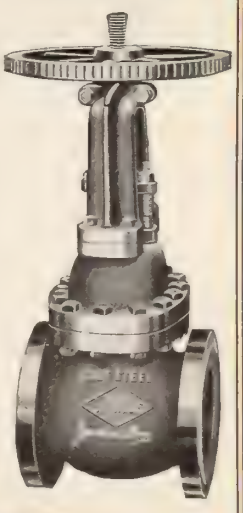
MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 5. Publication Office, Toronto—March 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE JENKINS MARK



Jenkins Bros



It pays to purchase Valves recommended by leading engineers for their modern design, quality of material, and reliable service—such valves are sure to require least attention and cost the least for upkeep.

Jenkins Valves have been on the market for over half a century; they have won the confidence of engineers and superintendents with their faultless and economical service. They endure where other valves fail because of their quality of metal, careful and scientific construction—they are made extra heavy and strong where pressure and strain is greatest.

There's a Jenkins Valve for every purpose. In making your purchase be sure you secure the genuine—you'll know them by the Diamond Trade Mark as indicated above; it's cast on the body of each valve; for your protection. Stocked by first-class dealers everywhere.

Catalog No. 8 Free on Request

Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street Montreal, Canada.

Agencies in all the Principal Countries of the World.

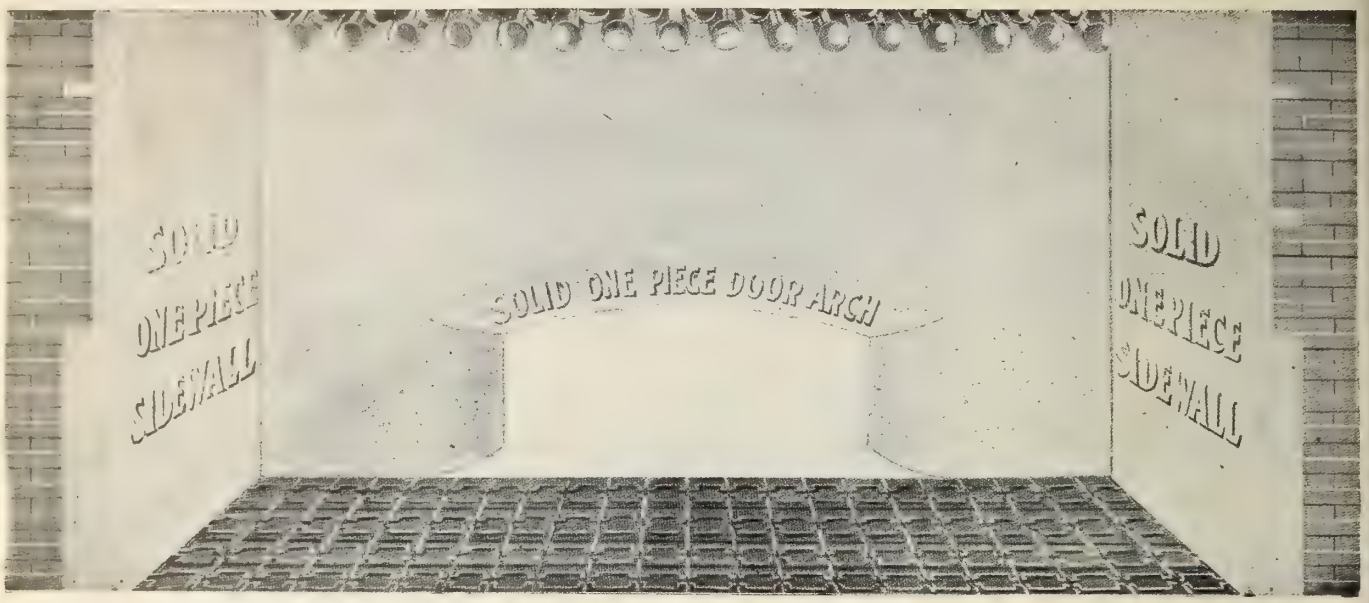
European Branch: 6 Great Queen St., Kingsway London, W.C. 2, England.

PYRO-PUTTY

TRADE MARK REG U S PAT OFF

FIRE BRICK IN PUTTY FORM

The World's Best Furnace Lining Material



Sketch above represents the fire box of a water tube boiler lined with PYRO-PUTTY

Standard fire bricks of the highest quality contain silica and aluminum oxide in almost equal proportions. This also is true of PYRO-PUTTY; therefore PYRO-PUTTY is

in reality

"The Highest Quality Fire Brick in Putty Form"

PYRO-PUTTY is superior to Standard Fire Brick of the highest quality **because** it can be installed **all in one piece,** instead of there being several hundred separate bricks and several hundred joints.

PYRO-PUTTY is also superior to other brands of Plastic Furnace Lining Material **because** it contains all natural refractories, so that when it is subjected to heat it "bakes" together naturally instead of being held together by asbestos fibre, etc., etc.

PYRO-PUTTY Should be used for—

building door arches, side walls, bridge walls, baffles, rear arches, curved stoker arches, dutch ovens and complete furnace linings of every description.

When a worn furnace lining is patched with PYRO-PUTTY the patches invariably outlast the balance of the lining

Any job that can be done with standard fire bricks can be done in less time and by unskilled labor if PYRO-PUTTY is used. And the finished job will be far more durable than a job done with standard fire bricks. **A few barrels of PYRO-PUTTY should be part of the emergency equipment of every steam power plant.**

REMEMBER— PYRO-PUTTY is put up in barrels weighing 700-lbs. each NET WEIGHT. A barrel is equivalent to 100 standard fire bricks.

PYRO PRODUCTS COMPANY

P.O. Box 685, Toronto, Ontario

STEEL TANKS AND BINS

We have made a success of building steel plate work by specializing in it.

The new additions and improvements to our boiler shops have placed us in a better position than ever before to do this work right.

Our facilities in every department have materially increased. We have the equipment and the experience to turn out this special work as it should be.

If you are confronted with any problem on this work send it in and let our Engineers give you the value of their experience.

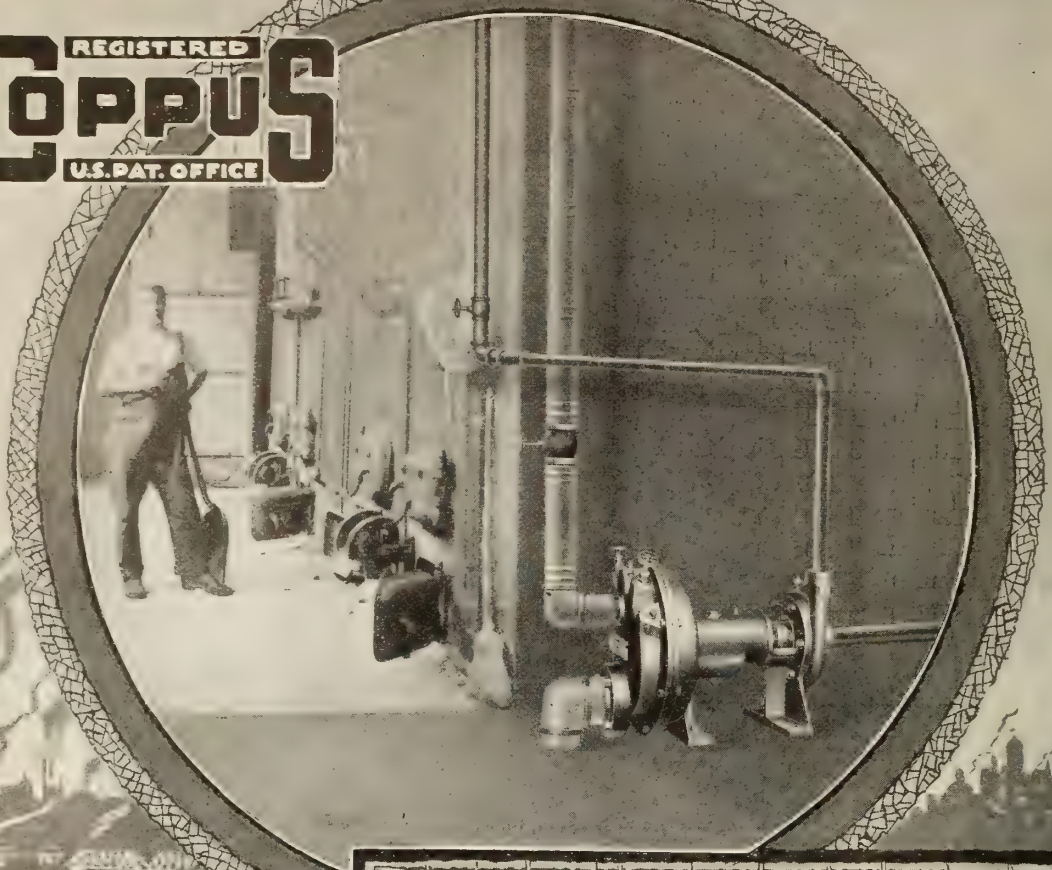
We design and build:

CONVEYORS
SMOKE BREECHINGS
STEEL STACKS
SPARK ARRESTORS
STEEL BUCKETS
ELEVATORS
RIVETED TANKS
STEEL TANKS
STORAGE BINS
COOKERS AND DIGESTORS
STEEL GAS MAINS
REFUSE BURNERS
WELDED TANKS
SETTLING TANKS

Waterous

BRANTFORD, ONTARIO, CANADA

REGISTERED
COPPUS
U.S.PAT. OFFICE



This Dependable Boiler Feeder for Your Power Plant

Possesses these distinct advantages:—

Simplicity of construction.
Steady feed without pulsation.
Easily controlled feed capacity.
Exhaust steam free from oil.
Less floor space required.
Lower upkeep—less attention required.
Higher steam economy.
Longer life—less depreciation.
Single unit construction.
Completely built in our plant.
Especially designed for the purpose.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save **you** money." Write for Blower Catalog.

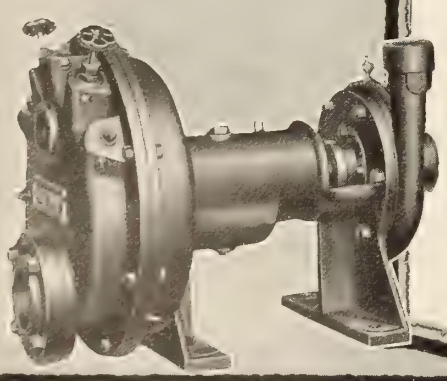
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.



COPPUS Centrifugal Turbo FEED PUMP

The New "Emco" A332
Stop and Waste Cock

A "Two in one Fitting."

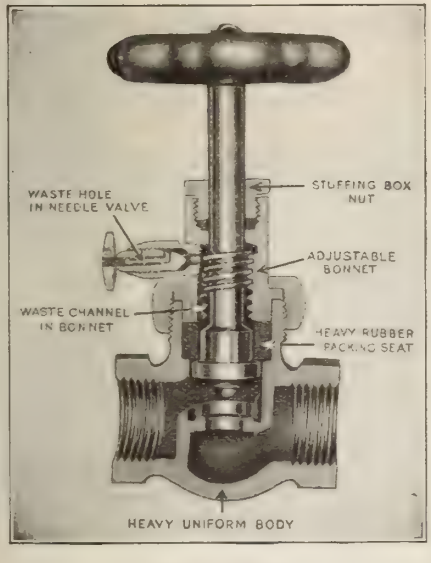
With five points of Superiority——

——five selling points in addition to the prestige that goes with the word "Emco," the trademark of its makers.

As a straight Stop-Cock or a Stop and Waste Cock it is equally adaptable.

Study the marked points in the cross sections. Pay particular attention to the arrangements for waste water:

FIRST——the adjustable bonnet which allows the needle waste valve to be placed in proper position for catching waste water.



Cross Section "Emco" A332 Stop and Waste Cock

SECOND——the needle valve which may be shut off independently to prevent a rush of water out the waste tube, when turning water on and off.

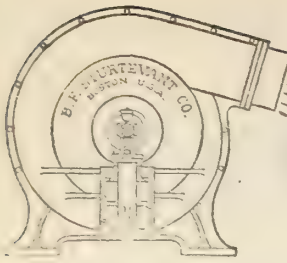
Every "Emco" is thoroughly tested before leaving our factory.

Write for our catalogues.

Order direct.

Empire Manufacturing Company, Limited

London and Toronto, Canada



Sturtevant

REG. U.S. PAT. OFF.

PUTS AIR TO WORK

BURN LESS AND CHEAPER FUEL

HAVE you given the same careful consideration to the operating cost of your boiler room as you have to the other departments of your plant? Because the boiler room does not come under your eye as frequently as the financial statement does is not a fair reason for letting it run day in and day out without giving it some consideration. To-day no one item of expense affects your profit and loss account more than the coal bill.

There is enough coal for you, not the kind you usually buy perhaps, but enough of cheaper grades, like hard coal screenings, to keep the boilers working. Your stack may not draw well enough to burn this cheaper fuel but a

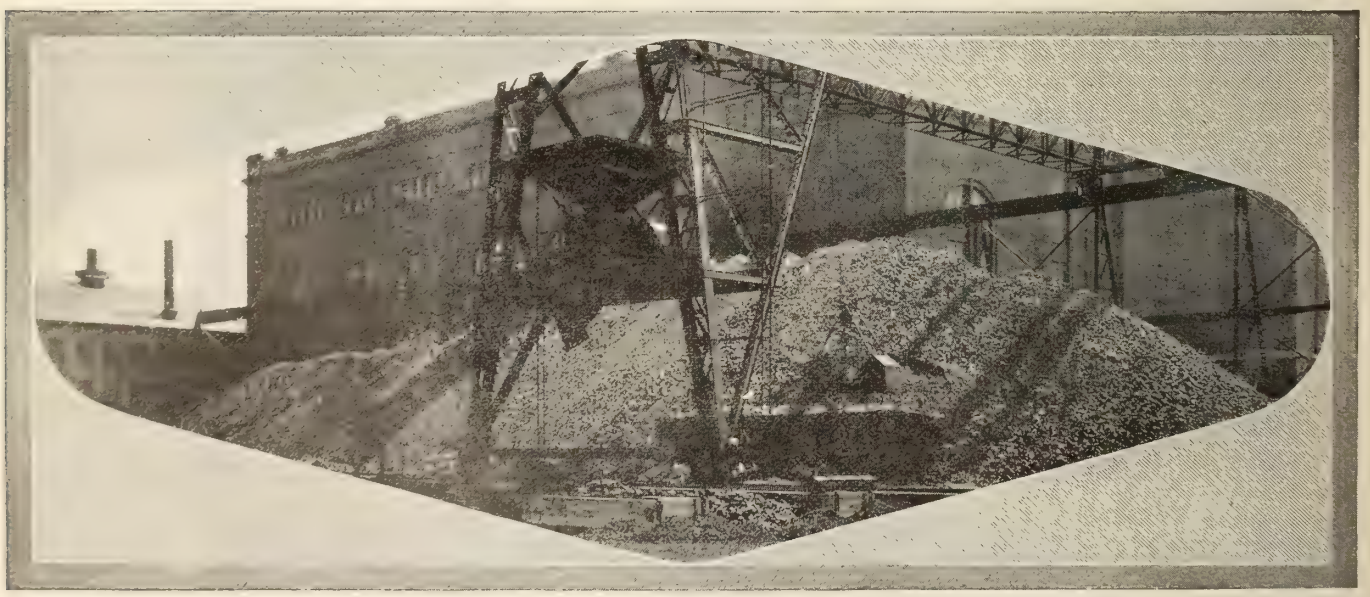
Sturtevant
(TRADE MARK)

MECHANICAL DRAFT SYSTEM

will. It will not only burn this cheaper coal while the present shortage exists but it will place you in a position to continue using this fuel year in and year out. The system pays for itself in actual fuel saving as well as making you independent of embarrassing shortages. These are not untested theories; they are facts, practically proven in many boiler plants using the Sturtevant System.

ASK US TO SEND CATALOG 236-U

B. F. STURTEVANT CO., OF CANADA, LTD.
HEAD OFFICE AND WORKS: - - GALT, ONT.
SALES OFFICES: TORONTO AND MONTREAL

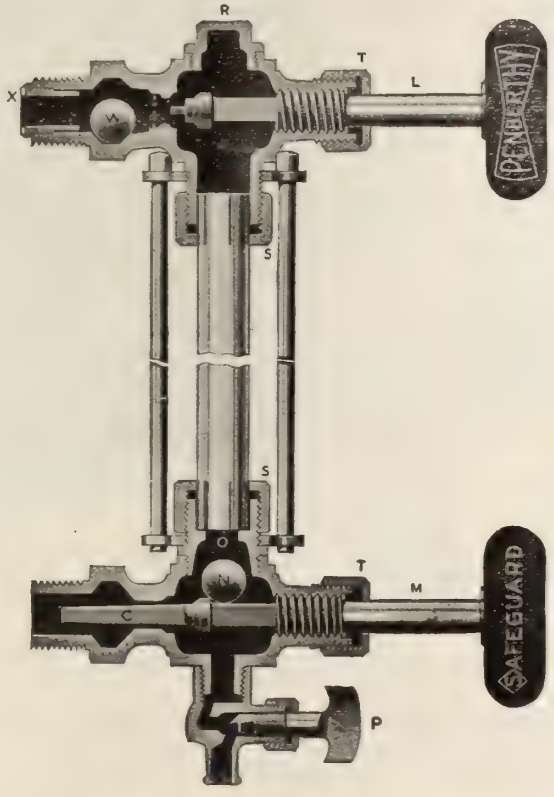


Power Plant of Union City Gas and Electric Co., Cincinnati, Ohio

TRADE

PENBERTHY

MARK.



"SAFEGUARD"
AUTOMATIC WATER GAGE

POSITIVE PROTECTION

¶ When a "Safeguard" gage glass is broken, your boiler room attendants will not be exposed to the dangers of shutting off the gage valves in the midst of escaping steam and scalding water. The quick, positive action of the "Safeguard" will automatically protect them and also prevent the burning of your boiler plates, as might happen when a boiler is nearly drained through a broken gage glass.

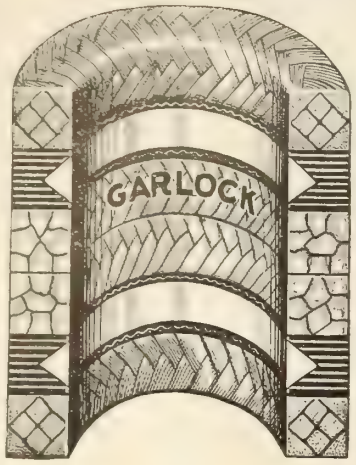
PERFECT OPERATION

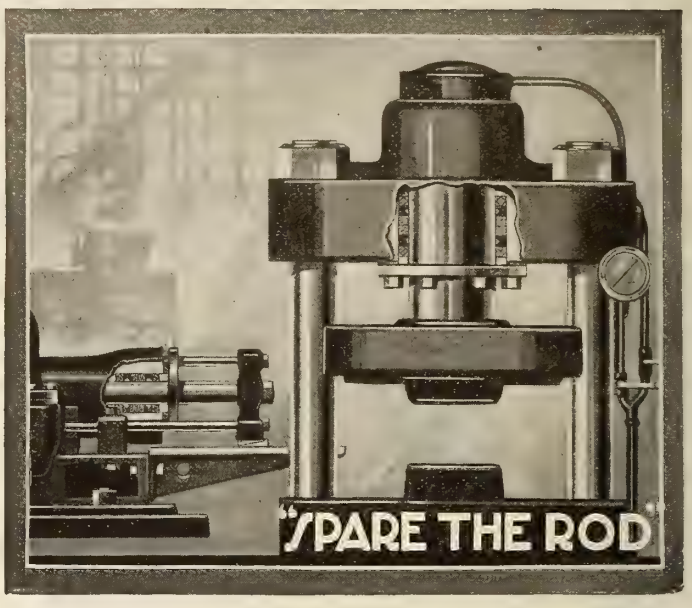
¶ The automatic ball-valves of the "Safeguard" close only when glass is broken and positively drop away from their seats as soon as the new glass is inserted. This feature makes the gage operate perfectly at all times and wholly prevents the showing of a false water level and the dangers which might result. We feel confident that the "Safeguard" is the utmost in automatic water gage construction.

"LET THE SAFEGUARD GUARD YOUR SAFETY"

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

GARLOCK PACKINGS





FOR GENERAL HYDRAULIC SERVICE

In steel mills and blast furnaces, where pressures vary by thousands of pounds, and where rams and plungers are often exposed to grit and corrosion,

Garlock Style No. 960

is guaranteed to give entire satisfaction. This combination is made up of braided copper, metal wedge and waterproof hydraulic rings. It will hold a pressure of 3,000 pounds.

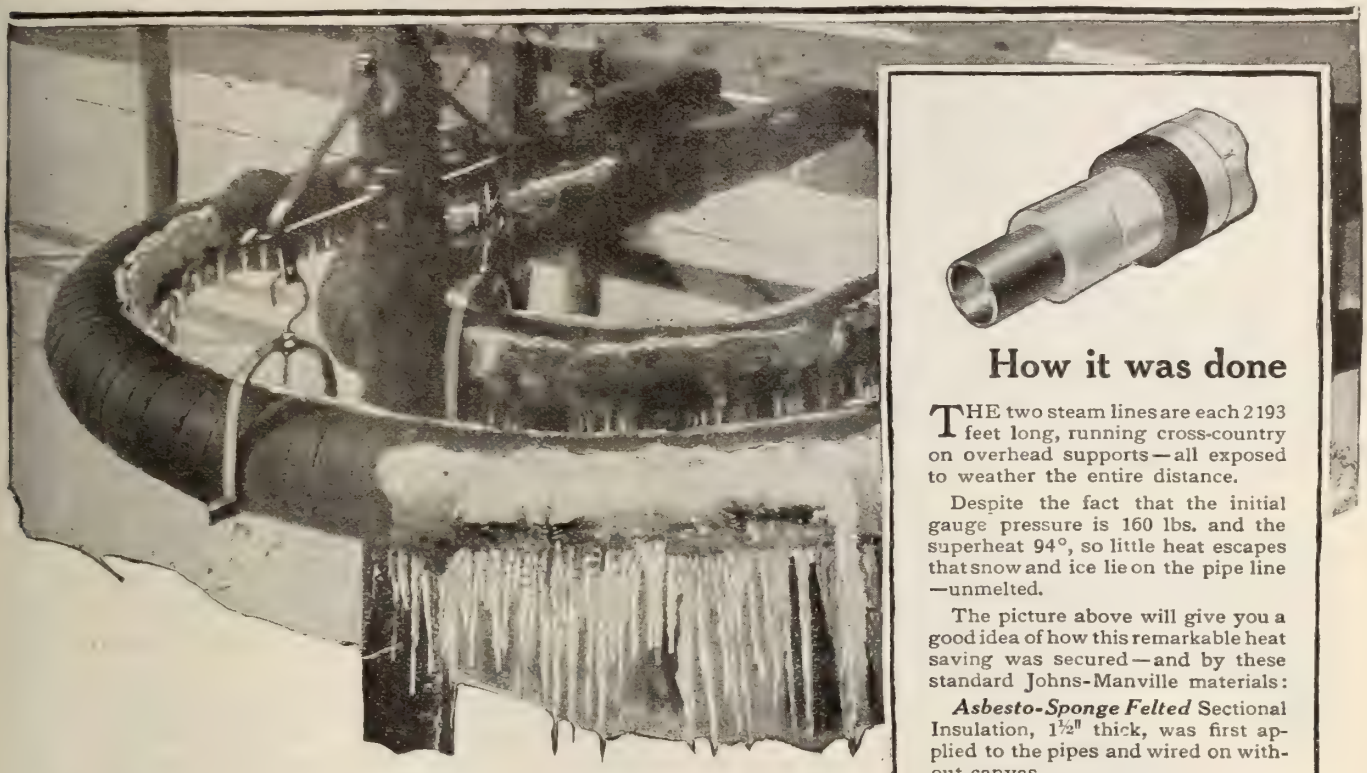
Write for our catalog.

THE GARLOCK PACKING COMPANY, - Hamilton, Ont.

BRANCHES:

Montreal, Quebec - - - 409 Shaughnessy Bldg.
Toronto, Ontario - - - 404 Continental Life Bldg.
Winnipeg, Manitoba - - - - - Galt Bldg.
Calgary, Alberta - - - - 211 Eighth Ave. W.

Boiling Water three inches under the ice!



How it was done

THE two steam lines are each 2193 feet long, running cross-country on overhead supports—all exposed to weather the entire distance.

Despite the fact that the initial gauge pressure is 160 lbs. and the superheat 94°, so little heat escapes that snow and ice lie on the pipe line—unmelted.

The picture above will give you a good idea of how this remarkable heat saving was secured—and by these standard Johns-Manville materials:

Asbesto-Sponge Felted Sectional Insulation, 1½" thick, was first applied to the pipes and wired on without canvas.

Johns-Manville Hair Insulation, 1½" thick, was then wrapped around the Asbesto-Sponge—and finally

3-Ply Johns-Manville Asbestos Weather-Proof Felt was wired on over the hair insulation to make an absolutely weather-proof jacket.

You will note that these are all standard Johns-Manville Insulations, included in the list below:

Asbesto-Sponge Felted, 85% Magnesia, Asbestocel, Zero Insulation, Anti-Sweat Insulation, Ammonia Insulation, Underground Steam Conduit and Insulating Cements.

H. W. JOHNS-MANVILLE CO.
New York City
10 Factories—Branches in 63 Large Cities
For Canada,
Canadian Johns-Manville Co., Ltd., Toronto

THERE is nothing new in the idea of covering pipes so that some of the heat in them may be saved.

But the exact science of maintaining temperature of fluids in pipes and other containers passing through a medium of different temperature is of comparatively recent origin.

To know the value of heat saving materials and the correct manner to use them is the basis of the science of insulation. And it is to this knowledge, combined with years of manufacturing skill, laboratory research and the application of our products, that Johns-Manville insulation owes its position today—in fact, it is the mother business of this Company.

For instance—it is doubtful if, twenty-five years ago, the conditions shown here and described in the column to the right could have been met efficiently. Now such a problem is simply a matter of engineering calculation, based on materials whose efficiency is accurately known in advance.

Accurately known because Johns-Manville insulating materials are the result of the most careful study of all materials and methods for heat saving. No Johns-Manville insulating material is advocated for use until it has proven with exactitude to be the most efficient for the purpose.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

Goodyear Builds Better Hose

There was a time when men thought that rubber tires had reached their limit of quality. Then Goodyear entered the field, and, by leaving the beaten path, built the largest tire business in the world.

When Goodyear scientists and engineers turned their attention to Industrial Hose they were not satisfi d with many of the existing standards. They started from the ground up. They built for Industry's needs. Was the rubber lining unsatisfactory—Goodyear men worked till they had discovered a better one. Did a cover wear out too quickly in hard service—the knowledge gained in building automobile treads was applied to hose covers. New specifications were worked out. New formulae were developed.

The Goodyear Industrial Hose offered you today is the result of a definite policy. It is the *solution* to your hose problems—not a makeshift.

In mines, mills, foundries, shipyards, railways, and a hundred other industries, all over Canada, it is setting new standards.

There is a Goodyear Industrial Hose for every particular use—yours among them. Let a man, trained by Goodyear in hose problems, call and explain them to you. No obligation. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver

GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE

LINCOLN ARC WELDER

Is Your Industry in this List?

If it is, you will find Lincoln Arc Welding to be an efficient, time and money-saving process that you can utilize to repair boilers, to mend cracked castings, to build up any piece of defective forged or stamped piece of metal equipment.

This list is representative of the users of Lincoln Arc Welders and the Lincoln Arc Welding Process.

In some cases two and more Lincoln Arc Welders are permanently employed on the job. In others, our welding shop is called on to do the work.

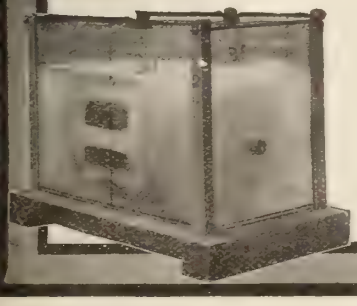
Either way assures you perfect and prompt repairs.

Where speed is necessary, as in the case of a leaky boiler, we realize that time is the all-important item. We start at once—and finish in a tenth of the time usually needed either by a replacement or other methods.

- Automobile Manufacturers
- Agricultural Implement Manufacturers
- Boiler Shops
- Car Builders
- Drop Forging Manufacturers
- Fan and Blower Manufacturers
- Industrial or Shop Tractor Manufacturers
- Locomotive Manufacturers
- Metal Specialties — Sash, Lockers, Wheel Barrows, Barrels, etc.
- Pressed Steel Frame Manufacturers
- Safe and Vault Manufacturers
- Steel Mills
- Switch and Frog Manufacturers
- Ship Yards
- Railroads
- Tractor Manufacturers
- Transformer Manufacturers
- Foundries
- Oil Refineries
- Steam Pump and General Machinery Manufacturers

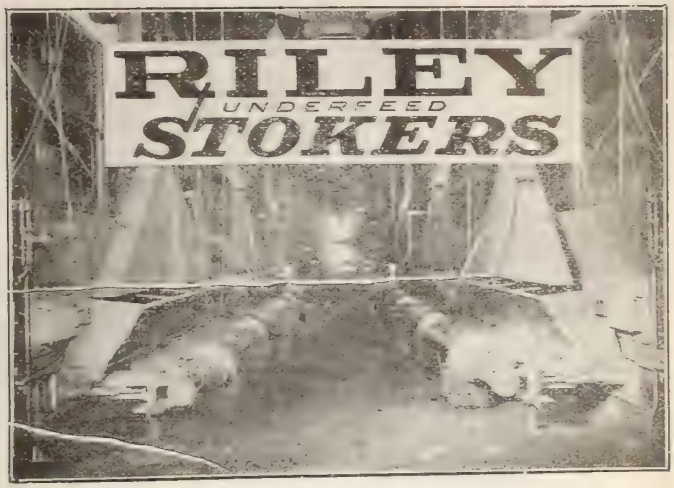
Get in touch with us. Phone Main 3768, wire or write for all particulars to-day.

"Link up with Lincoln"



THE
Lincoln Electric Company of Canada, Limited
Head Office:
1111 Temple Building
TORONTO, CAN.

Branch: Coristine Bldg.
Montreal Que.



Twelve eight-retort RILEY UNDERFEED STOKERS as installed under twelve 625 H.P.B. & W. boilers at the Port Morris Station of the New York Central R.R. Co.

One feature alone of the Riley Stoker—its ***moving grates***—is worth a dozen skilled operators. Even the most skilled would find it impossible to keep the fuel bed free from holes and clinkers without dropping the efficiency by opening the firedoors.

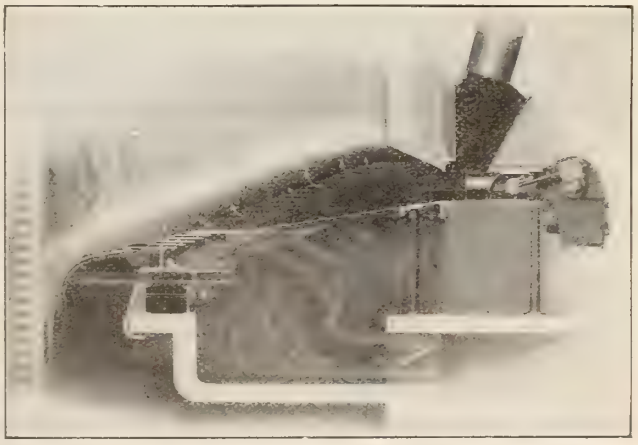
The Riley Stoker moving grates distribute the fuel—keep the fuel bed open and porous—clean the fires—and discharge the ash and refuse. All done efficiently and economically without the attention of the operator.

It is this kind of money-making and man-releasing machinery that pays dividends, not only for the central station but for the industrial plant.

Your plant may offer large opportunities for savings. Investigate today. Complete details of the Riley Stoker construction are illustrated and described in Catalog HR-3. Copy on request.

For information on the Murphy Automatic Furnace for smaller boilers see advertisement in last issue or send for Murphy Catalog HM-3.

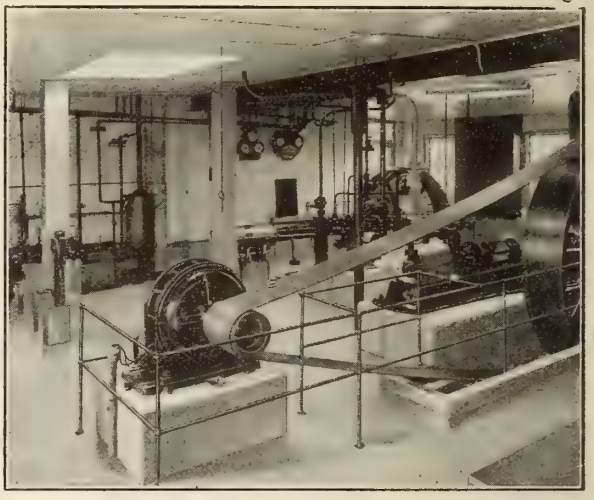
Sanford Riley Stoker Co.
WORCESTER, MASS.
British Licensees: Erith's Engineering Co., Ltd., London
French Licensees: Erith, Leroy & Cie., Paris, France



LINDE ICE MAKING MACHINERY

For Every Purpose

We can fill all requirements in Ice Making Machines. Our engineers will design and build equipment for any plant, no matter how large or small. Quality and simplicity are the special features embodied in Linde equipment. It will pay you to adopt Linde products and do away with the old and unsanitary methods. Write for detailed information.



Civic Abattoir, Toronto

The Linde Canadian Refrigeration Co., Limited

37 St. Peter Street, MONTREAL

TORONTO WINNIPEG VANCOUVER

The Annual Refrigeration Number

of Power House

will be issued on April 20th. This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the
REFRIGERATION NUMBER

Cold Storage Plants Equipped With

FRICK Refrigerating Equipment

are much more sanitary than the use of harvested ice—and more convenient.

Get in touch with our Canadian representative and secure from him such information as you desire.

Frick Refrigerating Plants are made to suit every practical condition.

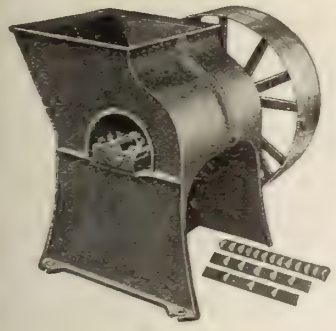
Write for Catalogs

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

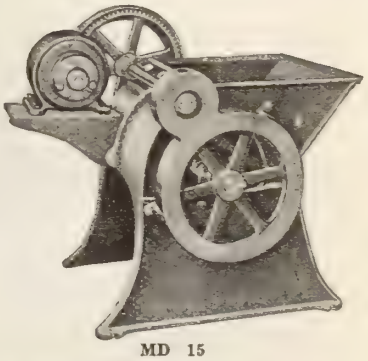
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



No. 13

Endorsed Everywhere by Users of Crushed Ice

BECAUSE—
1—Prepares ice in a jiffy.
2—Saves all the hard labor.
3—Saves ice because work is done without scattering.
4—Gives you uniformly crushed ice—fine or coarse as required.
5—Releases the time of employees for other work.
6—Saves you money by building a better business and reducing your upkeep cost to the minimum.



MD 15

A LITTLE GIANT ICE BREAKER

A 90

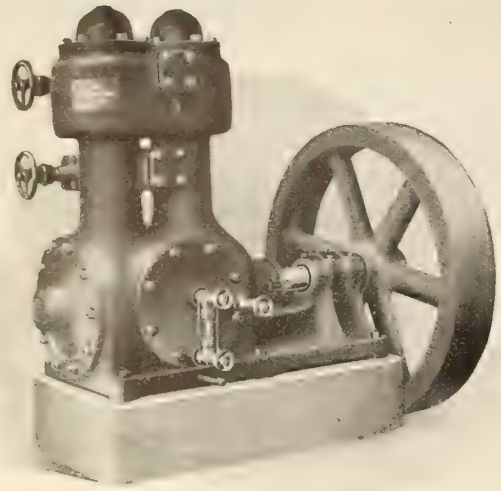
is a necessity to every user of crushed ice. It is not an ordinary ice breaker. Carefully developed to meet individual needs. Nineteen different sizes and styles. Uniformly fine or coarse ice as desired. The patented features—DIAMOND POINT DOUBLE CUTTING PICKS AND TWO-PIECE CONSTRUCTION—insure the effectiveness and longer life of the LITTLE GIANT.

Send for our interesting Special Catalog. It's FREE and contains much of value to you.

B. L. SCHMIDT CO., DAVENPORT, IOWA, U.S.A.

No. 90

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

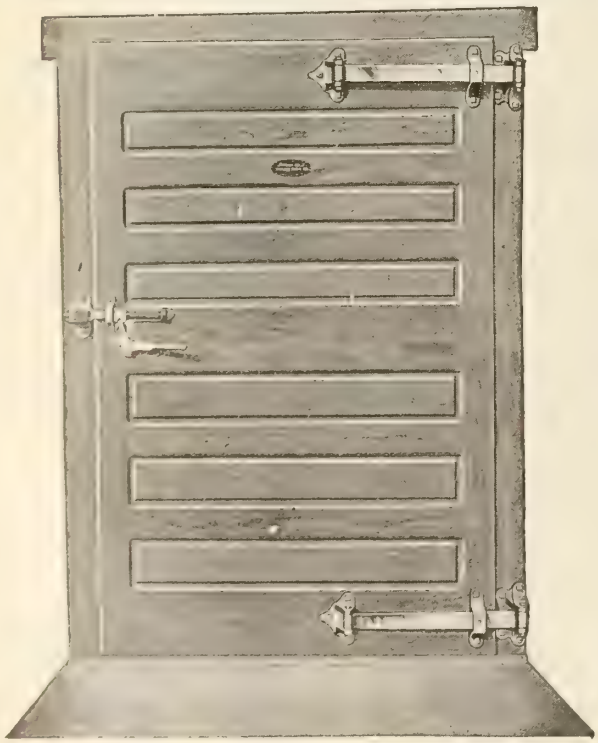
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant**, as we find **them substantially made** and the **insulation perfect.** We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are **equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

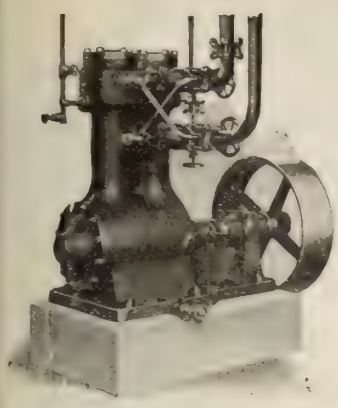
THE WASHINGTON MARKET, Washington, D.C.

"**The doors supplied by you,** in use at both plants, **have been in every way satisfactory,** and we think the **Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.



Ice-making and Refreigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

Refrigerating men who do not possess the 152-page book, "Nonpareil Corkboard Insulation," will find it to their advantage to send for a copy and keep it at the plant. It answers many perplexing questions and contains much good advice. There is no charge for it.

Living Up to a Standard that Science Sets

THE merits of Nonpareil Corkboard Insulation must be attributed, in large measure, to scientific experiments conducted in the Company's laboratories. The best grade of cork to use, the exact temperatures to employ for baking, the proper pressure to apply in compressing the ground cork in the molds, and the right length of time to leave the molds in the ovens—these are all results of carefully made tests.

Briefly, scientific research sets a standard which is observed in the manufacture of Nonpareil Corkboard Insulation from the first step to the last. And as long as results can be controlled scientifically, the quality of Nonpareil Corkboard is sure to be maintained.

Armstrong Cork & Insulation Company, 1504 McGill Building, Montreal, Quebec, Canada

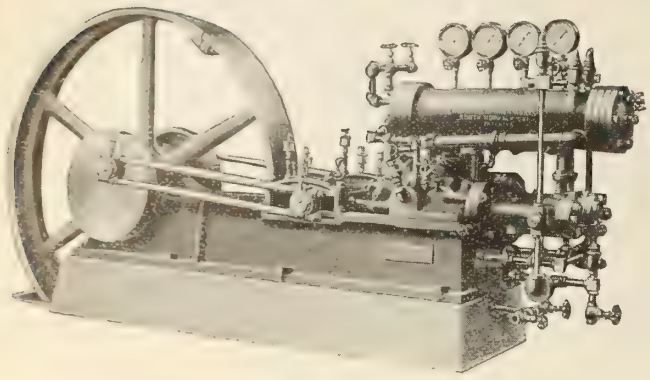
Also manufacturers of Nonpareil Cork Covering for cold pipes: Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings, etc.; Nonpareil Cork Machinery Isolation for deadening the noise of machines; Circle A Cork Brick for cold storage room floors, and Linolile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

for Cold Storage Rooms

NORWALK
AIR & GAS · COMPRESSORS

Efficiency Made Lasting



A Norwalk Four-Stage Air Compressor

All over the country there are Norwalk users who admit that their machines earned honorable retirement years ago. But the Norwalks keep right on delivering the results. It follows naturally that the owners are enthusiastic over Norwalk ruggedness of construction and quality of materials.

And they are right. Original efficiency in a machine is only part of the story. Making it last is what counts. Every Norwalk is built with that thought in mind.

We will be glad to give you both the efficiency and durability details on Norwalk compressors on request. Write for bulletins on Norwalks for air, oxygen, hydrogen, carbonic acid gas or acetylene—one or all.

THE NORWALK IRON WORKS COMPANY

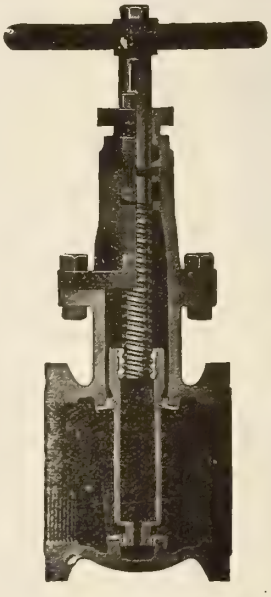
Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Here's Another Efficient Silent Chain Drive

700 H. P., 8ft. Centers

A LEATHER belt drive could never transmit this large amount of power on such short centers, yet Link-Belt Silent Chain transmits the power with highest efficiency. It combines the best points of the leather belt drive with the positive action of the gear drive. It is more efficient than either.

Probably you have a machine which could be operated more efficiently by a Link-Belt Silent Chain Drive. Send for one of our Drive Chain Engineers and get his recommendations. Also write for our 128-page Data Book No. 125.

328

CANADIAN LINK-BELT CO. LIMITED

WELLINGTON AND PETER STREETS TORONTO

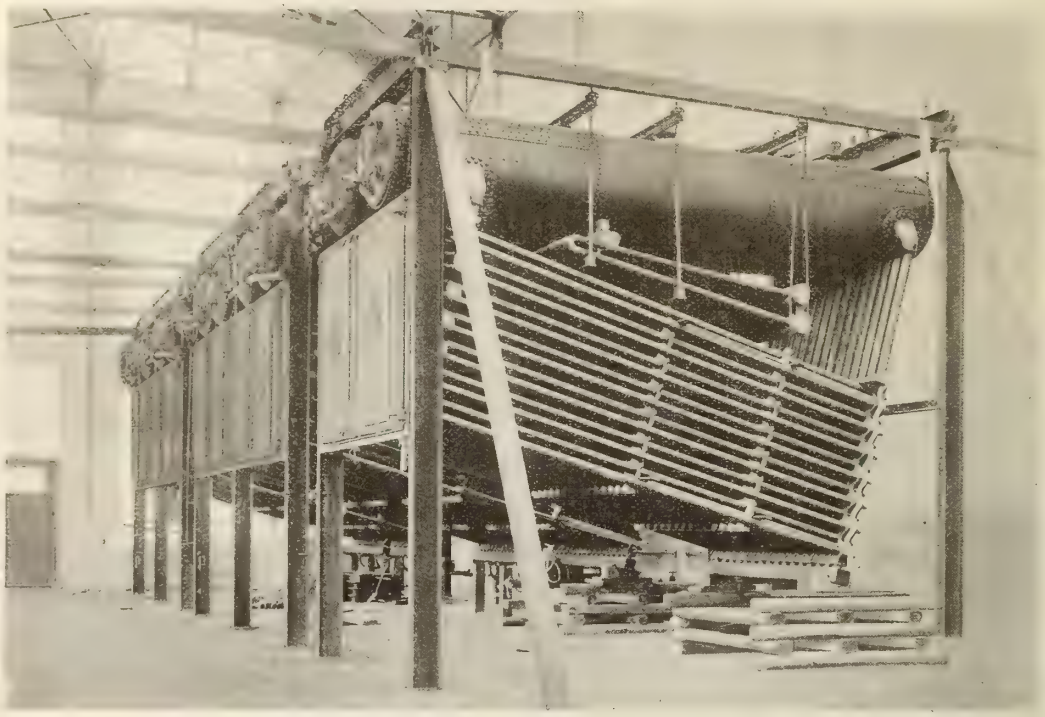
LINK-BELT SILENT CHAIN DRIVES

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets
- ☐ Complete Sand and Gravel Plants

Write for Catalogs
Place X in Square

MODERN AND DEPENDABLE POWER EQUIPMENT



Showing a recent installation of 5 Goldie & McCulloch Double Drum Sectional Water Tube Boilers with superheaters in course of erection.

G. & McC. Co. Sectional Water-Tube Boilers are equipped with large steam and water drums and connecting nipples of increased size, thus assuring positive and rapid circulation and increased steaming capacity. They are constructed of the best quality of steel, the headers and all other parts subjected to steam pressure being of forged steel.

WE BUILD HIGH-GRADE POWER EQUIPMENT OF EVERY DESCRIPTION:— Steam Engines, Steam Turbines, Return Tubular and Water-Tube Boilers, Heaters, Pumps, Condensers, Tanks, etc.

Our catalogues, plans, specifications and the advice of our engineering department are yours for the asking. Write to-day if interested.

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Works, GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Bank of Hamilton Bld'g.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig, 400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Re the Ontario Graded Certificate Act

Correspondence

Is the Second-Grade Plant Too Small?

THE suggestion given below as to the raising of the horse-power requirements for second-class engineers is a good one and should be productive of good results. The figure of 2,000 boiler horse-power mentioned is in agreement with suggestions already sent in and seems to be about the size most satisfactory to engineers. Until the Act has been in force for some time it is hardly possible to tell just how necessary such a change would be, but there is no doubt of its being desired by the majority of engineers.

The one most desirable feature of such a change is apparent in the recognition it will give to the older engineers who, while highly competent and capable of operating a plant efficiently, have not the technical training necessary for the passing of the first-class examination of the highly technical nature proposed.

The highly technically-trained man can extend his sphere of usefulness by helping those under him with the problems they encounter, too difficult for solution, without the skill which comes of much study. In this the writer of the letter below points out the help that can be given by the college-trained engineer to those that never had his advantages.

The Editor.

Sir:—I have been trying to be an engineer for quite a number of years on both large and small jobs, and have pulled through so far under some very trying conditions without any trouble worth writing home about, and I am not afraid of the new Act, although, since my school days were few, I am up against it just as hard as any other engineer. But I have thought since we were requested to suggest something re amendments to the Act, I might air my views on the subject. I do think there is room for some changes that would help all concerned.

First, I think for what the Board expects a man to know in order to get a second-class paper they have limited him a very small horse power capacity. I do not find it any more trouble to look after 1,000 H.P. than 300 H.P. I would say, draw the line at about 2,000 H.P., at least, for a second. I do not think that an employer would be mean enough to take any of the liners out of a man's pay envelope just because his papers are a grade lower than the job calls for. On the contrary, if he is equipped to think, and some of them are, he will have to engage a man with the better ticket, who will very likely want more money than the other fellow.

Now, as for the chief. I am not worrying about him if he is college-bred or not. I am working under a good one just now. Just a common, everyday man like ourselves, and came by his job honestly enough. But I sure would like to be with a good, well school-trained engineer. He is just what we want for chief. And we don't want them up a tree but right down here on the job to help us out with the problems that we don't understand. With his assistance we may become engineers yet. I think it requires something more than merely practical knowledge to be a good engineer.—Anonymous.

Will This Happen?

THIS correspondent states that the competent engineer will be driven into the field of the consulting engineer, taking over the duties which he fulfils. His qualifications are discussed and the faults of consulting practice as carried on to-day are pointed out. All this raises the old question as to whether practical or theoretical experience is the better, and the only answer that can be given is that neither is good by itself, but that the successful designing engineer requires both.

Theoretical knowledge, desirable by itself, has led to many expensive mistakes, particularly in power plant operation. Practical knowledge, on the other hand, may err in the direction of too much or too little equipment, too costly design or in other ways, which run the cost of power up.

The Editor:—

Ontario is due to have a big crop of new efficiency consulting engineers. Recently I spent several weeks in your "flu-filled" but beautiful city, and, of course, expended a large part of my holiday time in visiting power plants and talking to the men in charge. Many of these men are middle-aged, some of them even old, but all are strong and hearty. Most of them have spent a large part of their lives as operating engineers and chiefs.

Certain ideas appear to be like the "flue"—catching—the germ was in my own brain and it grew rapidly when it came in contact with others. Four different men, with no prompting from myself, informed me they intended putting out their shingle as efficiency and consulting power plant engineers. Can you beat it? These men were formerly first-class license-holders with the O.A.S.E., and were disinclined to pass another examination. They claim they are perfectly qualified to act as power plant experts in its real meaning, more so than many of the regular consulting engineers, who have had little or no experience as men in actual charge of plants in operation.

One of the men defined efficiency of power plants as "elimination of wastes, caused mainly by faulty engineering equipment, designed or recommended by incompetent consulting engineers."

In the United States many practical power plant engineers have started in this profession and have found it a lucrative field, most of them gaining considerable success. The capable operating engineer often meets with scant tolerance at the hands of the owner, the successful consulting engineer always gets the "glad hand" from the same source.

What makes me "chortle" is the fact that such consulting engineers can decide what kind of equipment is to be installed and receive a big wad of "long green" for his advice and supervision, while the poor boob who operates the outfit puts in long hours, night study, and passes a stiff examination, for small pay in comparison to the efficiency man. Remember, I could only visit a very few of the middle-aged engineers in Toronto, there

must be dozens in your city who are nursing this same idea. I had it myself, and am now wondering if, with a few dozen new efficiency experts, will there be enough owners requiring, or thinking they require, this kind of service?

Is it not amusing? Different times I have known operating engineers to recommend the installation of certain apparatus and they have been rather roughly turned down by the owners. Afterwards the owners have paid out good money to consulting engineers for advising them to install the same apparatus or something inferior. What tends to make the practical engineer a successful consulting engineer is his skepticism. He has an insistent desire to be "shown"! Unwillingness to take all things printed in papers for granted, this is a real asset to a successful engineer, he tries things out and separates the real from the doubtful. The technical-taught consulting engineer has not this advantage. It is unsafe to assume that a thing cannot be done because someone says so, and it is just as unsafe to assume something can be done for the same reason. This is where a practical experience is of wonderful help to the consulting engineer.

Of course, practical experience alone is of little use to a real engineer, consulting or operating, without considerable technical knowledge. No engineer worthy of the name is anything else than an efficiency engineer; his whole course of study and practice is to adapt economically nature's laws to practical needs.

A lot of special equipment has been devised which enables improvements to be made, tending to save labor, fuel, water, etc., and many new appliances are made only to sell. The practical, technical, consulting men will not be fooled by the latter.

It looks to me that the stationary engineer, as a power plant consulting engineer, acting not for one plant but for any plant, is due to arrive. Boost him along!

M. A. CULLING.

A Voice From Quebec

IT is seldom that we receive a letter which recognizes the relative value of the technical and practical in stationary engineering so well as the one below. The different avenues open to the engineer for the acquisition of knowledge are discussed and the sound advice given to use the bookshelf for the obtaining of knowledge instead of as an amusement.

The Editor.

I have followed with great interest, sometimes with amusement, and I am afraid sometimes with a certain amount of cynicism the many discussions aired by my brother engineers in POWER HOUSE on the graded certificate now in force in the province of Ontario. Our friend, Mr. Noble, makes rather a stinging remark when he calls the man without technical training a wop. In slang phraseology I take this to mean a fool. I have in my mind's eye, here in the city of Montreal, a splendid mechanical engineer, yet with not a particle of technical education. I have spoken to this man and his reply was: "What's the use? I get on just the same," and I venture to assert that the majority of engineers are of the same stamp; too much trouble to study. That is why I fail to see why any good, practical engineer of the present day should not be a very fair technical man. We shall find that the engineer of the future will be just as good on technical points as he is on practical, but at present I ask my brother engineers to follow POWER HOUSE articles and read, mark, learn and inwardly digest, for by them the engineer can learn better than by all the technical books, for every one is elementary and so plain to the dullest mind. If these instructions are carried out our friend will get the craze or bug as many hundreds have done before, and he will be able to cross swords with the consulting engineer instead of standing by and looking very foolish when that most estimable man is pulling the wool over his eyes by rattling away in technical patter.

I must say I don't agree with him in raising the B.H.P. for second and third class engineers or (tickets). My reason for this is that so many engineers who make first-class operators when the chief is in the plant seem to lose their initiative when trouble comes, the sequel is big trouble and plenty.

In finishing up my few remarks on our friend's letter, I must not forget his personal friendship with Mr. Smith. It goes to prove that the late Mr. Smith was not too proud too learn from a practical man. I myself ask POWER HOUSE many technical questions on points I am not quite clear on, and I have charge of the largest power plant in Canada, and am well advanced in years, and I tender great thanks to our present Associate Editor, Mr. Fenner, for helping me on matters technical.

In passing comments on our friend Mr. Stone's letter, I emphasize every word. No position in this world, even in engineering, is gained by remaining in a stagnant pool of knowledge.

I smile at his reference to a good library (engineering), for in that he echoes my sentiments. I only wish every engineer would do likewise, and when he is collecting his books for the library to remember they are for use not to ornament his bookcase. In concluding my remarks to Mr. Stone, I would remind him that we are getting more enlightened every day, and present-day conditions call for a technical man as well as a good, practical man to take charge of an up-to-date power plant, so please, Mr. Stone, persevere.

In concluding my few remarks, I must pay a tribute to the letter of Justice II., as a reader of very fair mind and gifted with knowledge and common-sense. There is no chief to-day who is worth a row of pins who is not gifted with a fair amount of technical knowledge, and it is only a cheap man playing on the reserve of the plant which sooner or later will have to be remedied. Now, Mr. Editor, I would like you to put these last few lines in blazing letters.

I hope the certificates of Ontario will not develop into the huge joke they are in Quebec. It would surprise a good many readers, but it is true here in the city of Montreal one of our largest plants, 1,000 boiler horse power, has a man with a fourth-class certificate in charge and the chief engineer of another large installation has no certificate at all. There are also other examples too numerous to mention. (Why bother reading books in the province of Quebec). I sincerely hope that these few lines may meet the eye of the people mentioned.

HENRY WRIGHT.

From the high prices of the year the aggregate market value of the common stocks of 20 leading industrial corporations has slumped approximately $560,000,000. A Wall Street compilation puts the combined market value of these stocks at the recent highs at $2,662,966,346. That figure is now around $2,100,000,000. That gives an idea of the extent of the decline in Wall Street security values. This does not take into consideration the fall in railroad stocks, in Liberty bonds, in railroad bonds, in fact, in all issues. General Motors common stock has slumped close to $250,000,000 in market value from the high price of 1919. This stock is not included in the 20 used in the compilation.

BY THE time a young man figures out the cost of a kitchen table, and stove, and a few sticks for the dining-room and bedroom, and still persists in the drift of matrimony—let us arise and shout: "There is a man!"

THE head of a New York grocery concern says prices will stay up for two years yet. If that chap ever predicted anything else he'd lose his job as the drum major in the grocery league.

Present Day Synchronous Motor Design

The Following Article Enters Into the Design and Construction of the Present-Day Synchronous Motor and Also Points Out Their Many Advantages for Industrial Power Purposes

By W. S. LOCKHART

Engineering Co. of Canada

PRESENT day Synchronous Motors of the best design are not the modified Alternators, of a few years ago. The earlier type of Synchronous Motors were not self-starting, they were nothing more nor less than Alternators run as Motors, and thus their applications were limited. Some Synchronous Motors of the present day are nothing more nor less than Standard Alternators with squirrel cage windings about their rotors, however, the better class of Synchronous Motors is designed from start to finish as Motors, and is really a combination of a Synchronous Motor and an Induction Motor. They are self-starting, have good starting and pull-in characteristics, and will carry as high as 400 per cent of full load for short periods, without pulling out.

They are now used on practically every drive where a constant speed is required, such as big air compressors and ammonia compressors, heavy jaw crushers, line shafts, big pumps, fans and heavy rolls. Synchronous Motors are run efficiently as low as 75 r.p.m., and for this reason are especially adapted for direct connecting to air and ammonia compressors.

They can be used as Condensers floating on the line for power factor correction only, or while operating at unity power factor load may be taken off, or the fields may be over excited thus drawing leading current from the line, improving the power factor of the system and at the same time do mechanical work.

Present day Synchronous Motors have all the characteristics of Induction Motors while starting. In the first designs of squirrel cage windings if a high resistance winding was used, it would give the motor an excellent starting torque, but unfortunately high starting torque and high pull-in torque did not go together, therefore, it was a case of sacrificing one for the other. At the present time manufacturers specializing in Synchronous Motors have overcome this difficulty by developing a special compound squirrel cage winding, and by so doing are now able to obtain excellent starting and pull-in characteristics without drawing excessive kva. from the line.

Mechanical Design

The Stator of the more modern type of Synchronous Motor consists of a core, as in the Synchronous Generator, built up of laminated steel segments rigidly anchored to the cast iron frame, provision being made, of course, at intervals for vent ducts in the assembled core. The ordinary double layer winding is used and these armature coils are placed in the open slots of the core and held in place by fibre or wood wedges. The part slot winding is being used to a great extent by one manufacturing concern, and this means of winding along with a specially designed rotor produces a current and voltage wave form very close to the sine wave.

FIG. 3—CORE BEFORE WINDING—NOTE THE SLOTS IN PUNCHINGS FOR DAMPER BARS.

The rotor consists of a circular spider having a web or spoke construction, according to the size and speed of the motor. One way of mounting collector rings as in the case of engine type Synchronous Motors, is by placing the rings on the extension of the heavy hub. This method of mounting collector rings symplifies matters in the erection of the motor as the rotor may be shipped out on the job and pressed on the engine shaft without any further trouble, from shrinking collector rings on the shaft.

Rotor spiders for slow speeds are usually made of cast iron, while in the high speed type, cast steel is used. Pole pieces are built up of soft sheet steel punchings of high magnetic quality held together with heavy steel rivets, passing through the complete pole. In slow speed machines, pole pieces are usually bolted on the periphery of the spider, while in the high speed type the dove tail, T tail or anchored type construction is usually adopted. See Figs. 1, 2, 3, and 4.

The result obtained from converting the Standard Alternator into an Induction Motor would be as follows: The air gap would be large and the pole embrace small, say from 50 to 65 per cent., and if we used the same whole slot winding in the Stator as in the Alternator, the combined result would be large magnetizing currents, very large current from the line in starting and thus poor starting torque at a reasonable starting current.

This difficulty has been overcome by Synchronous Motor experts of to-day, by specially designing the Rotor so as to get a very small air gap with a large pole embrace, say 70 to 80 per cent. This large pole embrace insures better wave form than a short blunt pole tip would give, and also gives a more evenly distrited squirrel cage winding about the Rotor. The combined result of this construction together with the part slot winding, see Figs. 5 and 6, of the stator gives us a motor of small magnetizing current and high starting torque at a very reasonable amount of starting current.

FIG. 4—ANCHORED TYPE POLE.

To complete this type of construction, a series of damper bars are inserted in slots in the pole faces, and joined through end plates. End plates of each pole are connected together thus forming a closed ring around the rotor. This produces a squirrel cage winding similar to the Rotor of an Induction Motor, see Fig. 7. The damper bars are selected with special reference to starting torque. Damper bars of high resistance metal give a higher starting torque than those of lower resistance. When the metal of lower resistance is used the starting torque is lower, but the pull-in torque is much higher. The resistance of the damp-

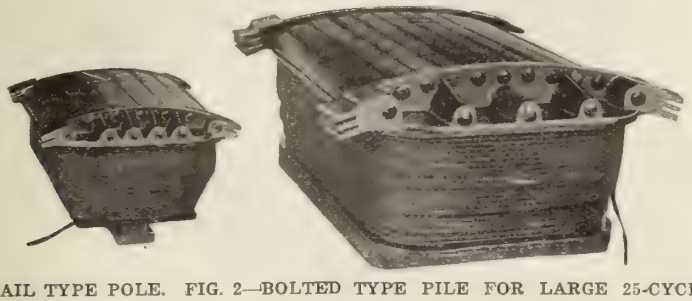


FIG. 1—T TAIL TYPE POLE. FIG. 2—BOLTED TYPE PILE FOR LARGE 25-CYCLE MOTOR.

er bars depends also on the size of this cross section.

The present Synchronous Motor is as easy to start as the ordinary Induction Motor, and does not require any special care to put it on the line in Synchonronism with the other apparatus. By

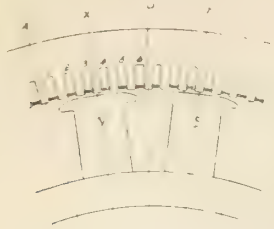


FIG. 5—EXAMPLE OF EVEN SLOT WINDING, 6SLOTS TO EACH POLE PITCH. SINCE THERE ARE THREE PHASES THIS MEANS 2 SLOTS PER PHASE PER POLE FROM A TO B IS ONE POLE PITCH.

throwing in starting switch we apply, say 50 per cent. line voltage to the motor. The motor starts to build up in speed, and at roughly 60 per cent. full speed, the starting switch is opened and the running switch is closed, thus applying full line voltage to the motor. The speed still further increases, and as the motor approaches synchronous speed the ammeter needle fluctuates somewhat, when this quiets down the field switch is closed and the motor is on the line.

This last performance of closing the field switch does not require any great skill on the part of the operator, as the motor will go on the line as long as the difference is not greater than five Electrical degrees.

Electrical Characteristics

Without going too deeply into the electrical calculations, let us take three practical cases of a Synchronous Motor operating on a line, and show by vector diagrams the resultant k.v.a., and power factor of system thus obtained. Let us assume our original system of 1,200 k.v.r. output operating at 80 per cent., lagging power factor and a Synchronous Motor of 400 k.v.a., nominal capacity to be added to the system.

First Case. An arc with 100 radius will indicate power factor circle. Draw the radius line or "vector" O A through point X, the intersection of the 80 per cent power factor line with the circle. This "Vector" will represent the 1,200 kva. output at per cent. power factor (length indicating k.v.a., and position indicating power factor). The Synchronous Motor is to be added driving a mechanical load of, say 250 k.w., including motor losses, at unity power factor. Draw the vertical line A B representing 250 k.w. vertical because at unity power factor. It will be seen that the added 250 k.w., of load at unity power factor, improves the power factor of the whole system. Now, draw the line O B, which by length indicates the new output 1,450 k.v.a., and by position the new power factor of the system, the point Y, where O B intersects power factor circle, giving the power factor at 86 per cent.

Second Case. Now, increase field excitation of the motor to give leading power factor until it is carrying its full capacity of 400 k.v.a., while still driving the same mechanical load. In this case the motor may be represented by a triangle ABC, the side AB representing the mechanical output plus losses in motor (disregarding increase in motor losses due to increased excitation), the side AC representing the 400 k.v.a. in-

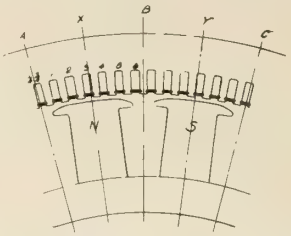


FIG. 6—EXAMPLE OF PART SLOT WINDING, 6¾ SLOTS TO EACH POLE PITCH, OR 2¼ SLOTS PER PHASE PER POLE.

put of motor at leading power factor, and side BC the wattless component at leading power factor 312 k.v.a., which is introduced into the system by the motor.

The new "Vector" O C by length, indicates the new output 1,280 k.v.a., and by position the new power factor of the system 05 per cent.

The power factor of the motor is the ratio of A B to A C = 63.7 per cent. leading.

Third Case.—Now, remove the mechanical load the motor was driving and still further increase the excitation until the motor carries its safe continuous capacity, 90 per cent. of nominal or 360 kva., at approximately zero P.F. (This will tax the motor field to its safe operating temperature limits on account of low P.F.).

The losses in the motor, say, 25kw., are now the only power load it carries. As in Case 2, the motor is represented by a triangle ADE, of which AD represents the power load of 25 kw.losses, AE the motor input, 360 kva., and DE the wattless component at leading power factor, 359 kva., introduced by the motor.

As in case 1, and in case 2, a new "Vector" OE indicates by length, the new output 1,050 k.v.a., and by position the new factor of the system 94 per cent. The power factor motor is ratio of A D to A E = 7 per cent. leading.

From the foregoing it is seen that in the second case there is even more corrective effect than in the third case, and the motor is at the same time doing a large amount of mechanical work.

The three cases may be summed up as follows (on a 1,200 k.v.a., system Synchronous Motor of 400 k.v.a. capacity).

First Case.—The Synchonous Motor at unity power factor, carrying 250 kw., load raises the lagging power factor of system from 80 to 86 per cent.

Second Case. The Synchronous Motor at 63.7 per cent. leading power factor, while carrying 250 k.w., load, raises the lagging power factor of system from 80 to 95 per cent.

Third Case. The Synchronous Motor at 7 per cent leading power factor, while carrying load of 25 k.w (losses in motor), raises the lagging power factor of system from 80 to 94 per cent.

General Uses

Synchronous Motors are being used today on practically any constant speed load. On account of their high efficiency and ruggedness, they are being used to drive sucessfully large jaw crushers, where tremendous variatians of load occur, air and ammonia compressors direct connected, and running as low as 72 r.p.m., reciprocating pumps (in this case starting conditions are usually relieved by a by-pass so that the motor can easily take care of the load and pull it into step without excessive k.v.a. input) centrifugal pumps, motor generator sets, etc.

We should not overlook the limitations to Synchronous Motor drive, such as small loads under 100 h.p., except perhaps in motor generator sets, also where frequent starting or stopping is necessary or where adjustable speed is required, and lastly, as Synchronous Motors are at present designed they can-

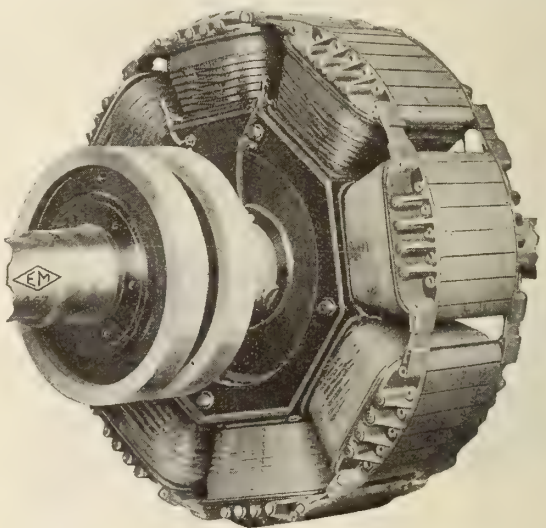
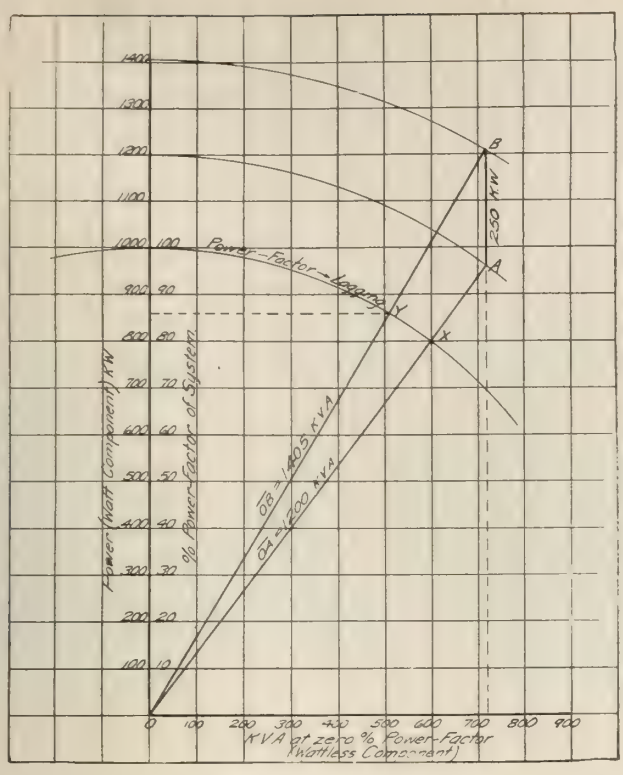


FIG. 7—EIGHT POLE ROTER, SHOWING SLOTS IN POLE FACES AND SQUIRREL CAGE WINDING

not start up under full load without exvessive kva. in-put. This last applies to rubber mills, cement mills, and line shafting, where the motor is required to start up practically a full load, In these cases Synchronous Motors are at the present time operating successfully by the use of properly de-



FIRST CASE CURVE—1.

signed mechanical or magnetic clutches, and this additional cost of clutch should not be considered where we get such increased efficiency and high power factor, conditions as in the Synchronous Motor.

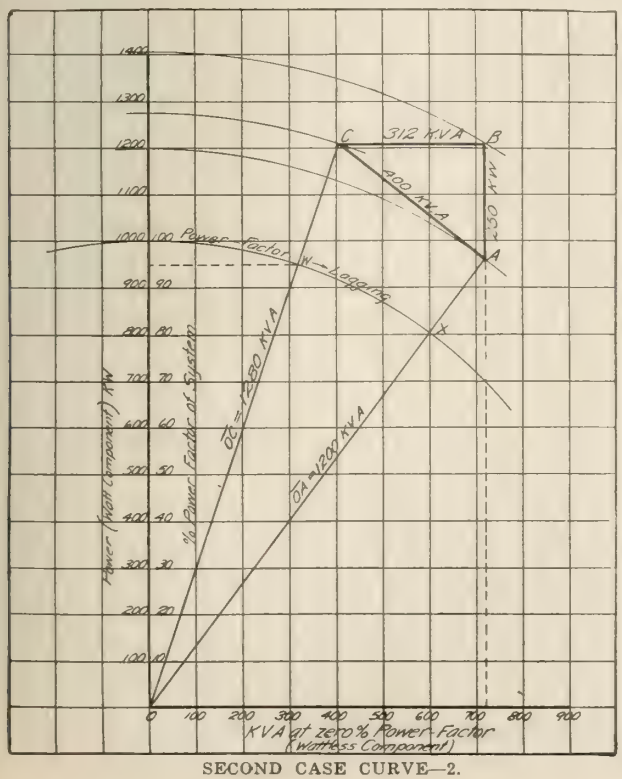
Perhaps the greatest use of Synchronous Motors to-day is for power factor correction. Synchronous Motors and Synhcronous Condensers, in order to give the best results should be located near the causes of low power factor, namely, the Induction Motor load. That is why it is much better to induce the power customers to install Synchronous apparatus of their own than it is to rely entirely upon the Synchronous Condenser of the central station.

Low power factor means waste all the way from the prime movers through the generating equipment, through the transformers, transmission lines distributing circuit clear to the motors. There is no exact place where the cost can be divided, so it is necessary that the power Company and the power customer work in harmony together. Low power factor means poor voltage regulation that is a very bad thing for the power company, as everybody knows, and it is also a very bad thing for the customer. Since apparatus is invariably over-loaded where voltage is lowered, coils are burned out and other break-downs frequently occur.

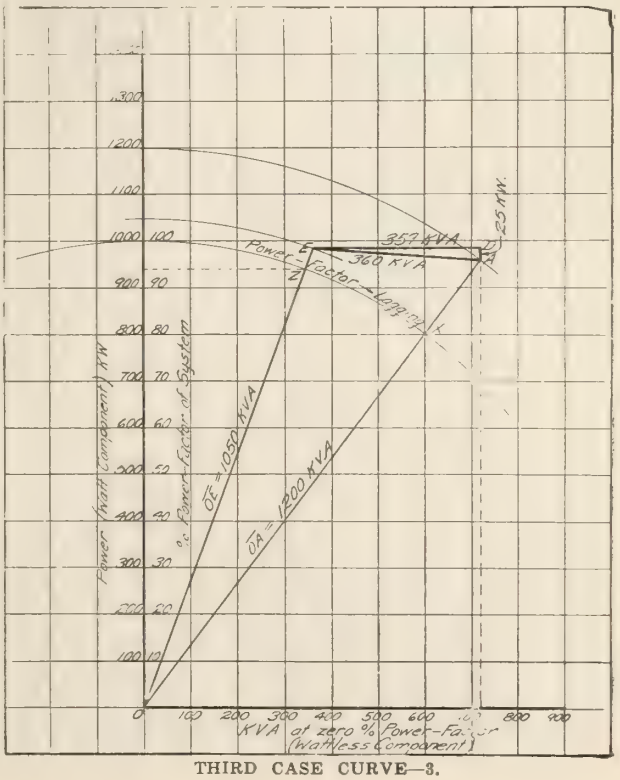
The torque of Induction Motors falls off as the square of the voltage, so many motors become stalled and do not carry their load, others operate at a much lower efficiency. The copper losses increase as the square of the current Current increases as power factor decreases, therefore the losses mount up at an alarming rate. This means a waste of coal to the power company, and a waste of money to the power customer, who has to pay for a certain amount of power which never reaches the motor.

People do not realize how much they are affected by power factor, many seem to think that it affects the other fellow and, that, of course, is a very bad thing, but they cannot believe that it exists right in their own plant. The most important cause of low power factor is the Induction Motor running at part load. The customer has grown up with the habit of buying motors larger than the load requires, this has had a very bad effect on the power factor of the circuit. The average Induction Motor at full load has a very satisfactory power factor when operating at half ... or lower the power factor is very poor.

Builders of machine tools and other types of motor driven apparatus are frequently responsible for bad power factor of motors. They often times recommend a larger motor than the machine really requires. This sounds like good advice to the customer, and he puts in an over-size motor and operates it at a very unsatisfactory power factor.



SECOND CASE CURVE—2.



THIRD CASE CURVE—3.

Some of the Principles Underlying Refrigeration

A Brief Account of the More Elementary Theory of Refrigerating Machinery and of the Various Methods by Which Refrigeration is Obtained

By ADAM TAYLOR

OWING to the graded certificate coming into force this year, a large number of engineers are showing signs of nervousness about the examinations, and in looking over the at I find one of the things that we are to be examined in is refrigeration. For this reason it is the purpose of this writer to try in as plain language as possible to give the engineers an idea of what the principles of refrigeration are.

A number of books are published on the subject, but they are so technical in their scope, that they leave the reader in a haze, and his last stage is worse than the first.

We will start with the gases first. All gases have been liquefied, that is to say, when they are subjected to a given pressure and temperature they become liquid. When a gas has become liquid and it is allowed by a reduction in pressure to become a gas again, it takes up a definite quantity of heat from whatever it comes in contact with. To give an illustration, let the reader take a long breath, open his mouth and breathe on the back of his hand, the sensation is warm. Now take another breath compress the lips and blow on the back of the hand, the sensation is cold. In the first instance you had no compression, therefore no expansion. In the second instance you had both compression and, after leaving your lips, expansion. That is the principle of refrigeration, only machines are built to do the work, and a gas is employed that has a low boiling point so as to get the desired effect.

Air, carbon dioxide, sulphur dioxide, and ammonia are among some of the gases that are used as refrigerants, but as ammonia is the most used, it will be taken up first.

Ammonia is a chemical combination of two gases, hydrogen and nitrogen. It is easily liquified at 90 lb. pressure, and by the use of cooling meter at 60 deg. F. Ammonia has a low boiling point, 28.5 deg. F. below zero (The boiling point of water is 212 deg. F. below zero), which makes it suitable for producing low temperatures.

We will follow the ammonia gas through the machine. The compressor sucks it in and discharges it to the condenser. In passing through the compressor its pressure is increased, and the creating of this pressure increases the temperature of the gas. This heat is taken out by the cooling water on the condenser, and the ammonia becomes a liquid. It is next passed on through a small pipe to the cooler or rooms that are to be cooled, it is then allowed to enter the pipes at a very much reduced pressure. This reduction in pressure will cause it to boil rapidly and turns into gas. The compresser then sucks away this gas as quickly as it is given off through boiling. In boiling the ammonia is absorbing heat from its surroundings, and this is the process that is going on all the time.

A mistaken idea that some engineers have is that the expansion valve is the one that does the work, whereas it is the suction side that counts, the more rapidly you can pull away the gas after it has been given off and before it can create a pressure, the more you can open the supply valve (expansion), and let more ammonia in; the more ammonia circulated the more refrigeration is done. There are various types of compressers made to handle ammonia, but the principle is the same in them all. When we consider the principles of refrigeration and the effects produced, it is simply exchange of heat. When we compress the ammonia gas, and after we abstract from it the resulting heat, and that, due to its liquifaction in the condenser, we have a liquid, under

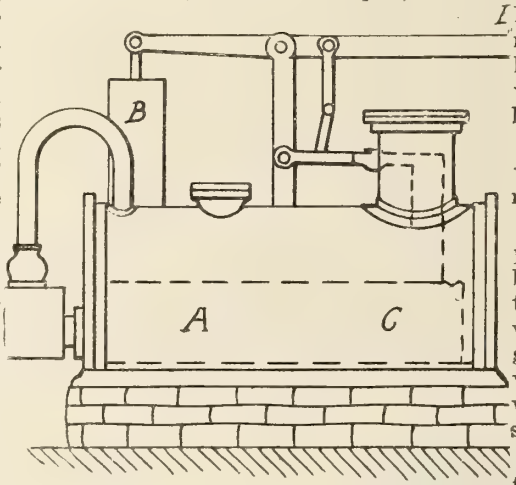


DIAGRAM OF REFRIGERATING SYSTEM.

high pressure, which is capable of becoming a gas under normal pressure. In doing so it must absorb a certain amount of heat, otherwise the conversion from liquid to gas could not be accomplished.

As I stated before it is the evaporation of the liquid ammonia that does the work, so that nothing but gas should return to the compressor. In practice this is not the case as a small quantity of liquid is allowed to get back to the machine. If nothing but gas came back to the compressor there would be no frost showing on the suction line, as ammonia gas has little effect in absorbing heat. Some engineers will state definitely that nothing but dry gas comes back to their machines, but, when there is frost on suction pipes and machines then there is unevaporated ammonia there. It is possible to limit this loss by watching very closely the temperature of the discharge pipe.

There are quite a few little things that crop up to add to a refrigerating engineer's worries. He may get his machine started up all right, the discharge and suction pressures may be right, the water on the condensers O. K., and plenty of ammonia in the system according to his gauge glass on the receiver, but it is not doing nearly the work he should do, the thing is to locate the trouble. Sometimes we may get ammonia containing impurities, and if ammonia contains more than two per cent. impurities it has a deterimental effect on the refrigerating qualities of the ammonia, watch for that. Take a small quantity of the anhydrous ammonia measured in a glass, and let it all evaporate in the open air, and see what is left, the impurities are all left behind. Theoretically ammonia will not disassociate unless under high temperatures, but the practical engineer knows different. Ammonia will seperate into the two gases, hydrogen and nitrogen, and these are so called permanent gases, they remain seperate and will not liquify and retard the work of the ammonia. Sometimes these two gases will have a certain percentage of another gas which has a bad effect on the throat and lungs.

Keep the machine free from gases, you will find them at the highest point of the machine.

There is generally a ½-inch valve and pipe there for purging out, some advise blowing it off into a pail of water, but the best way I have found is to open the valve a very little and light the escaping gas and burn it out. Hydrogen burns with a blue flame, pure ammonia gas will not burn itself, and one can readily see when the permanent gases are all out.

Sometimes you will get a gas there that will not burn, the only thing then is the pail of water with a short piece of hose, and when the gas is all out, and the ammonia gas starts to come you will hear a loud cracking noise as the ammonia and water mix.

The accompanying illustration shows one of the first in making machines. It consists of a cylinder containing sulphuric acid marked A, an air pump marked B, so arranged that it could be connected to the mouth of the carafe, and an agitator, G, which is so coupled to the air pump lever that it will be operated by the working of the pump to keep the sulphuric acid in the cylinder in motion.

The machine is where water is made to freeze itself. The pump is worked, and a vacuum is created where the water is and causes the water to boil at a temperature below 2 deg. F. The sulphuric acid absorbs the vapor given off by the water, in turn taking its heat from what is in the vessel and thus causing it to freeze and become ice.

This is called cooling off liquids by their own evaporation in vacuo.

Power Plant Features of a By-Product Coke Oven

The By-Product Coke Oven, While Making Gas and Coke Instead of Generating Power, Has Many Features of Interest to the Power Plant Engineer in the Handling of the Coal and Coke and the Power Plant

By W. F. SUTHERLAND

A GENERAL VIEW OF THE BY-PRODUCT COKE OVENS.

COAL is one of the most commonplace and prosaic of our minerals, yet it is doubtful if any other single mineral has within itself the potentialities for man's welfare that exist in coal. In the power plant, while it is burned for the production of heat and power, both important in themselves, its possibilities are not so readily apparent, and the coke oven is the starting point from which are obtained the dyes, explosives, fertilizers and drugs so common to-day.

The coke oven in itself is, perhaps, a trifle out of the usual field of stationary engineering, but a study of its functioning will prove fascinating to the engineer, and a visit to a modern by-product plant will provide much information of interest concerning strictly power plant subjects, for in the control of the various operations of the plant power plant equipment finds a most important place.

The following article is descriptive of the new coke ovens of the Steel Company of Canada, at Hamilton, and in addition to describing the power plant equipment first gives a short account of the operating characteristics of the ovens themselves.

The art of making coke, up to comparatively recent times, made comparatively little advance, and the beehive oven formerly used is still to be found in many places. This oven, merely a brick-lined chamber in which the coal was heated by the combustion of a portion of the charge, wasted all the gas and other valuable by-products obtained from the coal, although it made good coke and had the advantage of cheapness.

The modern by-product oven, a recent development, on the other hand, conserves the gas, tar and nitrogen content, while making an excellent coke suitable for blast furnace or other uses.

Coke is very light as compared to the coal from which it is made, and it is estimated that 50 per cent. of its volume is air space, and for metallurgical purposes should be strong, porous and regular in composition. The amount of sulphur is also important as an excess causes expense in its elimination in the blast furnace.

Since the physical properties and chemical composition of the coke are of such moment, the grade of coal used is of importance. In the present case two kinds are employed, one running about 34 per cent. volatile and the other about 17 per cent. Both run about 8 to 9 per cent. ash content and contain .8 per cent. or less of sulphur.

The coal is unloaded into a receiving pit capable of handling two cars and from this is lifted by an apron conveyor onto a 30-in. belt conveyor. This conveyor, driven by a 50 h.p. motor, carries the coal to the top of the coal-handling plant where it is delivered into the crusher. The crushing is done by a Bradford breaker and on being crushed the coal is screened, the slate, etc., being separated and delivered to a reject bin.

From the crusher the coal is delivered into either one of two mixing bins depending on its volatile content and from these it is drawn out onto the mixing table one floor below. This table consists of two short apron conveyors in line, with their upper surfaces travelling towards each other. The depth of coal on each conveyor is regulated by means of independently adjustable gates. By means of the gates any desired percentage of high and low volatile coals is obtained; at the present time the mixture runs about 85 per cent. high and 15 per cent. low volatile.

From the mixing table the coal now composed of the two grades goes to a hammer mill below, where it is pulverized fine enough for eighty per cent. to pass a ⅛-in. mesh screen. From the pulverizer the coal is conveyed by belt conveyors to a transfer tower and then at right angles by another conveyor to a coal storage bunker holding 1,400 tons. The hammer mill was supplied by the Williams Patent Pulverizer & Crusher Co., and is driven by a 300 h.p. three-phase Canadian Westinghouse induction motor of the wound rotor type. The mixing table is driven by a 10 h.p. squirrel cage induction motor, also of Canadian Westinghouse make. The coal-handling plant, together with the conveying system, was installed complete by Heyl & Patterson, Pittsburgh, Pa.

Coke Ovens

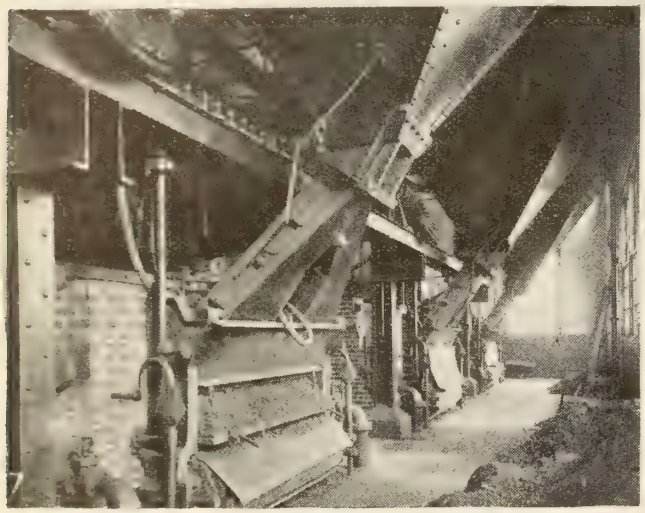
The Wilputte by-product coke ovens are arranged in two batteries placed end to end. Each battery consists of 40 separate ovens. Between each oven 28 flues are built into the side walls by means of which the ovens are heated by conduction through the brickwork. Below the ovens and flues proper, regenerative chambers are built in. These are filled with checkerwork and function similarily to those used with the open hearth. A cross-flue connects the tops of the vertical flues with whichever portion of the regenerator is on heat. The air necessary for the combustion of the gas employed passes through that side of the regenerator which is on blast and passes upwards into the twenty-eight vertical flues. At the bot-

tom of these it meets the incoming gas and combustion takes place.

A balanced draft system is employed, that is forced draft delivers the air to the regenerators and induced draft removes the products of combustion. The fans for the air supply are of Canadian Sirocco type and are steam-driven. Three are provided, two in constant use and one spare. The volume of air supplied is controlled from the chart room immediately above.

The induced draft apparatus is housed in a separate building and here three Canadian Sirocco fans are also provided, one of them spare as before. The products of combustion escape through two radial brick chimneys six feet by 75 ft. in height. These chimneys were installed by the M. W. Kellog Co., New York. The exhaust fans are steam-driven and the engines have 8 in. cylinders by 8 in. stroke.

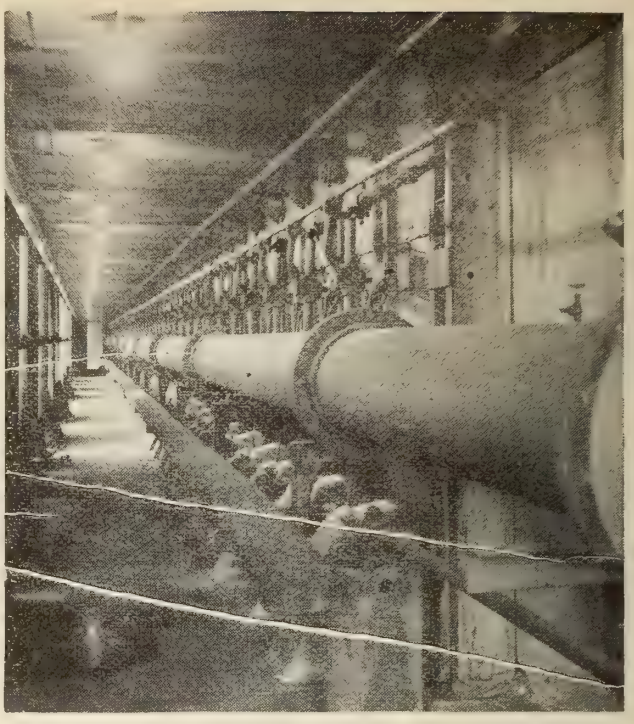
Ordinarily it has been customary on installations of this type to dispense with induced draft fans and to use 200 ft. chimneys for the securing of the necessary draft. It was thought, however, that better regulation and control



COXE STOKERS AND FEED CHUTES FOR COKE BREEZE.

could be secured with the equipment installed, and operation has confirmed this opinion.

The gas necessary for the maintaining of the proper temperature in the ovens is supplied by two sixteen-inch mains which are carried along the outside walls a few



ONE OF THE GAS MAINS ON THE COKE OVENS SHOWING THE RISERS AND VALVE CONTROL.

feet above ground level. From these gas mains risers are led off and into the flues. Each riser is equipped with a valve actuated by a rod running the full length of each battery and operated by a motor-driven controlling mechanism.

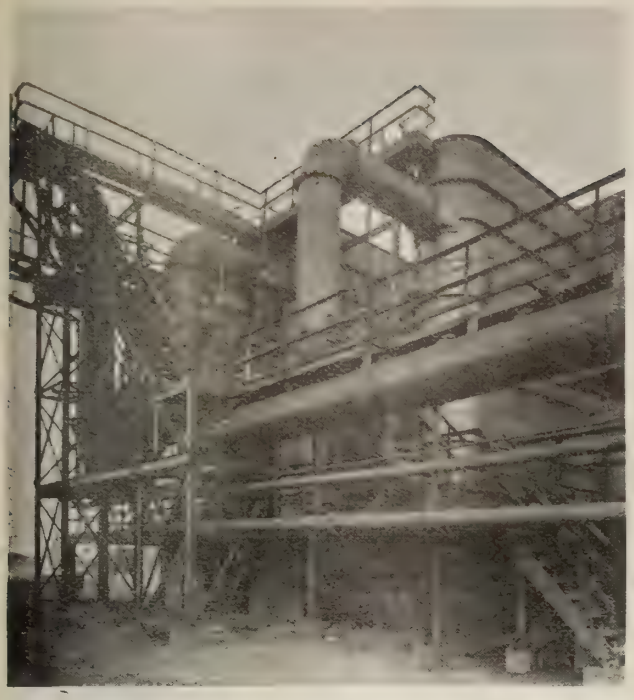
The air supply is also controlled by reversing valves, motor-operated, and at each half-hour period the flow of air through the regenerators is reversed.

Chart Room

Between the two batteries and over the fan room, a chart room is located. All recording instruments and controls are brought together in this room which provides a central point from which all operations can be directed.

The gas consumed in the heating of the ovens is here measured by two Venturi meters and the pressure on the gas main, the forced draft and induced draft pres-

THE COKE PUSHER WHICH REMOVES THE OVEN DOORS, PUSHES THE COKE OUT ON THE OTHER SIDE INTO THE QUENCHING CAR AND THEN LEVELS DOWN THE FRESH CHARGE.



THE PRIMARY COOLERS IN WHICH THE GAS IS COOLED AND IS FREED OF THE GREATER PART OF THE TAR AND AMMONIA LIQUOR.

sures are measured by three Bacharach pressure recording gauges for each battery.

Charging

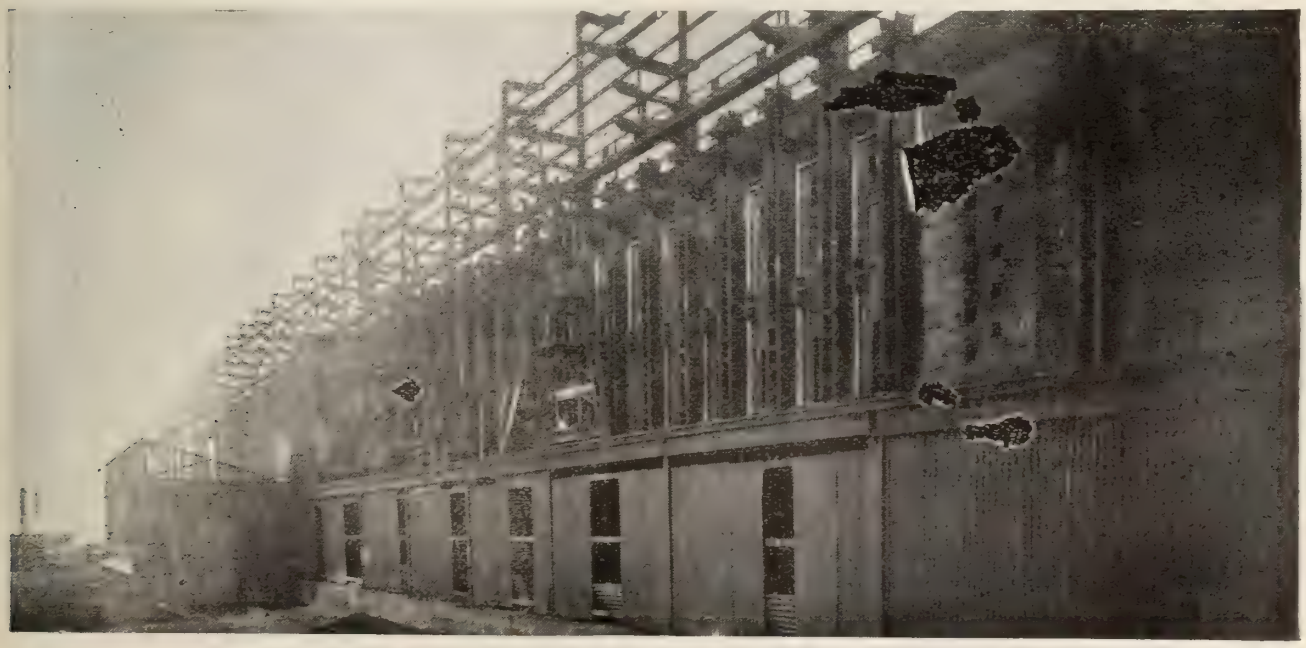
The ovens are charged from above through four openings to each oven. A charging lorry with four bins travels the full length of the two batteries and receives its supply from the 1,400-ton bunker which is located overhead. Each hopper of the charging lorry holds sufficient coal for the charging of its portion of each oven. Between the ovens and immediately over each of the twenty-eight flues in the side-walls inspection holes are provided by means of which the condition of the brickwork and the combustion going on below can be observed.

When the charge in each oven is converted into coke it is removed by a pusher, almost human in its functions. The pusher travels the full length of the two batteries and is provided with three rams, one of which lifts the oven door off and draws it back out of the way, rocking it about a horizontal axis first to break the clay luting provided for gas tightness. The second ram, when this is accomplished, is advanced and pushes the coke through the door at the other end of the oven. The third ram is used after the doors have been placed back in position and when the fresh charge is placed. It is advanced and withdrawn several times through a small opening in the door and serves to level off the top of the charge.

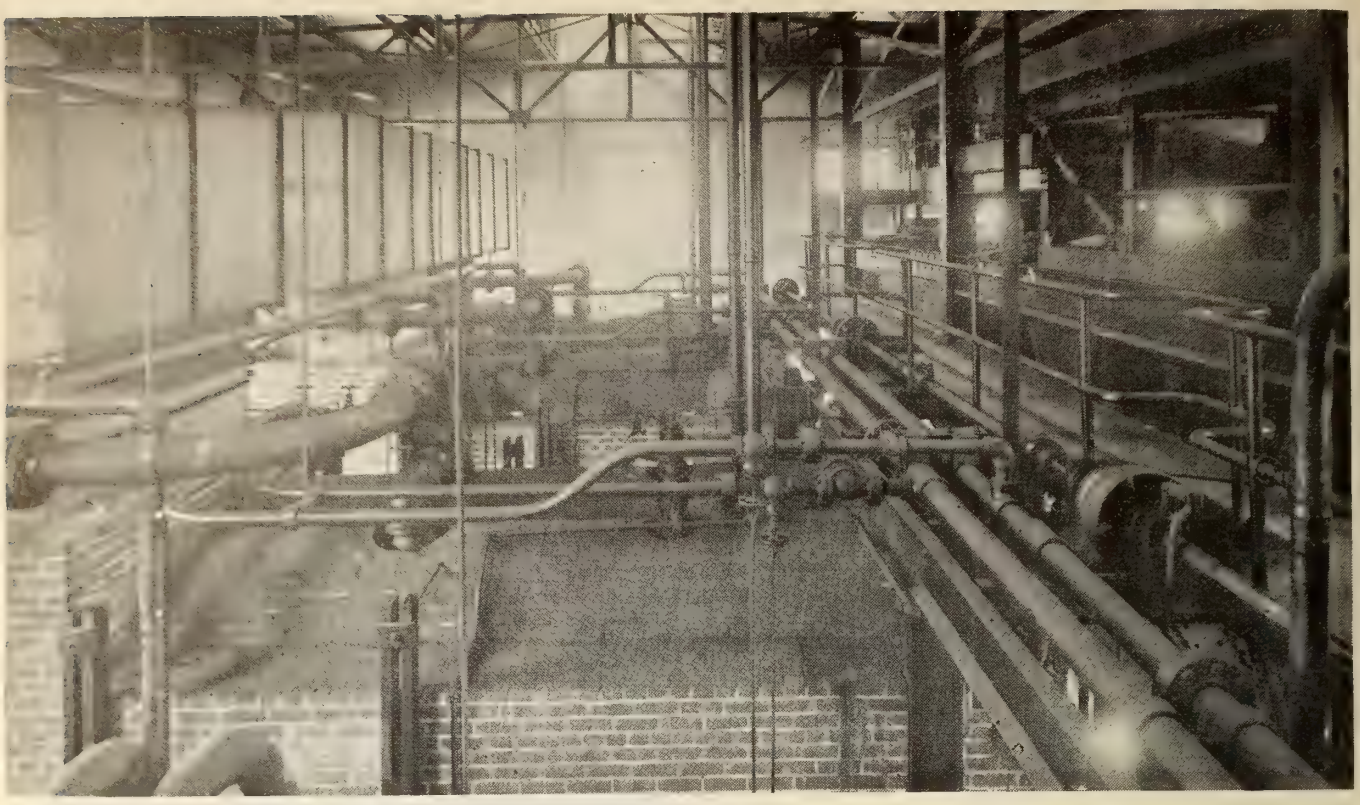
The main pusher ram is driven by rack and pinion through two intermediate gear trains from a 75 h.p. motor of railway type. A magnetic brake is provided. The levelling ram is driven by a similar motor through a drum and cables. The door extractor is advanced from the cab and its further operation controlled by the door man on the platform. The coke pusher was supplied by Wellman-Seaver-Morgan, Cleveland.

The doors on the discharge side of the ovens are removed by a travelling extractor which is also provided with a coke chute to guide the red hot coke over the platform and into the quenching car below. The quenching car on receiving its load travels to a quenching station, shown in our first illustration, where the coke is wet down and later discharged onto an incline from which

DRAFT FAN ENGINES AND FEED PUMPS.



THE DISCHARGE SIDE OF THE COKE OVENS, SHOWING QUENCHING CAR.



VIEW OF BOILER ROOM SHOWING BREECHING, STEAM AND FEED LINES.

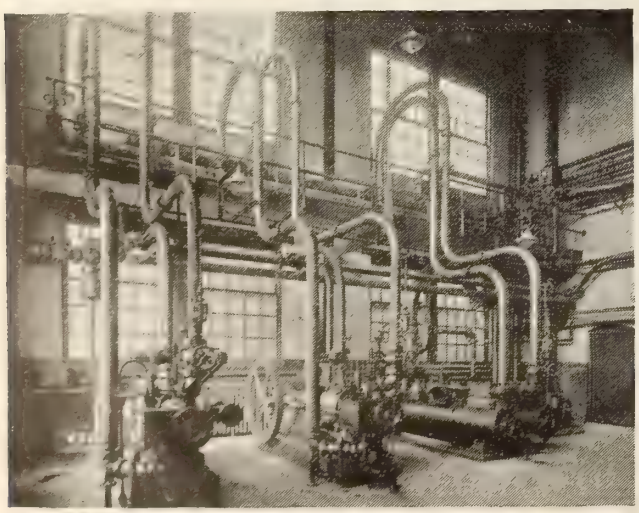
it makes its way by conveyor to the coke-handling plant.

The temperature at which the ovens are run has an important effect on the life of the brickwork; at this plant the side-wall temperature carried is 2,200° Fah. Silica brick are used of Harbison-Walker manufacture.

By-Product Plant

In the making of coke a number of valuable by-products are given off, gas which has a high calorific value, coal tar which finds use in the chemical industries and as a fuel, and ammonia compounds. All of these have considerable commercial value and when used in the steel mill or sold, materially lower the cost of the coke. A by-product plant is installed which purifies the gas and recovers the tar, ammonia content, and naphthalene carried over from the ovens.

Each oven is provided with an ascension pipe through which all volatile matters driven off during coking pass. Each pipe is equipped with a cap opening to atmosphere and a mushroom valve, and terminates in a common header. When charging, the gas driven off is allowed to escape until the operation is complete when the mushroom valve is opened and the gases allowed to pass into the header. The header running the full length of the two batteries has tar constantly circulating through it to catch any particles of free carbon carried over.



VIEW IN PUMP ROOM, BY-PRODUCT PLANT

From the header the gases pass over the pusher runway to the by-products plant and enter the condensers or primary coolers. These primary coolers, shown in one of our illustrations, are three in number, one of them spare. Each of them contain about 900 tubes through which water is constantly circulated on the counter-flow principle. The gases passing over the tubes have their temperature materially lowered and here most of the tar is thrown down, together with ammonia liquor and some naphthalene.

From the primary coolers the gas passes through the gas exhauster plant which provides the suction necessary to draw it over from the ovens. Three units are again provided here, two of them constantly in use and the third one as a spare. The blowers are built by the Connersville Blower Co., Connersville, Ind., and have a displacement of 51.7 cu. ft. per revolution. They are steam-driven, and Fleming engines are employed, made by the Harrisburg Foundry and Machine Works, Harrisburg, Pa. These units are controlled by electrical pressure regulators made by the Rateau Battu Smoot Co., New York. The speed is automatically varied according to amount of gas coming from the ovens and by this means a constant suction is maintained.

From the exhaustor the gas passes to the tar extractors which eliminate any tar fog which may remain. These extractors are three in number, one of them spare, and consist of vertical tanks which contain sheet steel bells perforated with 1-16 in. holes. The holes in successive cones are staggered and any particles of suspended tar are thus eliminated.

The gas is now free from tar but still contains considerable ammonia vapor. This is eliminated by the saturators through which the gas next passes. Three in number as before, these consist of large cast iron tanks lead-lined in which a 6 to 8 per cent. solution of sulphuric acid is maintained. The gas passing through this acid liquor gives up its ammonia content which unites with

the sulphuric acid to form ammonium sulphate. As this salt accumulates the solution becomes saturated and crystals of ammonium sulphate are thrown down. To effect their removal the principle of the air lift pump is adopted. A jet of air is blown into the bottom of a vertical discharge pipe and carries with it the crystals of sulphate together with some of the acid liquor. Flowing out of the saturator at the top, the mixture passes into lead lined settling trays where the ammonium sulphate falls to the bottom. It is then thrown into steam-driven, centrifugal separators where any remaining acid liquor is thrown off. The liquor is here recovered, and that from the ammonium sulphate is taken to the salt room where it is bagged and shipped to outside consumers.

Quite a romance might well be written about the by-product end of the coke industry. The coal tar is the starting point from which countless coal tar dyes and chemicals are made, and the nitrogen content of the coal is of great value to agriculture and other industries. Nitrogen compounds are essential to vegetable growth, and when these have been exhausted in the soil through intensive cultivation, artificial fertilizers are necessary.

Sulphuric acid has to be added to replace that used in the formation of the ammonium sulphate and it is found that about one pound of acid is required for each pound of sulphate made.

Ammonium sulphate can be used alone as a fertilizer, but more often reaches the farmer in the form of mixed fertilizers. It can be used with acid phosphate, potash salts, cotton seed meal, tankage and fish scraps. It is not subject to chemical action when thus incorporated into a mixed fertilizer and its freedom from free acid and moisture is also of advantage.

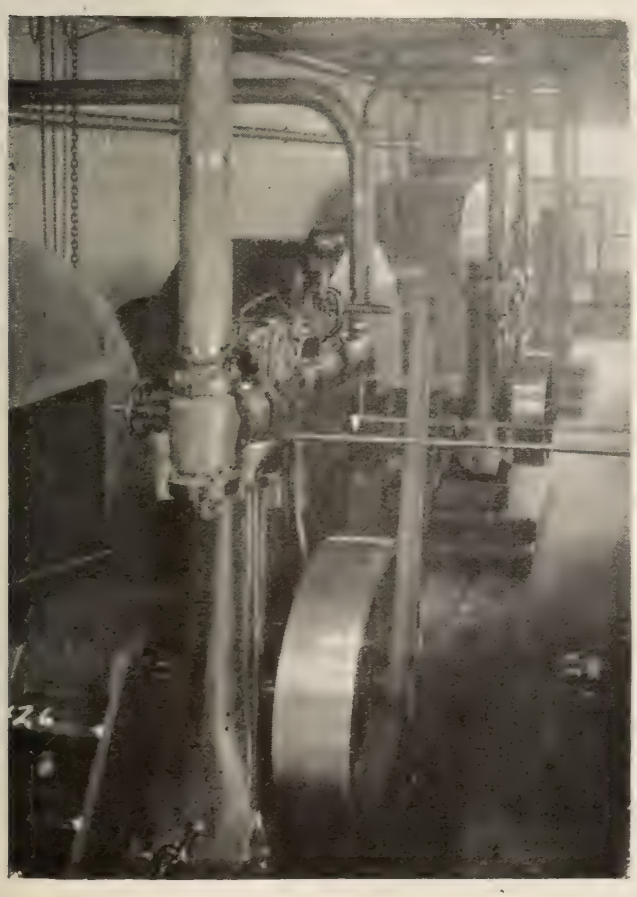
The gas, now free of tar and ammonia, finally passes through a washing tower where it meets a spray of water and is made ready for use. The water passing through this tower removes the naphthalene present in the gas and this is caught in settling basins for disposal.

MAIN ELECTRICAL SWITCHBOARD.

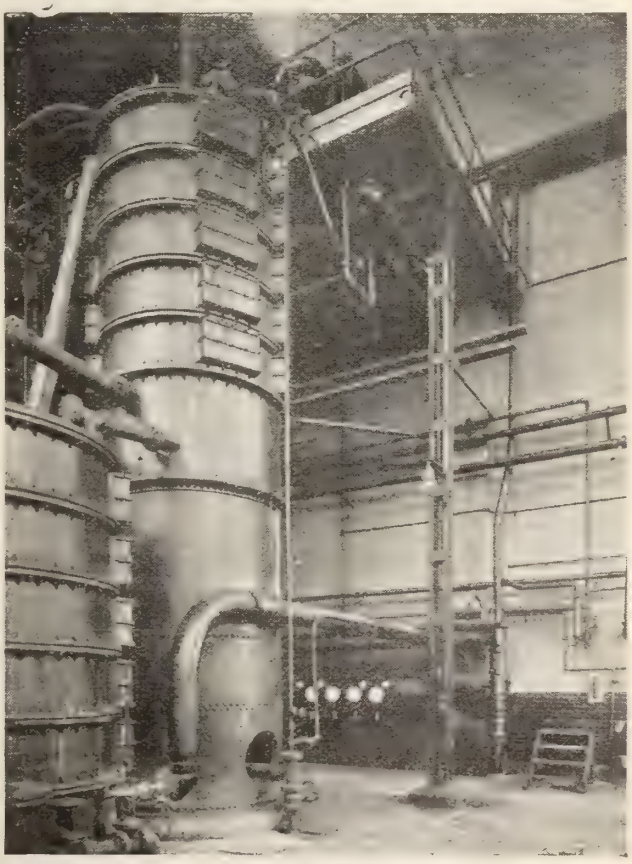
From the washer the gas goes to the gas holder and from this it is distributed to the open-hearths, the boiler room and to the coke ovens. That portion which goes to the open-hearth furnaces passes through an exhauster which raises its pressure to 5½ lb. The "Root" exhauster is driven by an R. 20x20 in. Ridgeway engine and has a capacity of 8,000,000 cu. ft. per 24 hours.

The operation of the by-product plant necessitates the handling of various kinds of liquids and a pump room is provided for the various pumps. Tar pumps of both centrifugal and duplex plunger type are provided for flushing the tar through the mains and headers. The centrifugal pump is of the Goulds single-stage type and has a capacity of 660 U.S. gallons against a 90 ft. head. It is driven by a Canadian Westinghouse 30 h.p. induction motor.

Two air compressors are also installed, made by the Chicago Pneumatic Tool Co.

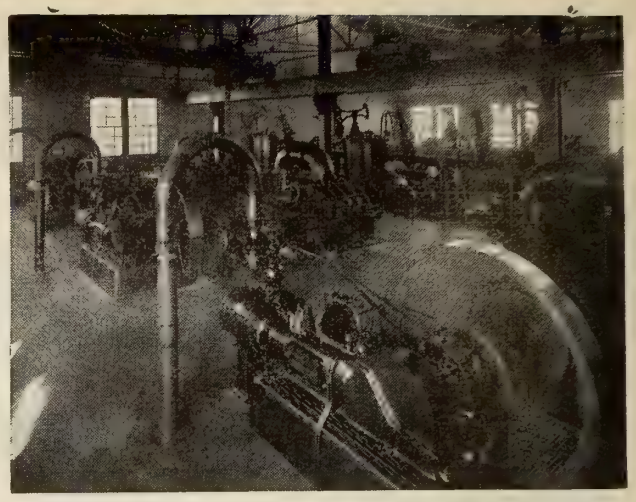


FAN ROOM FOR BY-PRODUCT OVENS



THE AMMONIA STILL IN WHICH THE AMMONIA LIQUOR GIVES UP ITS AMMONIA CONTENT.

COKE AFTER BEING QUENCHED.



THE EXHAUSTERS SHOWN HERE BRING THE GAS OVER FROM THE OVENS INTO THE BY-PRODUCT PLANT.

Operating Characteristics

Approximately 13 tons of coal are charged into each oven at a time. The coking time is 17½ hours and 108 ovens are charged per day, producing 900 tons of coke. Of this quantity the greater portion is required for the Steel Company's own blast furnaces, the remainder being disposed of to outside firms.

Each ton of coal as fired produces 11,000 cu. ft. of gas, 11 U.S. gallons of tar and 27 lb. ammonium sulphate. Forty per cent. of the gas is used in heating the ovens and the remainder is available for other plant purposes. The tar, together with most of the gas, is used in firing the open-hearth furnaces of which there are eleven. From each ton of coal three-quarters of a ton of coke are obtained.

Steam Generation

A considerable quantity of steam is used for the ammonia still and for the various engine-driven fans and exhausters. For the generation of this steam a boiler plant of 750 boiler horsepower has been erected.

Three Erie City double-drum water tube boilers are installed of 250 h.p. each. A steam pressure of 150 lb. is carried and the steam is superheated 100°.

In the making of coke considerable coke breeze or dust is made and this is used as a boiler fuel. The coke-handling plant screens all the coke and the fines are taken by belt conveyor to the boiler house. Here they undergo a further screening, chestnut size and over being eliminated, the remainder dropping into the bunkers in front of the boilers.

Coxe travelling grate stokers made by the Combustion Engineering Corporation, New York, are fitted to the boilers and are specially designed for the burning of the coke dust. This fuel is difficult to burn and in order to keep the ignition arches at the proper temperature it is necessary to burn gas as a supplementary fuel. Four two-inch gas pipes are led into the combustion chamber of the boiler setting above the grate and the gas passing through them is burned by excess air through the grates, no other air supply being needed. About 250,000 cu. ft of gas is burned per 24 hours in addition to the coke screenings.

The boilers are fitted with Diamond soot blowers made by the Diamond Specialty Co., Detroit and Windsor. All valves used in the boiler house are of Crane manufacture. Forced draft is supplied by a Canadian Sirocco fan provided with two engines, one of them spare. Pin and belt type clutches are provided for changing over from one engine to another.

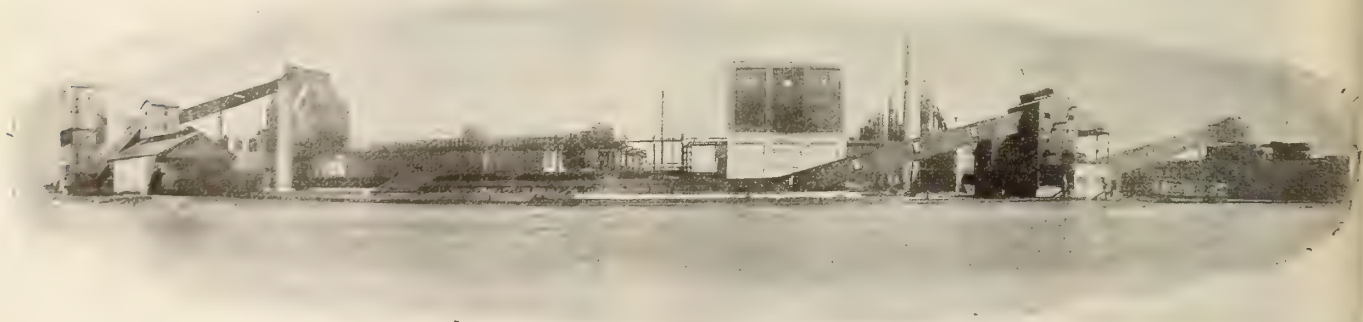
The feedwater is heated in a Cochrane feedwater heater to 210° Fahr. Exhaust steam from the engines at 15 lb. back pressure is used for this purpose.

The feed pumps are in duplicate, two Canadian Fairbanks-Morse 10x6¼ duplex plunger pumps being installed.

The boiler house is some distance from the by-product plant and two six-inch steam lines are provided. These, for part of the distance, are carried overhead on structural frame work.

Construction

The coke ovens and other equipment including the by-product plant and boiler house were designed and installed by the Wilputte Coke Oven Corporation, 469 Fifth Ave., New York City, who also acted as their own general contractors. The silica brick necessary for ovens, etc., was supplied by the Harbison-Walker Co., Joliet, Ind., while the firebrick was furnished by The Evans and Howard Firebrick Co., St. Louis, Mo. All tanks and tankwork were supplied by the Jas. G. Hagey Co., Joliet, Ind. The coal and coke handling plant was furnished by Heyl & Patterson, Pittsburgh, while the Hamilton Bridge Co. furnished the structural steel. The two radial brick chimneys for the coke ovens and a similar but larger chimney for the boiler house were supplied and erected by the M. W. Kellog Co., New York City.



A VIEW OF THE COKE OVENS, SHOWING THE COAL BREAKERS TO THE LEFT AND THE LOADING ELEVATORS TO THE RIGHT, OVER WHICH THE COKE IS PASSED IN BEING LOADED FOR SHIPMENT

Methods of Storage and the Weathering of Coal

A Description of the Various Methods of Storing Coal and Their Characteristics, Together With a Discussion of the Factors Affecting Its Weather

By ROBERT JUNE, Mechanical Engineer

COAL storage is a subject which is being given more and more consideration each year by power plant operators. There are a number of reasons for this increased appreciation of the economical advantages of coal storage. Not the least of these is the danger of expensive shut-downs, due to strikes by miners or transportation workers.

There are execllent reasons why coal storage should be generally resorted to by power plant operators, by railroads, and by operators. We, of course, are concerned with the power plant, but because coal storage by railroads and mine operators offers some indirect advantages to the power plant operators, we may mention the reasons for such storage, briefly, without discussing the means.

As far as the railroads are concerned, a million dollars invested in coal storage facilities is equivalent to three million dollars invested in locomotives and cars, if purchased for coal moving purposes only. This is true because railroads are caled upon to move coal in large quantities only through three or four months of the year and if they have sufficient facilities to meet this peak load, there is a large portion of the year when the rolling stock will be idle. Another reason for coal storage by railroads is that it permits the railroad to haul its own coal at times when the equipment can best be spared for this purpose, so that the equipment need not be taken from earning service to do non-productive work.

Coal storage is important to the coal operator inasmuch as proper facilities for this purpose will enable him to regulate production and to maintain a uniform output at the mines. As matters stand, the average mine is operated approximately 170 days in the year. We would have fewer mines in operation, smaller overhead and more contented labor if all mines were equipped with coal storage so coal could be mined when cars were not immediately available. Inasmuch as lack of coal storage facilities by railroads and coal operators is one important factor in the present high cost of coal, it is important for every coal user to be familiar with the condition so he can use such influence as he possesses to remedy it.

Getting down now to the individual power plant, let us see what reasons may exist for the practice of storing coal in large quantities at, or near, the plant, and whether this practice is worth the expense involved. The general reasons for coal storage by the consumer are as follows:

1.—He can buy coal in quantities to better advantage at certain seasons of the year than at others, saving perhaps in this way anywhere from fifty cents to one dolar.

2.—The practice of storing coal by power plant operators would tend to equalize prices on different grades of coal. As matters stand, over production of certain grades at certain seasons of the year, and under production of certain grades at other seasons of the year, tends to penalize power plants using certain of these grades.

3.—Miners' and railroad strikes, and embargoes and delays will not effect plants where large quantities of coal are stored.

4.—The general practice of coal storage at the nation's power plants would help tremendously in solving the national situation by providing the miners steady work—(hence at "lower wages per ton of coal mined," and avoiding strikes, which in the end the consumer pays for.

The question as to whether coal should be stored in the individual plant will depend entirely upon the particular conditions obtaining in the case. It is out of the question, for instance, to store coal in or near a power plant situated in the business district of a large city. Here space is entirely too valuable for any such purposes. Unless the needs of the plant are extremely large and the source of supply somewhat uncertain, the city plant will also usually find it impracticable even to store coal in the outskirts of the city.

When we come to the small, medium, or large size power plant, which is so situated that coal can be stored conveniently in close proximity to the plant, on land of medium or low rental value, the case is quite different. Here everything points to the desirability of maintaining a storage system commensurate with the plant requirements. By purchasing and storing a year's supply of coal in the spring or early summer, the plant can normally effect such savings in purchase price alone as to pay for the cost of storage and handling several times over, to say nothing of the advantages of an assured supply of coal.

As to a choice of mechanical means for effecting coal storage, this will depend entirely upon the location of the plant and the storage pile, and the amount of coal to be handled. In previous articles we have discussed various types of coal-handling equipment, such as Mono-rail, Bucket, Chain and Flight Conveyors, etc., and it is not necessary to again describe this equipment. It should be noted, however, that in a great many cases, particularly where the quantity involved exceeds 10,000 tons, the locomotive crane, with grab bucket, appears to offer the ideal economic solution.

In planning coal storage for very small plants, it may be well to remember that coal can normally be hauled cheaper by wheel-barrow than by cart, up to a distance of 250 feet.

Choice of Storage Systems

In determining a storage system to be employed, most if not all of the following points will have to be taken into consideration:

1.—Character, size, location and value of available ground.

2.—Desired total storage capacity and amount of coal which may have to be loaded and unloaded per day.

3.—First cost of storage system and costs of maintenance and operation.

4.—Percentage of breakage which can be allowed in hauling coal.

5.—Length of time coal must be kept in storage.

6.—Effects, if any, of climate.

7.—Adequate available water supply.

8.—Means for rapid loading out of coal in case of fire.

In considering a storage plant from an economic point of view, it must be remembered that if the equipment is in operation very irregularly, that costs are consequently higher per ton because of the heavy fixed charges for interest and depreciation.

We have spoken of the locomotive crane as a generally cheap and satisfactory means of handling coal for storage in the usual boiler plant. The special advantage of the crane, of course, is that its functions need not necessarily be confined to the coal pile, as it can often be employed for other purposes about the plant. The locomotive crane is also adapted to quite a variety of storage systems, being particularly suited to various "circular" types of storage.

Where locomotive cranes are used with large circular systems the gauge of the track on which the crane runs is important. When possible, the gauge should be approximately as follows:

4′	8½″	for maximum swing of		30	feet
14′	6″	"	"	45	"
16′		"	"	60	"
20′		"	"	100	"

In planning large circular storage systems, the usual arrangement is one whereby the coal is discharged from railroad cars into a pit at a central point, which pit is also the centre of the circular track system on which the crane operates, the radius of the circular track being equal to the maximum swing of the crane. With such a system, the locomotive crane can pick up coal from the dumping pit when standing at any point of the circular track. By a swing

of the boom the coal can be deposited at any point inside or outside the circular track as far as the boom can reach. While it would be feasible to do so, it is not considered good practice to cover up crane tracks since it is very desirable to be able to operate the crane over the entire range of the storage pile in case of fire.

Characteristics of Different Coals When Stored

Some coals may be stored with greater safety than others. Danger from spontaneous combustion, however, is more apt to be present as a result of improper piling of coal than to the kind of coal stored. In storing bituminous coal the important consideration, as far as freedom from spontaneous combustion is concerned, is to see that fine coal and dust are not present. This would seem to preclude the storing of slack coal and run-of-mine, which are precisely the grades which many boiler plants wish to store. It may be said unreservedly that it does preclude the storing of this kind of coal in the open air as far as safety from fire is concerned. Where provision can be made to flood or to rapidly load the coal which has caught first, there is no special reason why run-of-mine and slack should not be stored.

Spontaneous combustion is principally due to oxidation taking place on the surface of the coal. With very fine and powdered coal there is an immensely greater surface presented for oxidation than with lump coal, consequently the danger of fires is very much greater.

If lump coal alone is stored, the danger of spontaneous combustion is practically eliminated. Coal which has gone over a 1½ in. screen, can be stored with little danger of fire. Coal with screenings removed has been kept in storage for many years without firing. Heating usually occurs within three months after coal has been stored. The tendency to spontaneous combustion decreases rapidly after that period. Where one has choice of coals for storage purposes, choice should be made of coal which is least friable, because less dust and slack will be produced in handling. Run-of-mine and slack coal have, at times, been stored without fire occurring by the exclusion of air from the interior of the pile. Such exclusion may be accomplished by a closely sealed wall built around the pile, or by close packing of the fine coal. However, securing of satisfactory results by such methods is both difficult and uncertain. Many men with experience in storing coal, believe that wet coal, or coal stored on a damp place, is peculiarly liable to spontaneous combustion.

Water Storage

If fires are absolutely to be prevented in the storing of run-of-mine or slack coal, the only satisfactory means is by underwater storage. Coal keeps indefinitely in good condition under water, losing none of its heating value and absorbing comparatively little moisture. Water storage possesses the further advantage in that coal does not deteriorate in physical properties, such as slacking. The cost of under-waterstorage is, of course, an important item, and may be so great as to preclude the use of this system. Where old quarries or abandoned clay pits are available for under-water storage, they may be at times adapted with smaller initial expense than would be required for other systems.

Methods of Piling Coal

To store coal successfully, the pile must be so arranged that the heat generated will not exceed the losses by radiation. Coal freshly mined has a special tendency to oxidation and heat. This property pertains to all varieties of coal, though it varies in intensity. The liability of spontaneous combustion occurring decreases with the period of time lapsing between the mining and storing of coal; hence, coal should be exposed to the air as long as possible before being placed in the pile.

To avoid spontaneous combustion, one of two principles should be observed: either the coal should be piled so that the air may circulate freely through it and thus carry off the heat due to oxidation, or the coal should be so closely packed that air cannot enter the pile and cause oxidation of the fine coal. Unless care is used in piling, stratification of the different sizes of coal in the pile may occur. This is a dangerous condition, since the open spaces between the coarse lumps of coal provide a passage through which air may enter and come in contact with the fine coal, thus giving it the opportunity to start combustion. In this connection, it is well to remark that it is not considered good practice to mix, indiscriminately, different kinds of coal in the storage pile, as experience has shown that this almost invariably leads to starting of fires.

It has further been noted that coal of high oxygen content seems to be especially susceptible to spontaneous combustion, a fact worth remembering when its storage is being considered.

There is no set rule as to the height of coal storage piles. Coal has been successfully stored in piles varying from six to sixty feet. Spontaneous combustion frequently occurs in very low piles. Low piles are preferable, since the coal is more fully exposed to the air, and in case of fire can more readily be loaded out. The principal disadvantage of high piles lies in the greater difficulty of moving the coal quickly in case of fires. The idea that high piles caused heating at the bottom is erroneous, since as many fires take place at the top of the pile as at the bottom, and as many near the outside as near the interior. Indeed, a depth of five or six feet seems to be a favorite point for fires to occur.

Ventilation

Ventilation by means of pipes in the pile has not proven a success in the United States. The expense of placing and removing the pipes is very high, and unless they are very close together, it is doubtful if they are of any special value other than for the purpose of thermometer shafts. In Canada, the Canadian Pacific Railway has very successfully ventilated its coal piles, entirely preventing spontaneous combustion. The method used is that of driving pointed iron rods, 1½ to 2 inches in diameter, vertically, down through the pile. After the rod reaches the bottom, a bell-shaped collar is slipped over it and forced down about six inches into the coal. The rod is then tapped to pack the coal around it and to loosen the rod, and then both collar and rod are withdrawn. As soon as this is done, a rough funnel of tar paper is put on the top of the bell-shaped collar to prevent small pieces of coal falling in, or being washed in by the rain. The walls of the hole maintain themselves without protection, ordinarily lasting many months. Holes are usually driven sixteen inches centre to centre. The cost, which is almost wholly labor, amounts to seven or eight cents a ton, at present prices.

Testing for Fire

Freshly stored coal should be carefully watched for evidences of heat. Fire will often be made evident by the presence of steam or by gaseous odors. However, it is unwise to depend solely upon visual evidence. Thermometer pipes should be driven at intervals into the pile. It is impossible to set any critical temperature applicable to all coals in varying storage conditions. One very safe rule is to be ready to remove the coal if the temperature reached 150 degrees F. After coal has been loaded out, it should be thoroughly cooled before being placed in storage.

In putting out fires, water is an effective agent only if it can be applied in sufficient quantities to entirely extinguish the blaze and to cool all of the heated matters. A small quantity of water is positively dangerous.

It is the practice of the Canadian Pacific Railway always to use water if the fire is a small one and particularly if it is detected at an incipient stage. The point of high temperature is located by driving test rods into the pile. A pit one or two feet deep, is then dug right over the centre of the trouble, and pointed rods or pipes are driven down into the heated matter. The pit is then filled with water from the hose and kept full, thus quenching the fire at its very centre. If the fire is a large one, the central pit is used, and in addition, a water curtain made by digging a ring ditch one or two feet deep, with a row of holes in its bottom. This ditch, like the centre pit, is kept full of water from the hose, and if there is any tendency for the fire to be driven downward from the centre it is put out by the water curtain. This method of putting out a fire is not cheap but it is very much quicker and much less costly, and results in much less loss of coal.

Effect of Storage

The heat value of fcoal is decreased very little by storage. Firemen, however are almost universally of the opini

hat storage coal burns less freely than reshly mined coal. This tendency may e overcome by keeping a thinner bed n the grate and by regulating the draft. he loss in heating values of coal in torage may be taken as one per cent. for he first week, with a very moderate increase after that period, so that at the nd of a year the total loss in the aver- ge case will not exceed three per cent.

In conclusion, safety in the storage of oal depends upon a very careful and horough consideration of methods and lose attention to details. Remember hat you will almost invariably have angerous fires if you attempt to simply ile up coal without taking thought of our methods and of your means of ghting spontaneous combustion, should t occur.

HE BIRTH AND DEVELOPMENT OF THE BAROMETER AND ITS USE

There is probably no instrument to which the progress of modern weather orecasting owes so much as the baroeter, the measure of the pressure of he atmosphere.

The word is derived from the two Greek words, baros—weight, and metron —measure.

The story told in connection with its invention" was that some Florentine workmen building a well were unable to aise the water much over 2 feet, and vent to the scientist Galileo to inquire he cause. The rise of water in a pump had been attributed to nature's abhorence of a vacuum. He remarked upon this hat it was evident that this abhorrence lid not extend beyond about 32 feet.

Galileo had a pupil, Torricelli, and of ll those who went to him at the Uniersity for education, he probably hought more of and extended more riendship to Torricelli than to any of he others.

Some time after Galileo's death, Torrielli considered that this water column vas supported by the pressure of the xternal air upon its surface, this forcng the fluid up to a height varying with he pressure and the density of the matter raised.

He then considered experimenting with iquids, the density of which should be eavier than water

Mercury was ultimately selected, its lensity being thirteen and a half times s great as water at the same temperature.

After this the famous experiment tarted. He took a glass tube which was losed at one end, and filled it with mercury. This he inverted into another vessel, also filled with mercury. The mercury in the tube fell somewhat, part of t passing into the vessel and on measuring the distance between the level of the nercury in the tube and the level of the nercury in the vessel, he found it to be 30 inches. Here was the first barometer of mercurial type. The well had been reproduced on a table with a glass tube and a glass vessel, but thirteen and a half times smaller than the original.

As the mercury in the tube fell, it, of course, left a vacuum, and to-day that is known as the Torricellian vacuum. It is a nearly perfect vacuum and contains only a trace of mercury vapor.

In moving this "apparatus" about Torricelli found the height of the column varied.

Pascal, a teacher of geometry, was consulted and suggested that change was due to the air being different in weight in different places. This theory was not altogether proved, but it was found that when the apparatus was taken up heights, the column became affected.

It was taken to an extinct volcano in the Auvergne region of France, and the level of the mercury fell to about 25 inches in contrast to its level of 30 inches when this party of "discoverers" left Clermont.

The assumption immediately was that the smaller amount of air above, supported a shorter column, or in other words the weight of the mercury in the tube could not be held up by the pressure of the mercury in the vessel. This was correct.

Refinements in this first crude instrument produces the standard mercury barometer of to-day.

The earliest known form of which was put to real scientific use can be seen in the Academia del Cimento. It consists of an upright glass tube graduated along its length, the end being fitted into an almost closed "Cistern" containing the mercury.

A glycerine barometer (S. G. I. 26) is on exhibition at the Geological Museum in London. On account of its low specific gravity compared to mercury, it gives a magnified reading of pressure changes and the errors due to vapor pressure are much less, or quite inappreciable compared to barometers made with water for the working member. Water barometers are rare nowadays, but they have been constructed. When the column in a mercurial barometer moves one inch, the column in the water barometer will move 13.6 inches for the same amount of change in pressure.

The "Aneroid" barometer, so called because it is constructed "wholly of solids," has taken the place of the cumbersome mercurial instrument for many purposes to-day.

Mercurial instruments are subject to many corrections before a true reading of atmospheric presure can be taken; whereas with a well and sensitively constructed aneroid, providing it is compensated for temperature, readings can be read straight off the circular dial.

The sun is the standard of time, but we have watches and clocks (high grade) which run accurately and are less expensive than a sextant which would be a necessary instrument to us if we depended upon accurate sun time. Aneroid barometers are rapidly taking the place of mercurial instruments, but the mercurial will ALWAYS remain the standard, the portable and sensitive aneroid will need checking occasionally (once every year or so) in exactly the same manner as our clocks need setting.

The figures put upon the faces or dials of barometers represent the pressure of the air at the place and at the time of observation.

When the hand points between 29 and 30, the reading is expressed at 29.5 inches, for it will be noticed that the dials are divided into tenths between the inch spaces and sometimes these tenths are divided again into tenths making hundredths of the whole, but the degree of the dividing depends on the ability of the instruments to give a delicate reading.

The change in the pressure of the air brings changes in our weather, so reading the barometer dial is in reality feeling the pulse of the air.

The sun is directly responsible for all our weather changes. The world, the land, the atmosphere and the ocean are his servants—his great "distilling apparatus" as it has often been described. The warm south seas are the boilers, the northern and southern regions of cold the condensers, and the sun, the furnace.

This huge and complete pumping engine pumps up and showers down water. The atmosphere does not and cannot work alone—it works in company with the land and ocean under the sun's control.

The steadily heated tropical oceans send into the air streams of vapor, which as they rise become colder. They do not chill merely because the lessened weight of the air causes an expansion, and in this act of expansion or stretching, a certain amount of heat is given out.

The air growing colder becomes virtually damper because it is more nearly saturated—more nearly obliged to part with some of its hidden vapor. When it reaches the actual saturation point and does not lose moisture, the result is a fall of rain. The torrents peculiar to the "Calm Belt" receive a good amount of this precipitation, but the air still rising reaches that level where the anti-trade winds flow to the north and south and become carried in those directions.

In all these operations the real working power is the sun. The atmosphere without him would be like a steam engine without furnace fires—a powerful machine, but powerless to act.

Lifting these hundreds and thousands of tons of water—calmly, gently, noiselessly, with no sign of effort or strain, is done hourly by the sun through the obedient air.

Out of the ocean into the air; out of the air into the clouds; out of the clouds into the rivers; out of the rivers into the ocean, and so on through this endless circular chain.

P. R. JAMESON in the "TYCOS" House Organ.

The Possibilities of Pulverized Fuel

The Commission of Conservation Has Paid Considerable Attention to the Possibilities of Utilizing Canada's Low Grade Fuels and the Report on Pulverized Fuel, of Which This is an Abstract, Points Out One Successful Method

By WILLIAM J. DICK, M.Sc.

NEARLY a century ago pulverized coal as a fuel was experimented with, but its application to industrial purposes really commenced in 1895, when used in connection with the burning of cement. Its comparatively slow development was due largely to the fact that the advantages of thorough drying and fine grinding were not fully recognized. It was not until the pressing demands of the cement industry for a low-priced fuel of high efficiency became imperative that pulverized coal was found almost ideal. In this industry it is essential to grind cheaply the cement materials to a high degree of fineness so that the pulverizing of coal fell naturally into the hands of men able to powder cheaply, and to the same consistency, a material much less resistant than cement rock of clinker. The next general application of this fuel was in certain metallurgical processes, such as a source of heat for simple furnaces, where excessive temperatures were not required and where the ash deposits were either continuously removed with the heated material or could readily settle on the hearth and be withdrawn.

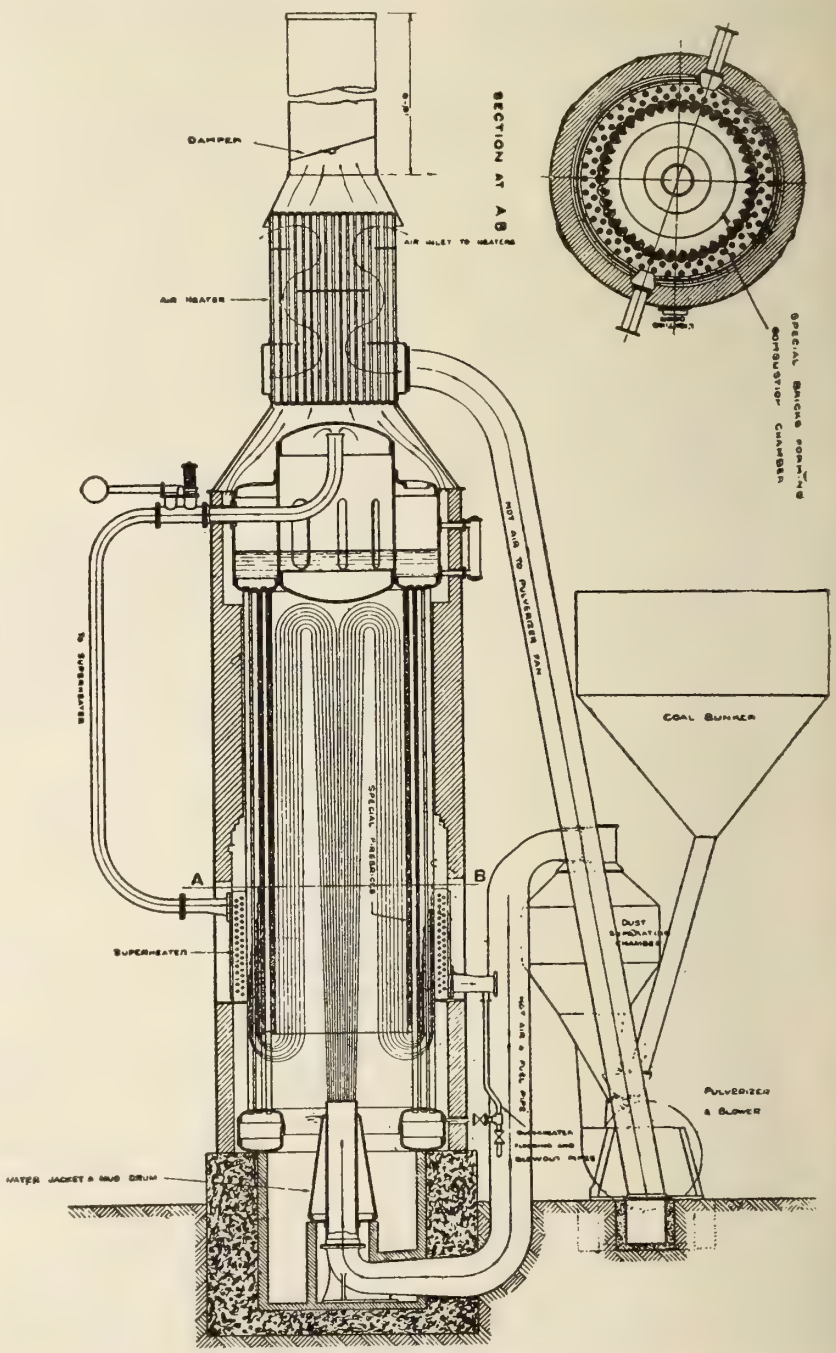
About sixteen years ago, the Manhattan Elevated railroad experimented with pulverized coal as a fuel on one of its locomotives. The equipment consisted of a combined pulverizer, blower and steam turbine situated on the locomotive. It is understood that, as the coal was not ground sufficiently fine and because certain mechanical details were not provided for, this method of burning coal was not successful.

During the last few years the Swedish Government and Swedish Boiler Society have carried on tests, using pulverized peat as a fuel on locomotives and stationary boilers, which have resulted in the successful use of this class of fuel.

In 1914, the New York Central railroad placed in operation a locomotive, of the ten-wheel type, having a tractive power of 31,000 pounds. This was the first locomotive of any size to be equipped and successfully operated for burning pulverized coal in suspension. Since then a similar application was made to an Atlantic-type locomotive of the Chicago and Northwestern railroad. Early in 1917 the Delaware and Hudson railroad installed the first complete commercial plant for supplying pulverized coal to one of its locomotives operating in regular train service.

In 1906 coal dust was experimented with in connection with reverberatory copper smelting at the Highland Bay smelter. While these experiments did not lead to its final adoption at this smelter, the results obtained showed very clearly that increased tonnage, with decreased fuel consumption, could be attained, and that such difficulties as were encountered were largely mechancial and presumably removable. In 1909 the use of pulverized coal as a fuel was investigated by Messrs. David H. Browne and Geo. E. Silvester, of the Canadian Copper Co., and, as a result, it was decided to instal coal-dust firing in connection with the reverberatory smelting of copper-nickel ore and flue-dust at their smelter Copper Cliff, Ont. Construction of the plant was begun in 1910 and completed in 1911. After investigating the work of the coal-dust fired reverberatories of the Canadian Copper Co., the management of the Washoe Reduction Works, Anaconda, Mont., decided to experiment with and ascertain the advantages of using coal-dust as a fuel in their reverberatories. In 1914 a reverberatory furnace was remodelled to use pulverized coal as a fuel, and the results obtained showed a decided saving in cost of smelting, as compared to grate-firing with lump coal.

In 1912 the American Iron and Steel Manufacturing Co. had carried its experi-



SECTIONAL VIEW OF BETTING BOILER.

ments to a point where it was ready to publish statements of the successful uses of this fuel. In their plant at Lebanon, Pa., pulverized coal was used as fuel for puddling furnaces and small reheating furnaces for nut, bolt and spike bars, and in large furnaces for continuous billet-heating and open-hearth melting.

During the last few years pulverized coal has also been successfully used in stationary boilers. In 1913 the Dominion Coal Co. installed Bettington boilers, burning pulverized coal, in connection with its power plant at New Waterford, N.S. This was the first installation of its kind in North America.

Pulverized Fuel in Boiler Plants

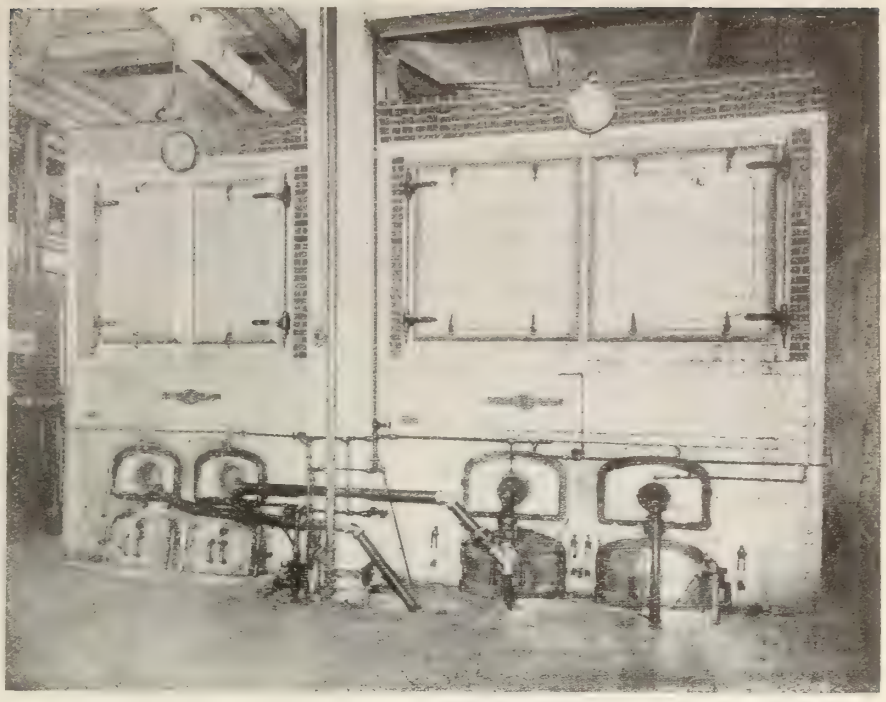
The development of the use of pulverized fuel in stationary boiler practice is of much later occurrence than its use as a metallurgical fuel. The early experimenters did not appreciate the necessity of fine grinding, nor the influence of furnace design upon the temperature of the resulting gases, consequently trouble was experienced through the action of the high temperature flame upon the brickwork. The blow-pipe effect of the high-velocity jet tended to melt the brickwork. A layer of slag, formed by the fusing of ash and brickwork, accumulated in the bottom of the combustion chamber and discouraged those who depended upon this fuel for continuous service. Difficulty was also encountered in the minute particles of liquid slag being carried in suspension and deposited upon the tube-sheet or water-tubes of the boiler, therefore interfering with its operation.

The knowledge gained recently, both in experimental work and by experience in equipped plants, has shown that these difficulties can be, and have been, overcome. The economy secured by the use of pulverized fuel in stationary boilers, instead of hand-fired coal, is not as great, in comparison as that derived from its use in locomotives. This is due, largely, to the fact that, it is possible to equip stationary plants with the best mechanical stokers. There is an advantage of two or three per cent. in combustion efficiency in favor of pulverized coal, but this is offset by the additional cost of fuel preparation. While the above comparison is made from the standpoint of efficiency, and where almost similar coal is used, there are many localities, especially in Northern Ontario and portions of Manitoba, Saskatchewan and Alberta, where pulverized peat or pulverized coal could be used to decided economic advantage instead of higher-priced imported coal.

Bettington Boiler

Boiler Plants—This combined boiler and pulverizing plant is the result of a long and expensive series of experiments, commenced in South Africa, continued and first patented in United States, and finally completed and commercially exploited in Great Britain. A summary of the difficulties encountered in applying pulverized fuel to steam-boiler practice is presented as follows in the catalogue published in the interest of this boiler:

(1) The difficulty of maintaining continuous and steady ignition; a difficulty only met by maintaining a uniform and very high temperature in the furnace.



500 HORSEPOWER PLANT USING PULVERIZED FUEL IN THE L. C. SMITH BLDG., SEATTLE, WASH.

(2) The failure to find an economical material to stand the destructive temperature necessary in the furnace as hitherto arranged for boiler firing.
(3) The difficulty of producing a continuously homogeneous mixture with varying grades of coal, sometimes very wet, and high in ash.
(4) The difficulty of maintaining a homogeneous mixture of fuel-dust and air during the full period required for complete combustion; the tendency of the larger solid particles being to concentrate in certain lines of direction; a difficulty met in part by extremely fine pulverization of the fuel.
(5) Difficulty of handling the molten ash, which from the required type of, furnace and temperature, must usually form solid deposits of slag.

The essential features of this type of boiler are:—

(1) Pulverizer and blower.
(2) Dust-separator chamber.
(3) Water-cooled nozzle or tuyere.
(4) Vertical water-tube boiler.
(5) Air heater.

The coal is fed automatically to the pulverizer, which acts also as a blower. The air, before being drawn into the pulverizer, is heated by means of an air-heater placed in the path of the waste gases from the boiler. By pre-heating the air, coals containing up to 15 per cent. moisture can easily be disintegrated and burned.

The coal, after being disintegrated, is delivered into the dust-separating chamber, the fines passing direct to the fuel nozzle and the coarser particles returning by gravity to the pulverizer for further reduction.

The fine coal delivered at the nozzle, and which, practically speaking, may be considered as a gas, is ignited and burns in the combustion chamber of the boiler. The heated gases pass from the combustion chamber up between the water tubes, through the economizer and air-heater, to the stack. The boiler consists of top and bottom headers, with solid drawn-steel tubes connecting them. Special bricks in combination with the innermost circle of tubes form the wall of the combustion chamber. No binding material is employed for these special bricks. The combustible matter in the fuel is said to be consumed and the residue is an irreducible vitreous slag. The slag solidifies at a relatively high temperature, and soon chokes up and hermetically seals all crevices, cementing the lining into one solid piece. The bulk of the slag falls into the ash-pit below in the form of small globules which are easily removed, the quantity being very small in comparison to the ashes from an ordinary hand-fired boiler. The steam, before passing to the turbines, is superheated by means of pipes spirally wound around the boiler tubes.

For this type of boiler, the manufacturer claims the following advantages:

(1) The boiler will give an efficiency not given by any other boiler on the market.
(2) They can be fired at any desired rate by adjusting the feed of the pulverizer.
(3) They are easily cleaned.
(4) After being closed down for a time, full steam can be generated quickly.

In 1913 the Dominion Coal Co. installed in their plant at New Waterford, N.S., three Bettington boilers, each having a normal evaporation, from and at 212 degrees Fahr., of 20,000 pounds per hour. They are fired with slack coal which could not be economically used to generate power in the ordinary boiler. This plant was the first of its kind to be installed in America. Other users of this boiler are the British Admiralty, Johannesburg Municipal Power Station, Clifton and Kersley Coal Co., British Oil and Cake Mills, of London, Hull and Manchester, Erith Urban District Council, De beers Diamond Mines, Donisthorpe and Co., Jupiter Gold Mining Co., Warren Hill Syndicate, Ltd., Crown Mines, Ltd., Bantjes Consolidated Gold Mines, Ltd., all of which,

it is claimed, are securing the greatest satisfaction.

The boilers are built in five standard sizes, with evaporations from 6,000 to 40,000 pounds per hour, at normal evaporation from and at 212 degrees Fahr., as follows: No. 1, 6,000; No. 1*a*, 8,000; No. 2, 12,000; No. 2*a*, 20,000; No. 3, 40,000 pounds per hour.

The following are the results of tests on this boiler, as outlined in the catalogue before mentioned:

Coal used	C.R.C. nuts	Dant		South African		Duff	Welsh anthracite duff
		Clifton Kersley	Ellesmere	Partings	Pickings		
Analysis (on dry coal)—							
Ash	22.18	23.00	21.12	22.58	21.30	19.92	12.64
Volatile matter	25.97	20.00	26.46	27.38	27.68	22.94	11.66
Sulphur	.....	.....	3.13	0.85	0.95	0.76	0.99
Fixed carbon	51.85	57.00	52.42	50.04	51.02	57.14	75.70
Calorific value on dry coal (B. t. u.)	8,710	10,700	11,250	10,098	10,494	11,088	12,276
Calorific value on dry coal (B. t. u.), expressed as pounds of water, evaporated from and at 212 deg. Fahr.	9.01	11.08	11.65	10.45	10.86	11.48	12.71
Absolute steam pressure, pounds per sq. in.	140	164.5	164.8	152.3	152.15	130.45	151.1
Average temp. gases escaping from boiler, deg. Fahr.	514	592.7	658.8	558.3	587.5	603.7	560.3
Average temp. feed water deg. Fahr.	76.6	.....	56.6	56.0	56.0	56.0	57.2
Pounds dry coal fired per hour	1,084	1,020	1,179.2	1,183.3	1,347.8	1,183.5	1,242.2
Actual water fed per hour, pounds	6,380	6,550	7,984	7,348.1	8,803.6	8,471.4	9,217
Equi. water evap. per hour from and at 212 deg. Fahr.	8,495	8,476.8	10,290.4	9,437.2	11,321.4	10,909.5	11,776.4
Pounds water per pound coal, actual	5.37	6.418	6.635	6.111	6.401	6.986	7.36
Pounds water per pound coal, actual from and at 252 deg. Fahr.	7.15	8.309	8.726	7.975	8.40	9.218	9.48
Thermal efficiency, based on coal	79.3	75.0	74.9	76.31	77.35	80.30	74.59
Percentage of moisture in coal during test	8.66	15.6	2.00	1.6	2.00	2.4	0.8

R. H. Fernalde states that an examination of the installation at the works of the agents of the Bettington boiler "gave an excellent impression of the operations of the pulverizing equipment, with its freedom from floating dust. Unfortunately, no examination of the effect of fusing of the ash could be made, as the boiler was under test and access to its interior was out of the question. The company claimed that, after years of experimental work with special fire bricks, it has developed that the method of inclosing the water tubes of the boiler practically amounts to water-cooling the brick. It is, therefore, possible to dispense with special, expensive, high-grade brick for this purpose and to use common fire-brick.

"This installation consists of a boiler of slightly over 2,600 sq. ft. of heating surface, which has an evaporative capacity of 14,000 to 22,000 pounds of water per hour. The power required for pulverizing and feeding the fuel is stated to be about 3 per cent. of the boiler capacity.

"No definite information regarding depreciation and maintenace was available, but by some these items are regarded as excessive.

The manager of a steel plant in Wales reported that he was using two of these boilers. He had installed two boilers rated to evaporate 20,000 pounds of water each per hour. He stated that he was using refuse coal containing 25 to 27 per cent. ash —a mixture of colliery dust and coke dust. The boilers had been installed only about two weeks and had consequently not been thoroughly tried out. Tests of the boilers showed an efficiency of 75 per cent., and the indications were that the boilers would be entirely successful."

The following is the result of a comparative test of a large marine-type Babcock and Wilcox boiler and a Bettington boiler of nearly the same size. The latter was the first of its type, and is no doubt capable of some improvement as the result of the experience gained. It will be seen, however, that it compared well with its older rival. The figures are as follows:

Item	Bettington tests	Babcock and Wilcox tests
Date of test	June 26, 1913	June 27, 1913
Duration of test	9.8 hours	10 hours.
Gauge pressure	173.7 lbs. per sq. in	161.9 lbs. per sq. in.
Feed temperature	65.5 deg. Fahr.	64.7 deg. Fahr.
Steam temperature	510.3 deg. Fahr.	546 deg. Fahr.
Water evaporated per hour	31,561 lbs.	29,370 lbs.
Coal consumed per hour (no allowance made for carbon value of ashes)	4,477 lbs.	4,183 lbs.

Item	Bettington tests	Babcock and Wilcox tests
Pounds of water evaporated per 1 pound coal (as fired)	7.050 lbs.	7.014 lbs.
Evaporative equivalent from and at 212 deg. Fahr. (as fired)	9.049 lbs.	9.140 lbs.
Evaporative equivalent from and at 212 deg. Fahr. (dry)	9.464 lbs.	9.868 lbs.
Efficiency on gross calorific value	78.6 p.c.	77.4 p.c.
Percentage auxiliary power	3.8 p.c.	1.0 p.c.
Net efficiency on gross calorific value	75.6 p.c.	76.6 p.c.
Efficiency on net calorific value	81.4 p.c.	80.0 p.c.
Net efficiency on net calorific value	78.3 p.c.	79.1 p.c.

Pacific Coast Coal Company, Seattle, Washington

This company was the pioneer in the development of the use of pulverized fuel on the Pacific coast, and, to-day, the industry has reached a high stage of development, particularly in connection with the use of pulverized coal for boiler plants, and for power and heating purposes.

This company owns and operates the following mines in the state of Washington: Black Diamond, Newcastle mine, and the Burnett or South Prairie mine, all of which are in the vicinity of Seattle.

DELIVERING PULVERIZED FUEL BY MOTOR TRUCK.

The following are analyses of these coals:

Black Diamond Mine

(As Mined)

Moisture	2.05	per cent.
Volatile matter	47.25	"
Fixed carbon	46.70	"
Ash	3.55	"
Sulphur	.40	"
B.T.U.	12,651	

(Dry coal)

Volatile matter	48.46	per cent.
Fixed carbon	47.89	"
Ash	3.64	"
Sulphur	.41	"
B.T.U.	12,976	

Newcastle

(As mined)

Moisture	7.08	per cent.
Volatile matter	36.55	"
Fixed carbon	29.92	"
Ash	25.73	"
Sulphur	.57	"
B.T.U.	8,842	

(Dry coal)

Volatile matter	39.64	per cent.
Fixed carbon	32.45	"
Ash	27.40	"
Sulphur	.62	"
B.T.U.	9,540	

Burnett

(As mined—No. 4 vein)

Moisture	.96	per cent.
Volatile matter	39.24	"
Fixed carbon	46.33	"
Ash	13.47	"
Sulphur	1.28	"
B.T.U.	12,052	

(Dry Coal)

Volatile matter	39.62	per cent.
Fixed carbon	46.77	"
Ash	13.60	"
Sulphur	1.29	"
B.T.U.	12,169	

This company owns and operates two pulverized coal plants—one at the Newcastle mine and the other at Black Diamond mine.

Newcastle Plant—This plant has a capacity of five tons per hour, and consists of one Ruggles-Coles dryer and one 46-inch Fuller mill. The pulverized coal is used in the mine power-plant, and for shipment to Seattle.

Black Diamond Plant—This plant has a capacity of five tons per hour, and consists of one Ruggles-Coles dryer, and one Raymond mill. The pulverized coal is used in the mine power-plant and for shipment to Seattle.

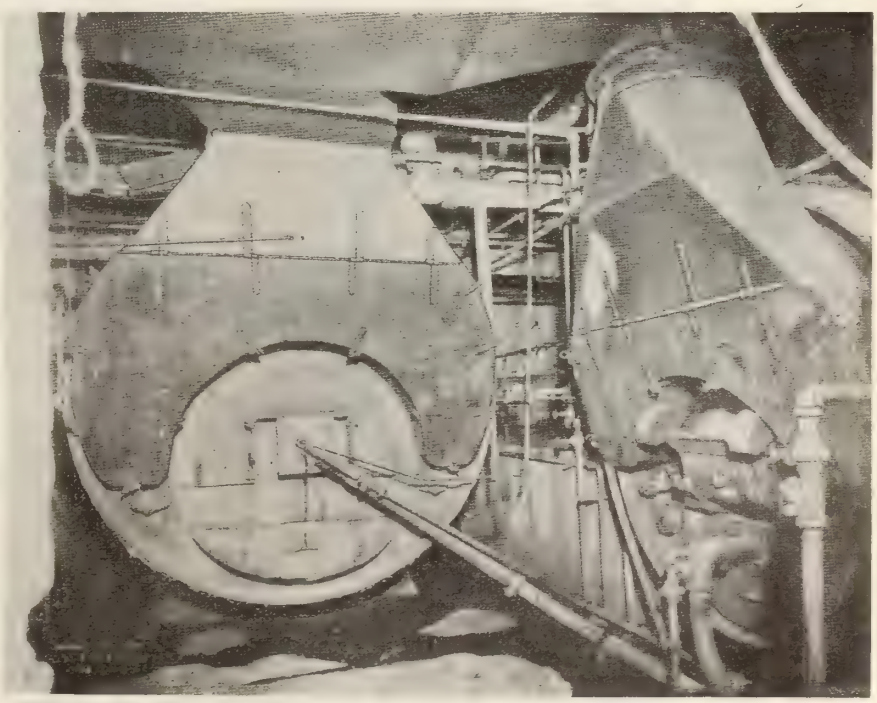
The pulverized coal is shipped to Seattle in tank cars, and distributed by tank motor trucks. This company has built up a commercial business of about 30 tons per day, and the following buildings have converted their boilers from oil-burners to the use of pulverized fuel: The L. C. Smith building (42 stories), Pacific block, Broadway high school, New Richmond hotel, Seattle natatorium (Crystal Pool), and Independent laundry. The price of pulverized fuel, delivered, is $7.75 per ton, a saving over fuel oil, which formerly cost $2 per bbl. of 42 gals.

FIRE SMALL QUANTITIES AT FREQUENT INTERVALS

When soft coal is placed on a hot fire a considerable quantity of gas commonly called violatile matter is driven off rapidly. This process which is known as distillation takes place whether or not air be present. However, to secure the entire heat of the volatile matter, these gases must be completely burned before passing out of the combustion chamber. Most coals used in this state have a high percentage of volatile matter. In the case of some coals the volatile matter represents over 40 per cent of the heating value.

Since distillation takes place in the first few minutes after firing, and the rate of flow of air through the fuel bed is practically constant, extra air must be admitted above the fire during this time, in order to secure complete combustion. It is usually found necessary to admit this extra amount of air required, either through the damper openings in the fire doors or by leaving the fire doors open slightly for a few minutes immediatey after firing.

As the amount of gas given off depends entirely upon the amount of fresh fuel, small amounts should be fired at frequent intervals to maintain as nearly as possible the proper proportions between fuel and air supply. The fire door dampers should be opened, or the doors cracked slightly for 2 or 3 minutes after firing. The fire doors should be closed as soon as the gas is burned or the furnace will be cooled off and heat wasted.



SCOTCH MARINE DRYBACK BOILERS, CAPACITY 935 HORSEPOWER. NEW RICHMOND HOTEL, SEATTLE, WASH.

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - - President
H. T. HUNTER - - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII. TORONTO, March 5, 1920 No. 5

PRINCIPAL CONTENTS

Re the Ontario Graded Certificate Act; Correspondence 101
Present-Day Synchronous Motor Design 103
Some of the Principles Underlying Refrigeration 106
Power Plant Features of a By-Product Coke Oven 107
Methods of Storage and the Weathering of Coal 113
The Possibilities of Pulverized Fuel 116
Editorial 120
New Equipment 122
Readers' Queries 123
Operators' Point of View 124
Selected Market Quotations 126
Trade Gossip 44

The Wisdom of Boiler Inspection

ON July 26 last a boiler exploded at a cheese factory in Pittsburgh township, near Kingston. An investigation brought out the fact that it had never been properly inspected since installation, and no doubt the failure could have been prevented if this measure of precaution had been observed. The explosion, in addition to much material damage, caused the loss of a life, and this fatality has recently been the cause of a decision handed down by the Supreme Court. A jury has awarded $1,000 damages to the father of the deceased, since the death was due to the negligence of the defendant in having installed a boiler which had not been officially inspected.

This decision opens up an interesting line of thought, and would imply a material extension of the owner's responsibility. While boiler inspection is not in every case a preventive of explosions, it is recognized as being a sensible and indeed a necessary precaution, and when it is not done, as in the present case, the jury would be perfectly right in assuming contributory negligence.

Do Fashions Change in Engineering?

LUBRICATION experts have told us for a long time that acid of any kind in lubricating oils was dangerous and should never be tolerated. Corrosion troubles, under certain conditions, and other disadvantages were supposed to result from any lubricant not almost chemically free from either mineral or fatty acids.

Along came two investigators who, in a paper before the Society of Chemical Industry, claim that this is all wrong, and that by adding a small proportion of fatty acids the lubricating qualities of the oil are vastly improved.

The authors use the expression "germ process" to describe the oil made by using one or more fatty or other acids with one or more mineral oils, because the world has been taught for generations to look upon acid as the deadliest enemy to good and safe lubrication. Had they not used guile of some kind to cover the leopard's spots, "peaceful penetration" had been almost impossible.

The word germ has been used in this sense since, while the fatty acid germ is not alive in the sense that germs are, it is very active and so, it is claimed, affects the properties of the oil in a profound manner. Compounded oils have, of course, long been known, and many specifications call for so much mineral oil and so much of some particular vegetable or animal oil. Formerly all specifications and other requirements strictly limited the amount of free acid in compounded oils to a very small amount, and in mineral oils to none at all.

These investigators have upset all this, and instead of vegetable or animal oils and fats, they add fatty acids to mineral oil and eliminate the organic oil. The fatty acid produces an oil with varying properties as desired and it is quite possible to produce an oil which will work well in the crank-case of forced lubrication engines without emulsification.

For a good, heavy marine engine oil it has always been considered necessary, and is so to-day, to use from 10 to 25 per cent. of a thickened or blown oil—as a rule, thickened rape oil. This gives great viscosity, also very good "latherng" properties to the oil. A marine engineer must see the oil "lather" well, or it is no use.

The standard specification for marine bearing oil for one of the semi-Government departments in Great Britain is a compound of about 20 per cent. "of fatty oil"; but the total fatty acid content must not exceed 1 per cent. This department was considered most conservative, yet germ-process-marine-engine oil is doing, and has done for about eighteen months the same work for which a 20 per cent. compound oil was previously considered essential.

In the power plant and on board ship it is quite possible that this new lubricant may affect considerable changes.

An Error in Topography

A WRITER in an American contemporary, speaking of a new 15,000-ton steamer now building for the White Star-Dominion Line, says that she is to be named the "Calgary," after the Canadian province in which the Prince of Wales owns a ranch. This reminds us of an old lady, who, after listening all evening to a traveller's tales of the Orient, remarked, "Yes, China must be a wonderful city."

"Why Do the People Rage and the Heathen Imagine a Vain Thing?"

The Editor *The Engineer*,
London, England.

SIR:—It was stated in *The Times* for January 13th that a professor in the United States has invented a rocket which is capable of passing right through the atmosphere. The question arises in my mind as to whether there is not a certain amount of risk about experiments of this kind which it is undesirable to run.

Professor Jeans, in his book, "The Dynamical Theory of Gases," states, it seems with good ground, that "the proportion of a light gas, however rare at the bottom, must necessarily exceed that of all heavier gases after a sufficient height," and that consequently at very remote altitudes there is a large proportion of hydrogen. In the absence of sufficient oxygen, it, of course, would not burn, but it is more than possible that an explosive belt may occur, which the new rocket would ignite, if it ever got there. This operation might merely lead to an unprecedented display of the nature of an aurora; on the other hand, it might bring about the end of the world, so far as we are concerned.

It may be objected that if this was likely to happen, the effect would have been produced long ago by meteoric agency. The answer to this objection is that meteors derive their incandescence from the friction of the atmosphere, which is practically non-existent where the latter is so highly attenuated as it would necessarily be at the levels under consideration. In other words, all their heat is generated when nearing home.

Perhaps some of your other readers will say what they think. If my view is correct, an authoritative protest should be sent to the Smithsonian Institute at Washington.—C.F.O.M.

The Good Old Styles

THERE'S not much end to ways and styles that folks is usin' now, and some is awful common like and lowly in the brow. While others aim at higher planes, a most delightful thing, and of them now let's string our lyre and raise a voice and sing.

There's lots of folks wear dinky hats what squat upon their head, in temperatures that make the snout turn most alarmin' red—they walk along the streets they do, in manner quiet and smug, a hangin' to their nose a spell and wackin' at their lug.

And on their hands they wear, they do, gloves of some dainty hue, what let their fists become at onct both numb and freezin' blue.

Upon their feet they grow silk socks, yes pleasant things in June, but ugly things, my lad, by heck, when frost hangs on the moon.

And there they strut both to and fro, rigged out in truck like that, silk socks, and gloves to torture them, likewise a cardboard hat.

Bring back, my son, the armament, we wore in days of yore, them days what's fled and gone, my boy, yes gone to come no more. 'Twas then we had the woollen mitts, the fuzzy knitted kind, the old wool scarf around the neck that hatched fine peace of mind.

And on our head there rested sweet a cap both deep and wide, with fur and wool entwined, by gum, and restin' side by side. And ear-tabs, too, was sprouted there, the things was built to last, and save my brains from being exposed to every wintry blast.

Ah, yes, bring back them things once more, that I may walk about, without a frozen set of feet, without a chilly snout. Yes, let me put those wool socks on, wool mitts upon my paws, a scarf about my chilly neck in either frosts or thaws, and on my dome then place that cap, so I'll raise up my song unto the comforts of the lid what has the ear-flaps on.—ARK.

The Business Paper

AN association of railway executives undoubtedly represents the most capable and progressive business men on the continent. Practically all of them have worked their way up from minor positions and they know every phase of labor, business and public opinion. They should know it better than any other class in the community.

Recently the Association of Railway Executives of the United States wanted to lay before the country the fundamental facts of the railway situation. They selected a number of newspapers for this purpose. Out of the total number, 42 were purely trade and technical newspapers.

In repairing a drawbridge across the Passaic River, at Newark, N.J., it became necessary to remove a casting and pin from a granite pier. After several unsuccessful attempts to draw the pin, as narrated in Stone, the pin projecting down 3 inches into the masonry, it was found necessary to cut a trench in the hard granite so that the casting might be shifted laterally to one side for removal and replacement by a new and larger centre casting. This trench was 4 ft. long, 9 in. wide and 3 in. deep, extending under the old casting. The cutting of the trench would have been an endless task had it not been discovered that an oxy-acetylene flame chipped the granite quite readily and could be used under the old casting without damaging the balance of the masonry. The desired channel was thus quickly obtained. The flame was also used for cutting away the abutment back of the fixed span bottom chord to provide expansion clearance.

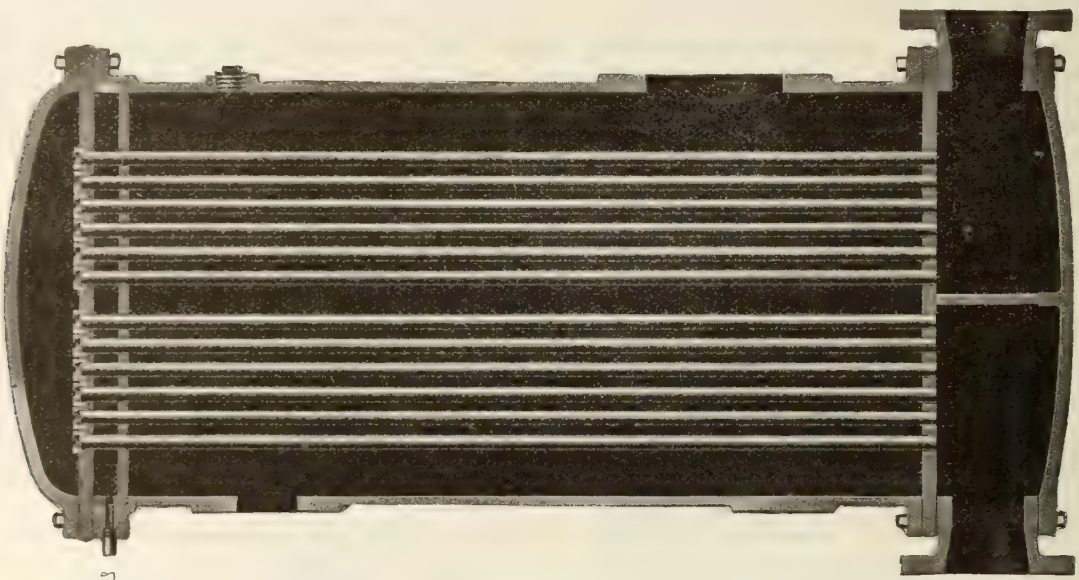
WHILE going through the fitting shop of a large engineering works the manager noticed an apprentice, who was holding his hammer close up to the head, in an unworkmanlike manner. The manager remonstrated with him in this fashion: "Look here, my lad, that's no way to hold a hammer. When I see a man holding his hammer by the end of the shaft I pay him $30 a week. If he holds it half way up I pay him $20 a week, and when its held higher than that I pay him only $10 a week. Do you get me?" "Yes, sir," replied the youngster; "but you might tell me where I should hold it. I only get $5 a week."

The Old Actor—"I'm afraid I'm past playing the hero; but it's something to know that I will have a star part as the villain."
Partridge in "Punch" (London).

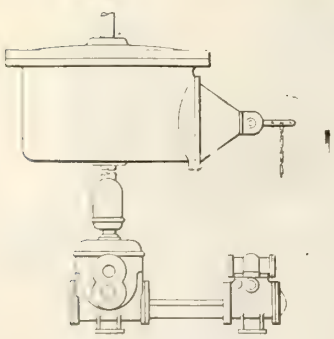
Progress in New Equipment

A NEW WHEELER CONDENSER WHICH ELIMINATES LEAKAGE TROUBLES

It was recently brought up at a meeting of marine engineers that most of the ships now in service are experiencing trouble with leaky condensers. These leaks have been almost invariably traced to the stuffing box between the tube and the tube plate. It has been found that in spite of the kind of packing used, some leakage is practically unavoidable, due to the expansion and contraction of the tube with temperature change.



NEW WHEELER CONDENSER WHICH ELIMINATES LEAKAGE TROUBLES.



The illustration herewith shows a new type of condenser developed by S. Morris Lillie, inventor of the well-known and highly efficient Lillie Evaporator This condenser is used chiefly in connection with salt circulating water on board ship or in regions where the water which is used for circulating purposes would be very bad for boiler feed in case of leakage into the condenser and consequent mingling of the bad water with the condensate.

It will be noted on reference to the illustration, that the tubes are tightly expanded into the right hand tube plate, which eliminates the possibility of leakage at this end. At the other end the tubes are provided with the standard ferrules and condenser packings. It is not considered good engineering practice to expand condenser tubes at both ends, because, due to constant expansion and contraction ,they inevitably loosen, and leakage becomes greater than where packing is used.. The packing permits the tubes to expand freely and yet maintains an almost leakless joint. It is, therefore, at the left hand end that leakage occurs, if at all.

At the left end of this condenser a thin auxiliary tube plate or baffle is provided, through which all of the tubes are passed. The holes in this plate are of such size as to make a sliding fit with the tubes. It is obviously not necessary that these joints be absolutely watertight.

In case of leakage of circulating water through the ferrules and packing, such leakage immediately drops down to the bottom of the compartment between the two tube plates, and is then carried off by the drain shown at the bottom, to which is attached either a small direct-acting condensate pump, or a vacuum trap, depending upon conditions.

We are advised by the manufacturers of this condenser, the Wheeler Condenser & Engineering Co., Carteret, N.J., that they now offer this condenser in all sizes, the cost of which is but slightly greater than the cost of a standard condenser of the same type.

CAUSES OF CLINKER

As clinker is caused by melting of ash any coal will form clinker if the ash is heated to the Melting temperature.

The most common causes of clinker are thick fires, stirring the fire, firing coal containing much slack, closed ash pit doors and fire in the ash pit. Clinker forms in a thick fuel bed because the smaller supply of air through the grate permits the ash to become heated to the melting point. By stirring the fire, ash is lifted into the hotter parts of the fire and fused to clinker. Coal containing much slack may cake or form a crust over the fire, thus stopping the flow of air through the fire in the same way as a fuel bed which is too thick. Closed ash pit doors and fire in the ash pit cause overheating of the grates and the ash above them.

INTRINSIC BRILLIANCY OF THE SUN

The intrinsic brilliancy of the sun, deduced by M. C. Nordmann from temperature measurements made by a heterochromatic stellar pyrometer, shows close agreement with the estimate of Muller, arrived at by entirely different methods.

After allowing for the light absorbed in transmission through the atmosphere, Nordmann finds the intrinsic brightness of the sun to be in the neighborhood of 319,000 cp. per square centimeter, which is about 2,072,000 cp. per square inch. Muller's estimate was 301,500 cp. per square centimeter.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question.—A certain single non-condensing engine is capable of developing 500 h. p., with 125 lbs. throttle pressure and exhausting at atmospheric pressure. A low pressure turbine inlet is connected to the exhaust pipe of the engine and its outlet to a surface condenser carrying a vacuum of 29 inches. The turbine develops 500 h. p., Explain how you get this power?

Why is it necessary to run turbines at a high rotative speed?

Why is a high vacuum more beneficial to a turbine than an engine?

Answer.—In the engine referred to the steam, at entering, has a temperature of 352.827 degrees F. On exhausting it has a temperature of 212 degrees F. If allowed to exhaust to the atmosphere and condense it will carry with it 1146 BTU's. the total heat above 32 degrees F., per pound on steam.

In putting the exhaust steam from the engine through the turbine, and expanding it to a pressure of 1 pound absolute we have available a further number of heat units from 212 to 102. The amount of heat delivered to the condenser would be only 1133 BTU's. Energy expended by a gas is at the expense of temperature only so we will see how the efficiency of the different points compares.

$$\frac{T - T}{T}$$

$$\frac{460 + 352 - 460 + 212}{460 + 352} = 17.3\%$$

= The efficiency of the engine.

$$\frac{460 + 212 - 460 + 102}{460 + 212} = 16.2\%$$

= The efficiency of turbine.

$$\frac{460 + 352 - 460 + 102}{460 + 352} = 30.7\%$$

= The combined efficiency.

The power to drive the turbine is derived from the heat in the steam which would be lost if allowed to exhaust from the engine to atmosphere. Even then we cannot help losing a considerable amount. The latent at one pound absolute is 1043.015, and there are still 70 degrees sensible heat at that pressure.

Take it this way: You have an engine developing 500 h. p. That is 16,500,000 ft. lbs., per minute. The energy given up per pound of steam is 352—212=140 BTU. Multiply this by 778 to get foot lbs., we have 778 × 140 = 108920 ft. lbs., per lb. steam. This gives a consumption of 18.18 lbs. per hour on the engine, which, of course, is too low practically, but may be allowed to stand for our purpose.

Now the total horse power is 1000, of engine and turbine. That is 33,000,000 ft. lbs. The overall drop in temperature is 352—102 equals 250 BTU's per lb. steam. This is equivalent to 194,500 ft. lbs. Dividing this into the total gives 170 lbs. steam per minute, or 10,200 lbs. per hour divided by 1,000 h.p. equals 10.2 lbs. steam per hour, which is also too low practically. However, the main thing is to point out that the power available is dependent on the drop in temperature.

Turbines must be run at a high rotative speed to get the best results from the steam. In the impulse turbine the potential energy of the steam is changed into kinetic energy by the high velocity and drop in pressure of the steam issuing from the nozzle. The most efficient speed for the turbine vanes is half the velocity of the issuing steam. If this could be attained the steam would drop back from the vanes having lost its motion entirely.

In a reciprocating engine the vacuum in the cylinder is always a pound or two higher than that in the condensor. The free outlet from the turbine enables a higher vacuum to be kept. Another point is that to handle the volume of steam at very high vacuum the proportions of the ports and passages in a cylinder would have to be very large. There is no practical gain in carrying vacuum much beyond 27 inches in a reciprocating engine, but in the turbine well defined gains are made up to the highest vacuum obtainable.

READER'S QUERY RE GRADED CERTIFICATE ACT.

Question?—Could you give me the following information through the columns of POWER HOUSE? Under the new Graded Certificate Act in Ontario, can a man who was a pipe-fitter act as a chief engineer in the same plant, without a license, but having three or more licensed engineers under him? He himself would not stand watch but would have control of plant.

Answer—The interpretation of the Act in this respect is somewhat difficult at the present time, and until it has been in operation for some little time this and other similar questions are not likely to be definitely settled. In general, we would say that the propriety of a man without papers being in charge would depend almost solely upon his jurisdiction, and the scope of his duties. In the first place he cannot operate the plant nor can he take charge of a shift. It would almost seem that he should not give engineering advice, but that his duties should be confined to purely those of an executive nature.

If this were done, and his authority recognized as that of a plant executive, in charge of the engineering end of it insofar as economical operation, etc., are concerned, then we do not see how the act could interfere with him.

It must be remembered that the Act applies only to operating engineers, and it is sometimes difficult to define the latter's duties, and to draw the line between operating and executive duties.

HOW TO HELP THEM.

The following letter from a subscriber, show how POWER HOUSE can help you: Dear Mr. Fenner:

> "Many thinks for your letter re Thermal Efficiency of Reciprocating Engine vs. Turbine. If you have a little time I am enclosing three questions you might send me your answer to. I am greatly interested in Thermo Dynamics, so that you will understand your articles in this last issue comes as a boon and please keep calculus out of it if you possibly can. I got Moyer's Book on Steam Turbines, from the Wiley Series. In your formula of Temperature Mixtures, there is a little error, "Weight of Water" is mentioned twice instead of "Steam and Water." I would also ask "Does not Adiabatic expansion expand at the expense of its own temperature?" Please correct me. I hope you will continue this series with the result that all can see the advantage of the Turbine, and please explain in your series of articles the Entroph diagram relative to the lowest absolute pressure between Turbine and Reciprocating Engines.
>
> Thanking you very much for your past kindness, and in anticipation of future ones, I beg to remain."

The Operators' Point of View

WATER SOFTENERS

A WATER softener should be part of the equipment in every power plant using steam boilers, but from personal observation in power plants I have visited, very few of the plants had them. Many plants have numerous so called labor and money-saving articles of various kinds, some of them are good, some of them only look good, and some of them neither look good or do good. Some otherwise. Good power plant inventions require such constant and careful attention that the proper operation is improperly performed by insufficient care by the perhaps, small operating staff in the plant. A water softener requires attention and intelligent attention at that, but the beneficial results obtained are so great that it would be quite possible to increase the number of helpers in the staff and still be many dollars ahead in operating costs, besides, quite possibly, extending the life of the boiler tubes and shell from 50 to 100 per cent. As a matter of fact experiment has shown that when a water softener is installed the number of the operating staff is usually reduced as the boiler cleaning is reduced to a minimum, repacking and repairing valve rods and valve stems is greatly reduced, pitting and corrosion inside the boiler are much less likely to occur. Numerous men financially interested in boiler compounds will warn the engineer against using caustic soda or soda ash water softeners, the statement has been made that an analysis of most commercial steam boiler compounds will show they contain caustic soda or soda ash. In the plant where I am engineer I use a compound containing caustic soda, the compound is mixed in a thin sheet iron tank, .045 thick, corresponding to number 17-B and S gauge. The compound has been made in this light tank for years, and allowed to remain therein until its contents are gradually used up, remember this is the concentrated mixture, still the iron shows not the slightest sign of pitting or corroding, or thinning. The compound costs $6.00 a barrel and does better work than different compounds I have used costing $75 to $90 a barrel.

The compound consists of caustic soda, japonica, sal-ammoniac, granular, and ground elm bark. Pretty simple surely. It is necessary to have an analysis made of the feed water if the exact quantity of sal-ammoniac to be used is required, but the approximate quantity can be determined with little or no danger of injury to the boiler metal.

About 2 pounds to the barrel will be about right, with 15 pounds of caustic soda and 10 pounds of japonica and 2 pounds of ground elm bark. Feed from one to two quarts of the compound to each 100 B. H. P. per 24 hours.

How to mix the compound:

Place the caustic soda into a barrel. Put several pails of very hot water upon it. Separate the japonica into small pieces and place it in the barrel with the soda solution, stir it up and place the ground elm bark with it, also the sal-ammoniac, granular, and fill the barrel with hot water. When the mixture cools it is ready for use.

Japonica is Japanese flowers compressed into a pulpy mass and nearly odorless. All these drugs can be secured from Lyman Bros, Toronto.

You have the satisfaction of knowing what is in this compound, and it surely will give as good results as most of the compounds mixed and sold to treat waters without an analysis. However the best and safest compound made, fed to the boilers in the best method devised, will not begin to compare with the excellent results secured with a water softener of approved make. Do not miss that word, approved, buy the softener from a manufacturer who is responsible, and do not forget. Keep his guarantee

Any engineer who is interested in this matter should secure one of the books, "Chemistry for the power plant." and learn a few of the simple rules pertaining to water softening; it will prove as interesting as a novel.

A good many of you have employers who would be delighted to install water softeners if you can show them where the profit to them will result, but if he decides to install a machine on your advice let him understand you will not be responsible for results unless he secures a softener of proved worth, let him know that he is not to go around looking for some second-hand discarded junk.

Before bringing the subject to the notice of your employer, secure catalogs from responsible firms, look through the selling section of your power plant journal for the address of such firms.

Do not get the idea that a steam, feed water heater and purifier, and a water softener are practically the same thing, nothing of the kind, every plant over 50 B.H.P. or over should have one of the best of each of these auxilaries as part of its equipment.

James E. Noble.

A SUGGESTION

The Editor:—Being confined to the house for a few days with a badly bruised leg, I have been going through a large pile of back numbers of the POWER HOUSE with a pair of scissors and a paste pot. I found an old well bound diary and have been busy pasting in clippings and have now quite a valuable scrap book.

To read the POWER HOUSE one might imagine that all the steam plants in Canada were burning coal or fuel oil. In British Columbia the manufacture of lumber is our leading industry and a large proportion of our steam plants are fired with wood, sawdust and shavings. Every saw-mill accumulates a far larger quantity of wood refuse than it can consume under its boilers and this has to be burned on the rubbish heap, or in a specially constructed burner. All this heat is absolutely wasted. The saw-mill engineer does not have to study economy of fuel The difficulty he meets with is the varying quality of his fuel which is sometimes so wet that it is very difficult to keep steam at all. Many of the mills are located in remote country districts where skilled help is hard to get and the engineer has to be a very handy man indeed in making repairs to his machinery. I am sure that some of your subscribers among my brother saw-mill engineers could contribute some valuable articles from their experiences if they would.

John Shirley Richardson.

A CORRECTION

A correspondent calls our attention to an error in the article on thermodynamics, namely in finding the resulting temperature of a mixture of water and steam we have neglected to take into account the latent heat. This error occurs on page 33, column 2. Our correspondent points out that the resulting temperature is much higher than 147.4 degrees. the result we gave, and he is quite correct in this. As a matter of fact, the resulting temperature would be 212° unless the mixture was in a closed vessel at a higher than atmospheric pressure. Putting a jet of steam into an open tank of water at atmospheric pressure, will result in a temperature of 212°, no mat-

ter how much steam may be added. Here is one of the fruitful sources of waste in many manufacturing processes, such as dyeing, washing and cleaning tanks such as used in nickel plating works.

To return to our problems, the resultant temperature of 10 lbs. of water at 62° and 5 lbs. steam at 100 lbs. pressure.

The total heat of steam at 100 lbs gauge pressure is 1185. The latent heat is 876.3. We have therefore 5 lbs. steam with a total heat value of 5925 B.T.U. to be added to 10 lbs. water at 62 degrees. Neglecting the specific heat in this case for the sake of avoiding fractions, we get

$$\frac{10 \times 62 + 5 \times 1185}{10 + 5} = 436°$$

Obviously, this is impossible. Therefore we must look back and find how much of the heat is absorbed in raising the temperature, and how much is employed in a different manner.

To raise one pound of water from 62 to 212 takes 150 B.T.U. To raise 10 lbs. requires 1,500 B.T.U. Therefore from the total heat available in the steam, subtract 1,500. 5924—1,500 = 4,425 B.T.U. still available. However this amount of heat will turn a certain amount of water to steam at atmospheric pressure. The latent heat of steam at atmospheric pressure is 966 B.T.U. 4425 ÷ 966 = 4.58 lbs. water turned into steam at atmospheric pressure. Therefore we shall have 10.42 lbs. water at 212° and 4.58 lbs. steam at atmosperic pressure, neglecting the specific heat. which makes only a small difference.

THE TELESCOPIC CANDLESTICK

The telescopic candlestick, designed by J. O. McDonell, and shown on page 97. The POWER HOUSE is not likely to be used by many engineers. Electric light is used in nearly every power plant at the present and an insulated waterproof socket and extension wire is away ahead of anything like the outfit suggested by Mr. McDonnell. Five pieces of round wood, about ¾ inch in diameter, and 5 feet long with thimbles at each end so that they can be put together like a fishing rod would be a lot simpler and handier than the pulley extension rig shown. For seeing the inside of a boiler through the end handholes where there is no electric light, a nail driven through one end of a long stick and a piece of candle forced onto the nail, is a hard thing to beat. To use a candle in restricted places use the pantograph. As this instrument is about a thousand years old and is used considerable in engineering practice, most engineers know all about it.

A handy size to make is from strips of hard wood 19 inches long, ½ inch wide, and ¼ inch thick. Make holes for ⅛ inch bolts ½ inch from each and tighten the nuts on the bolts pretty tight.

The size of this pantograph when folded will be 19 inches long, 3 inches wide and ½ (half) inch thick. Therefore it can be kept in a desk, cupboard, box or even a suitcase.

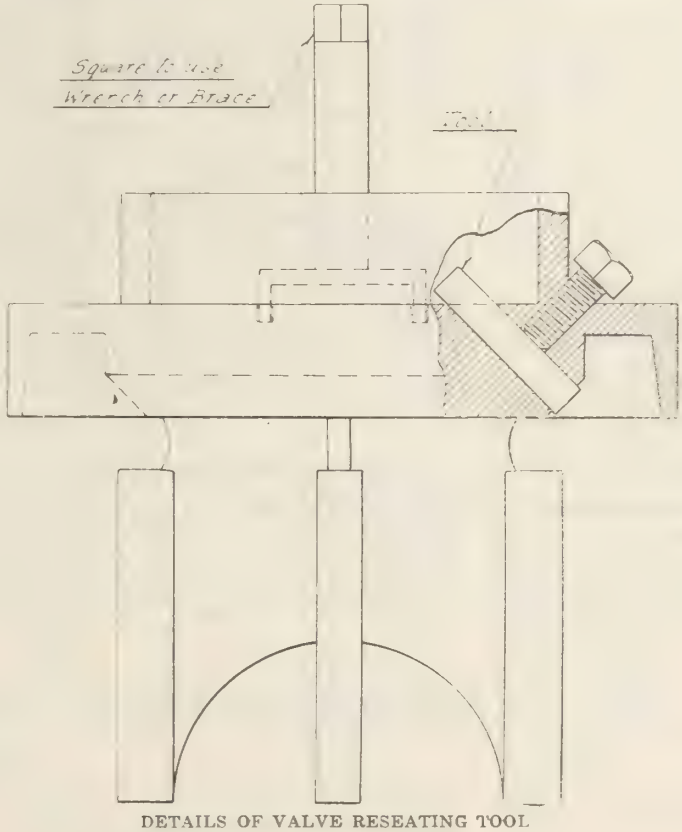
It will extend from 19 inches up to 9 feet and can be used in any position, flat, upright or at any angle. Use a thin candle or a short piece of candle on the end. It is a good idea not to use candles inside steam boilers if there is any possibility of having a properly protected electric light outfit. Many engineers in small country plants use the dry electric cell lantern when cleaning the boilers.

Cases have occurred where cleaners have left candles inside the boilers, these candles would melt and prove a source of danger as a burned boiler shell would be possible.

W. Whip.

VALVE RESEATING TOOL

I had occasion to repair some very much worn safety valves, and as the discs were too badly damaged to be worth machining, some new ones were ordered. I took one of the old ones, drilled it through the face as shown in the sketch, and put in a cutting tool, using a set screw to hold the tool in proper adjustment. A forked tool with a square shank was used to attach the brace or handle to turn disc, there being two holes in the top of the disc formerly used for grinding in purposes. The seats were deeply grooved but this arrangement served very well to smooth them down and made the work of grinding in very easy. It has the advantage of being easily and cheaply made and the material needed is usually to be found about any power plant. The guide vanes help to keep disc central and if tool is not set too deep there will be very little chattering.



DETAILS OF VALVE RESEATING TOOL

Allen Norgrove.

CARRY A THIN, LEVEL FIRE OVER THE ENTIRE GRATE

A fuel bed of uniform thickness should be carried over the entire grate, so that combustion takes place at the same rate in all parts of the furnace. If the bed is not of uniform thickness too much air may flow through the thinner spots, while too little may flow through the thicker parts due to their greater resistance.

The thickness of the fuel should vary according to the draft, but in all cases should be thin enough to allow sufficient air for complete combustion to flow through it. Just how thick a fuel bed should be cannot be said offhand, as the thickness which should be maintained in any particuar plant depends upon the kind and size of fuel and the draft. With coals commonly used in Iowa, fuel beds should be from 4 to 6 inches thick to give the best results in most plants. Fuel beds less than 4 inches thick have a tendency to allow air to pass through without giving up its oxygen on account of the small holes that are usually found in them.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Add 5% to list above.

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	**Lapweld**
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 75
Steel bars, base, Toronto....	4 75
Steel bars, 2" to 4" base.....	6 00
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 75
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$7 00	$6 75
Sheets, Black, No. 10..	6 50	6 50
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.		9 25
Premier, 10¾ oz.....		9 65

PROOF COIL CHAIN B

¼ in.	$13 00
5-16 in.	11 00
⅜ in.	10 00
7-16 in.	9 80
½ in.	.....
9-16 in.	.....
⅝ in.	.....
¾ in.	.....
⅞ in.	9 20
1 in.	9 10
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.....	....
Royalite, per gal., bulk.....	22½
Palacine	25½
Machine oil, per gal.	86
Black oil, per gal.....	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	89½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$2	20
Leather in sides 1	75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and leg screws.....	30
Stove bolts	50
Plate washers	50
Machine bolts, 7-16 and over	10
Machine bolts, ⅜ and less..	20
Blank bolts	25
Bolt ends	10
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex., blank.....add	1 75
Nuts, hex., tapped.....add	2 00
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	43
Emery Cloth .....list plus	37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.....	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon...	2 00
Whiting, plain, per 100 lbs..	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1'' rd..$0	34
Sheets, 24 oz. and heavier base 0	42
Brass tubing, seamless 0	46
Tubing, I.P.S., 1" base..... 0	48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
K press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

METALS

Lake copper $24	25	$25 00
Electro copper	24 00	25 00
Castings, copper....	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12	00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.

Announcement

The Canadian Farnsworth Company, Engineers and Manufacturers of Condensation Pumps, Automatic Boiler Feeders, Return Steam Traps, all of the Duplex Type, and General Steam Utilities, have opened and are now operating their new factory, at 1-24 Hillingdon Avenue, Toronto. These lines formerly manufactured by the Canadian Fairbanks-Morse Company.

This new organization is under the management of Mr. W. H. Rose, who was well known to engineers as General Manager and Chief Engineer of the Geo. W. Cole, Limited, Toronto.

The Farnsworth line is thoroughly well known, having a world-wide reputation for efficiency in manufacture.

The largest order for Condensation Appliances ever placed is now in process of manufacture by this Canadian Company, for use in a Canadian plant, and consists of a number of Automatic Boiler Feeders of 1000 h.p. each, and a quantity of Lifting, Separating, Condensing Types of Machines. Photos of this installation will appear in later issues of Power House.

The Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

OPPORTUNITIES

STATIONARY ENGINEERS

Those who wish some practical tuition for their Graded Certificates from a practical power house engineer holding highest certificates are invited to communicate with T.H.F., Box 208, Power House.

BOOKS

on all branches of Engineering, every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT.
Books Bought. Best Prices Given.
W. & G. FOYLE, Ltd.,
121-125, Charing Cross Road, London, England.

Second-hand 15 H.P. Motor Generator Set. Generator 220 v. D.C. Motor, 550 v. A.C., 3 phase 60 cycle, or would consider separate motor and generator. Apparatus must be in first-class condition and pass inspection.

DAVIES IRWIN LTD.,
17 St. Sacrament St., Montreal, Quebec.

Where Do You Live?

We are going to put a representative in every town in Canada. Be the one in your territory.
We teach you how to build a permanent, substantial business. Whole or spare time. Write for particulars to-day.

Dept. B., Agency Division
153 University Ave., Toronto, Ont.

SPLENDID OPPORTUNITY

Engineer or **Steam Specialty Salesman wanted** to handle a high grade Canadian-made return steam trap. District, Quebec. Headquarters, Montreal. A good proposition to the right man. All inquiries confidential.

Apply to Box 210,
POWER HOUSE

NEW LINES FOR THE INGERSOLL-RAND CO.

Deals Completed for Making and Selling Several Lines in this Country

Arrangements have recently been concluded between the Wellman-Seaver-Morgan Company, of Cleveland and Akron, Ohio, and the Canadian Ingersoll-Rand Company, Limited, whereby the latter firm are now making and selling in Canada the Wellman-Seaver-Morgan line of Rubber Mill Machinery. The latter comprises crackers, washers, mixing and warming mills, grooved rolls, refiners, calenders, reduction gears, fabric dryers, vulcanizing presses, tire rimming and applying presses, tubing machines, accumulators, high-pressure pump, etc. The Canadian Ingersoll-Rand Company, Limited, will also take up the manufacture in Canada of Wellman-Seaver-Morgan hydraulic turbines, and a department for this work is now being organized.

The Canadian Ingersoll-Rand Company have also been appointed Canadian agents for, and manufacturers of, the Ryther and Pringle line of wood preparing machinery, for use in ground wood and chemical fibre mills, consisting of slashers, swing saws, kickers, loaders, log hauls, splitters, chip screens, shredders, etc., including the Barienger Braking Device for lowering heavily loaded sleighs or other vehicles down steep slopes, and will also manufacture and sell the Bird Machine Company's pulp and paper mill specialties, comprising Bird Inward Flow, Rotary Screens, Walpole Screens, Beating Attachments and Save Alls.

TRADE GOSSIP

To Erect School.—The York County Building Department issued building permits for work aggregating $30,000. A portable school house will be erected on Danforth Heights at a cost of $3,500.

Clay Workers' Association Meets.—At the annual convention of the Clay Workers' Association of Western Ontario held at London, Ont., the president, Mr. C. S. Parker, urged the members to keep up with the times in the use of machinery, thus reducing costs and raising production. Addresses were also delivered by members of the committee.

Belgian Orders for Canada. — Large orders for Belgian locomotives are expected to be secured by Canadian firms in the near future. Senator Nicholls, of the Canadian General Electric Co., stated that he had received a long cable communication on this subject, but declined to say any more at the present stage of the negotiations.

Big Increase in Customs.—The eleven months of the fiscal year show a big increase in the Customs receipts. A statement issued by the Department gives the following figures: $163,527,100, as against $143,564,204 for the corresponding period last year. For the month of February alone the increase was $3,481,688.

Plans Big Improvement.—Extensive improvement tending towards increasing the capacity of the Consolidated Mining and Smelting Company, Trail, B.C., is making rapid strides. The plans call for improvements in the copper refinery estimated at $250,000, the erection of a rod mill to cost $200,000 and the erection of a large addition to the machine shop.

To Build a Dam.—The municipality of South Vancouver are making application to the Provincial Comptroller of Water Records for authority to construct a storage dam at the outlet of Loch Lomond. The proposed reservoir will have a capacity of 3,000 acre feet and will flood about 20 acres of land. The reservoir will be used to supply South Vancouver with water.

The Annual Refrigeration Number of Power House

will be issued on April 20th. This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the REFRIGERATION NUMBER

Fuel Board Continues.—The President of the United States has, by a special order, continued the existence of the Fuel Administration, its powers being lodged in a committee of four. The Railroad Administration, which is being discontinued from March 1, has been exercising the functions of the Fuel Board, but the situation is considered so serious as to warrant the continuance of the Fuel Board.

To Manufacture Oxygen.—A $5,000,000 corporation has been formed by Montreal and Toronto capitalists for the manufacture of 100 per cent. pure oxygen. Plants are being established all over Canada. The Toronto branch, known as the National Electro Products, Ltd., has been making oxygen for some time at the plant at 297 Dufferin Street. The Toronto directorate includes W. J. Cluff, president; W. W. Nearn, R. J. Cluff and A. J. McDougall. The Montreal group are represented by H. W. Beauclerc, G. H. Duggan and W. F. Angus.

NEW CATALOGUE

The Beaudry & Company, Inc., have issued a very attractive catalogue on their line of power hammers. Both belt and motor driven types are shown; together with the various features peculiar to this line of tools. To anyone interested in power hammers this catalogue should especially appeal.

CATALOGUES

The Sterling Engine Company of Buffalo, N. Y., have issued a bulletin, descriptive of the Model G. R. Sterling Marine Motor. While this folder describes engines up to 300 h.p., it is intended to construct the series up to 450 h. p.

These engines have been developed from previous models, and are not a radical departure from Sterling practice. To an engine that has proven itself in the past six years as being one of the best the market affords, the makers have added a detachable cylinder head, containing overhead dual inlet and dual exhaust valves, in addition to which various bearing surfaces have been increased, and by exhaustive testing the correctness of the design of the overhead valve operating mechanically has been proven.

The Sanford Riley Stoker Company, Worcester, Mass., have issued a new publication on "Riley Underfeed Stokers." This stoker takes up the various details of the stokers manufactured, and is particularly interesting to the engineer on account of the engineering data relative to installations contained in it.

The Garlock Packing Company, Hamilton, Ont., have issued an attractive calendar of considerable usefulness to power plant engineers.

The Builders' Iron Foundry have recently published a new four-page, two-color bulletin, No. 197, entitled "Why your power plant needs a venture."

PORTABLE BELT CONVEYORS.

Portable belt conveyors for handling material horizontally or at a slight incline are described and illustrated in a new folder, entitled "Type B Portable Belt Conveyors." This folder, just published by the Portable Machinery Co., of Passaic, N. J., contains prices of these machines which are made with 16" wide belt, and in standard stock sizes, as follows: 12'-6", 16', 19'-6", 23', 26'-6", 30', 35'-6" and 37'.

These machines in addition to being used for handling coal, sand, crushed stone, fertilizer, etc., are being used for conveying many manufactured products, bagged material, such as cement, etc.

Used in series or in conjunction with fixed conveying system, they afford a flexible, convenient and automatic conveying arrangement.

The Green Fuel Economizer Co., Beacon, N. Y., and the Kent Building, Toronto, have issued a publication on "Green's Hi-Efficiency Radial Flow Fans" for forced draft. This bulletin No. 152, in addition to a description of the fans and their applications, contains dimension tables and other engineering information relating to their use.

SAVING FUEL AUTOMATICALLY AND SCIENTIFICALLY IN THE BOILER ROOM.

This is the title of a new 24-page booklet published by the Northern Equipment Co., Erie, Pa. It is based upon matter that was prepared for the United States Fuel Administration during the war. In the preface of the booklet the manufacturers say: "When the war ended we thought we had done our duty, and that the fuel situation would ease up a bit. However, we find the fuel problem now becoming serious. Prices will not come down because wages will evidently stay up or will go higher."

The booklet compares hand and mechanical feeding with mechanical regulation, as performed by the Copes Regulator. It shows in a convincing way what is to be desired in the way of scientific boiler feed regulation.

Use The LONG STEAM for TRAP SATISFACTION

Automatically drains jacket kettles, separators, steam mains. Works against 1 to 20 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with success. Read this letter.

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson, Superintendent

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

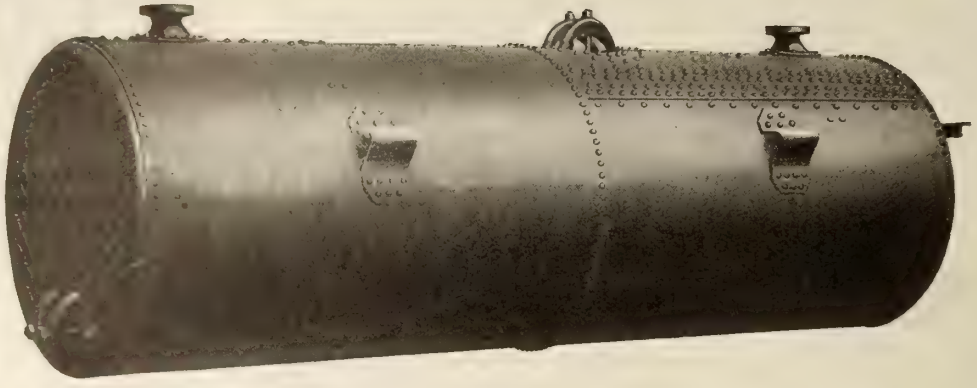
J. T. LONG
48 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.

NON-CORROSIVE CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)



THAT BOILER ORDER

Send it to St. Catharines—to us—the Engineering & Machine Works of Canada, Limited.

When it comes to clean-cut work and strictly modern shop practice, to say nothing of our 35 years of experience, you'll go a long way before you'll beat our service.

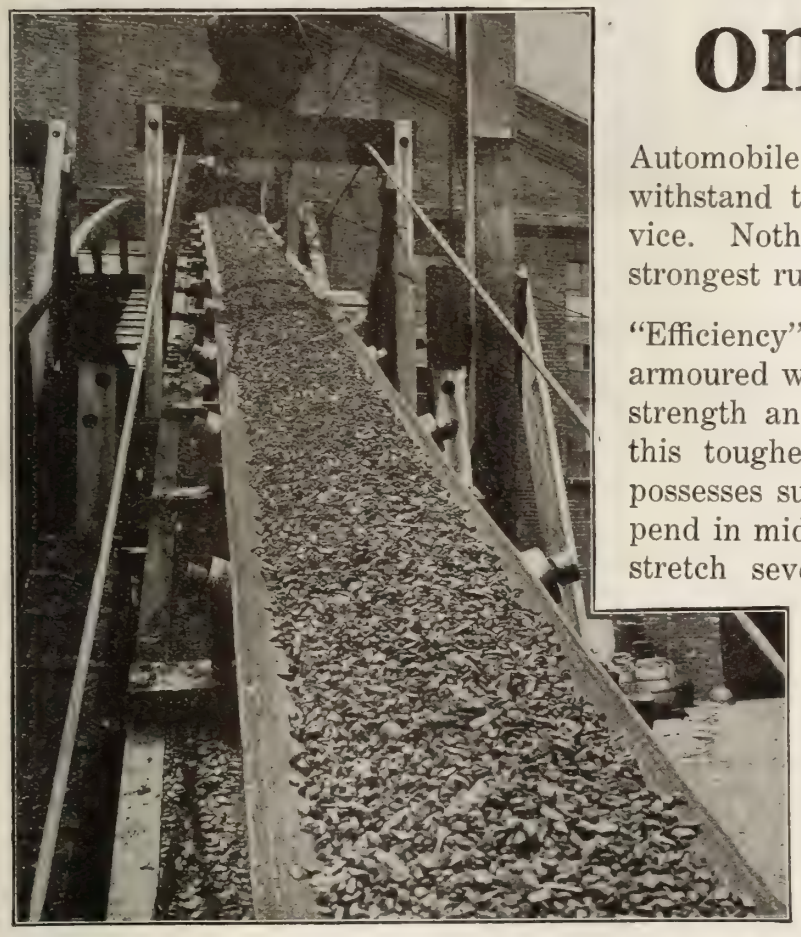
Engineering & Machine Works of Canada

LIMITED

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, Que.

Conveyor Belts that Stay on the Job



Automobile Tire Treads encounter and must withstand the most abusive, abrasive service. Nothing but the very toughest and strongest rubber stock will stand it long.

"Efficiency" Conveyor Belts are heavily armoured with Tire Tread Rubber of great strength and elasticity. A single cord of this toughened rubber, one inch square, possesses sufficient strength to readily suspend in mid air a big load of hay and will stretch several times its original length without breaking.

"Efficiency" Conveyors, like highest grade Auto Tires, are made for the most exacting service.

Though of immense strength they trough perfectly, and, of their own weight, automatically conform to the idlers.

Other very important features in their construction we are unable to detail here, but they represent economy in operating cost for you. When in need of Conveyor Belting let us send a representative to demonstrate them.

Rubber Belting for Every Purpose.

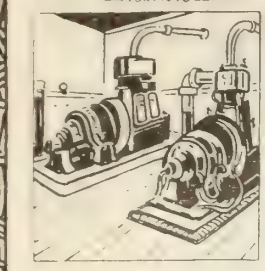
Rubber Goods of all kinds for Every Mechanical Service

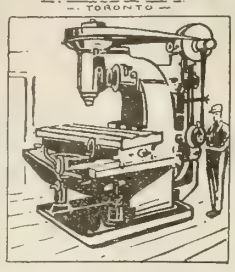
Gutta Percha & Rubber, Limited

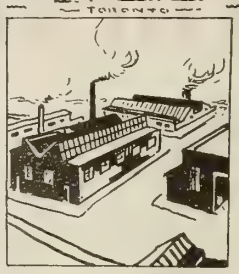
Head Office and Factory: Toronto, Ont.

Branches:

Halifax, Montreal, Ottawa, Toronto, Fort William, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria







For Self-Promotion And Sales Promotion Use These Publications

POWER HOUSE

Twice a month—$2.00 per year.

Serves the power plant engineer—Steam, Electric Refrigeration, Hydraulic.

CANADIAN MACHINERY

Weekly—$3.00 per year.

Covers the metal working field—serving shop executives, purchasing agents and owners. First-class mechanical paper and market paper combined.

CANADIAN FOUNDRYMAN

Monthly—$1.00 per year.

A paper for the foundry owner, superintendent and foreman. Claimed by its readers to be unexcelled.

MARINE ENGINEERING

Monthly—$2.00 per year.

Interprets marine engineering in its broad sense, serving the shipbuilders, navigation companies and their officers. (The editor holds an extra first-class B.O.T. certificate).

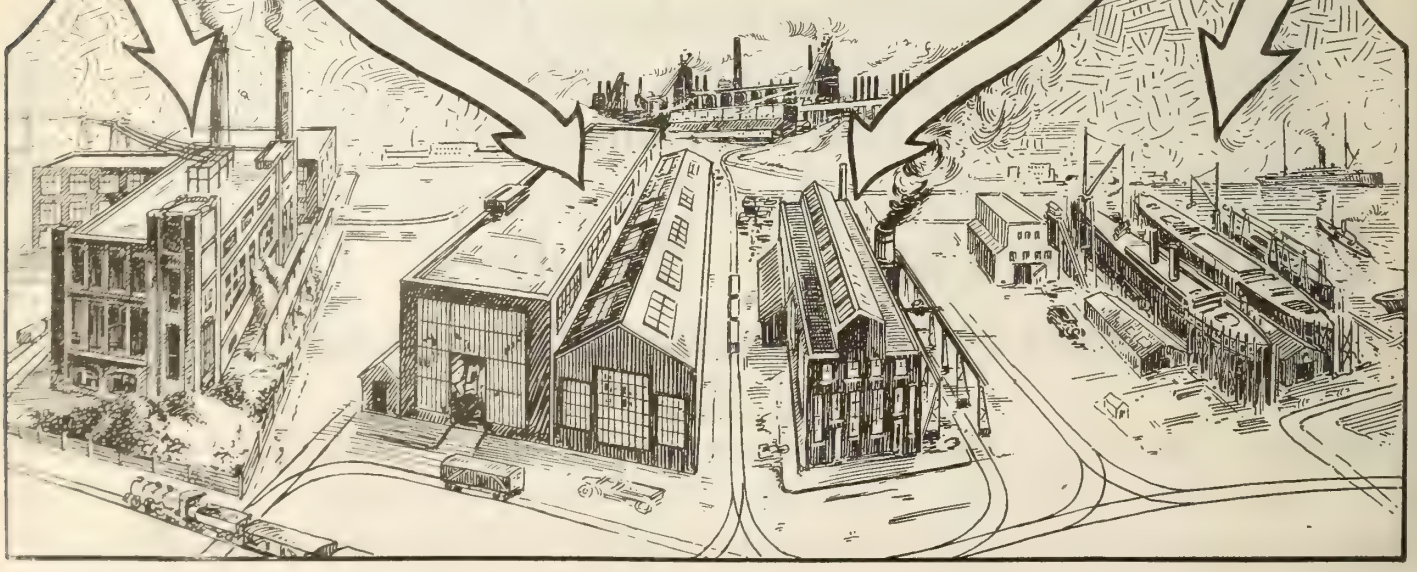
Published by

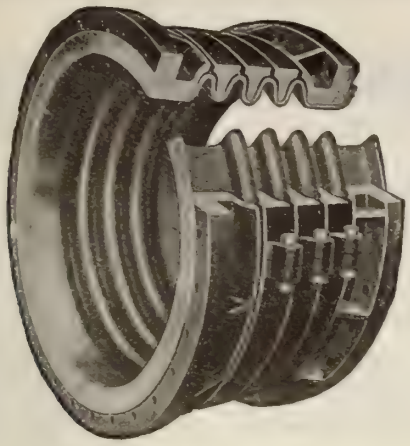
THE MACLEAN PUBLISHING CO., LIMITED

143-153 UNIVERSITY AVE., TORONTO

A company whose idea of service has made it the largest concern of its kind in the British Empire.

Thirty years experience and dozens of practical men in your own line, stand ready to serve you. Let them! Subscribe for your paper to-day.





The BADGER SELF-EQUALIZING EXPANSION JOINT

is a one-piece joint, thus eliminating the necessity of frequent renewal of packing; it is properly designed, and manufactured from material with sufficient elasticity to stand the repeated changes in shape, and it absolutely controls the expansion and equally distributes it on all corrugations.

Write for our new book today

E. B. BADGER & SONS CO.
75 PITTS ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

ECONOMY Carling BLOWERS SUPERIOR

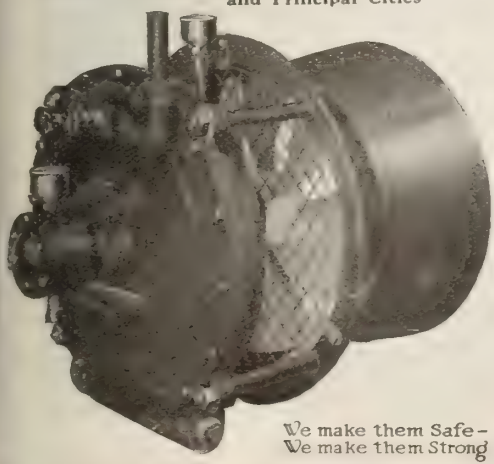
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong

UND. LAB. INSPECTED

ECONOMY Renewable FUSES Mean DOUBLE PROTECTION

ECONOMY renewable FUSES were approved—IN ALL CAPACITIES—by the Underwriters' Laboratories on Dec. 9, 1919—the old "APPROVED IN ALL CAPACITIES" renewable fuse using an inexpensive bare link to restore a blown fuse to its original efficiency.

Economy renewable Fuses—from 0 to 600 Amperes in both 250 and 600 Volts bear the Underwriters' approval label. Economy "Drop Out" renewable links also bear the inspection symbol.

There were millions of Economy Fuses in use before this approval was granted—a fact applicable to no other electrical device listed in the code as requiring approval.

Both the unrestricted use of Economy Fuses and the granting of approval were due to the fact that these fuses live up to all claims made for them — accurate, efficient, economical and safe.

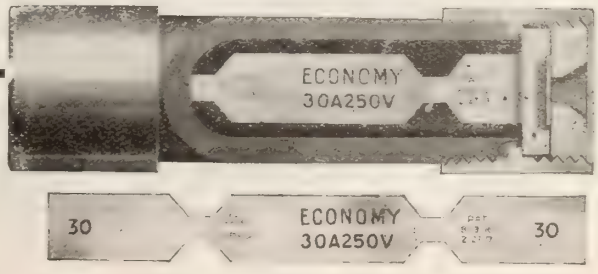
The use of ECONOMY renewable FUSES means double protection—the dependability of the fuse itself—the regular inspection by the Underwriters' Laboratories.

Approved In All Capacities

Economy Fuses, approved in all capacities, ferrule and knife blade types, are stocked and sold by all leading electrical dealers and jobbers in the United States and Canada.

Economy Fuse & Mfg. Co.
of Canada, Limited
Unity Bldg., Montreal

Branches in All Principal Cities



"The Jeffrey Carrier Will Cut Down Our Operating Expenses"

THERE'S but one way that we can fight increased costs and that is to use mechanical equipment wherever possible. In the boiler room a JEFFREY Carrier will handle our coal and ashes for a fraction of our present costs. "The Carrier will also relieve the men of the disagreeable job of handling hot, dusty ashes in wheelbarrows.

"I have studied the JEFFREY blue prints and specifications very carefully and must admit that they are actually putting out the 'last word' in coal and ash handling machinery."

Our new Catalog No. 210-4 tells all about the JEFFREY Improved Carrier. Write today for your copy.

THE

Jeffrey Mfg Co.

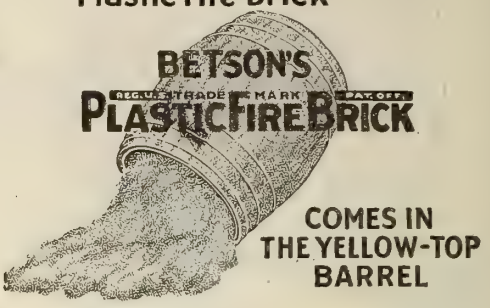
Canadian Branch and Warerooms

MONTREAL

CANADA

Handle it Mechanically

There Is Only One Plastic Fire Brick



Anyone

can see that the weakest parts of a boiler lining are the joints.

The logical remedy is to have no joints—to cover all the brick work with a one-piece, monolithic furnace lining.

But the ordinary fire brick is not elastic. If you used it for this work it would crack and crumble away to dust.

The successful furnace lining is

BETSON'S

REG. U.S. TRADE MARK PAT. OFF

PLASTIC FIRE BRICK

It is the pioneer and a tried boiler refractory material. It has twenty years' practical experience behind it. It is elastic—won't crack and crumble.

There is nothing about a Betson lining to loosen or fall down. Use it in the furnace, on door arches, on rear arches, on baffles, bridge walls, etc.

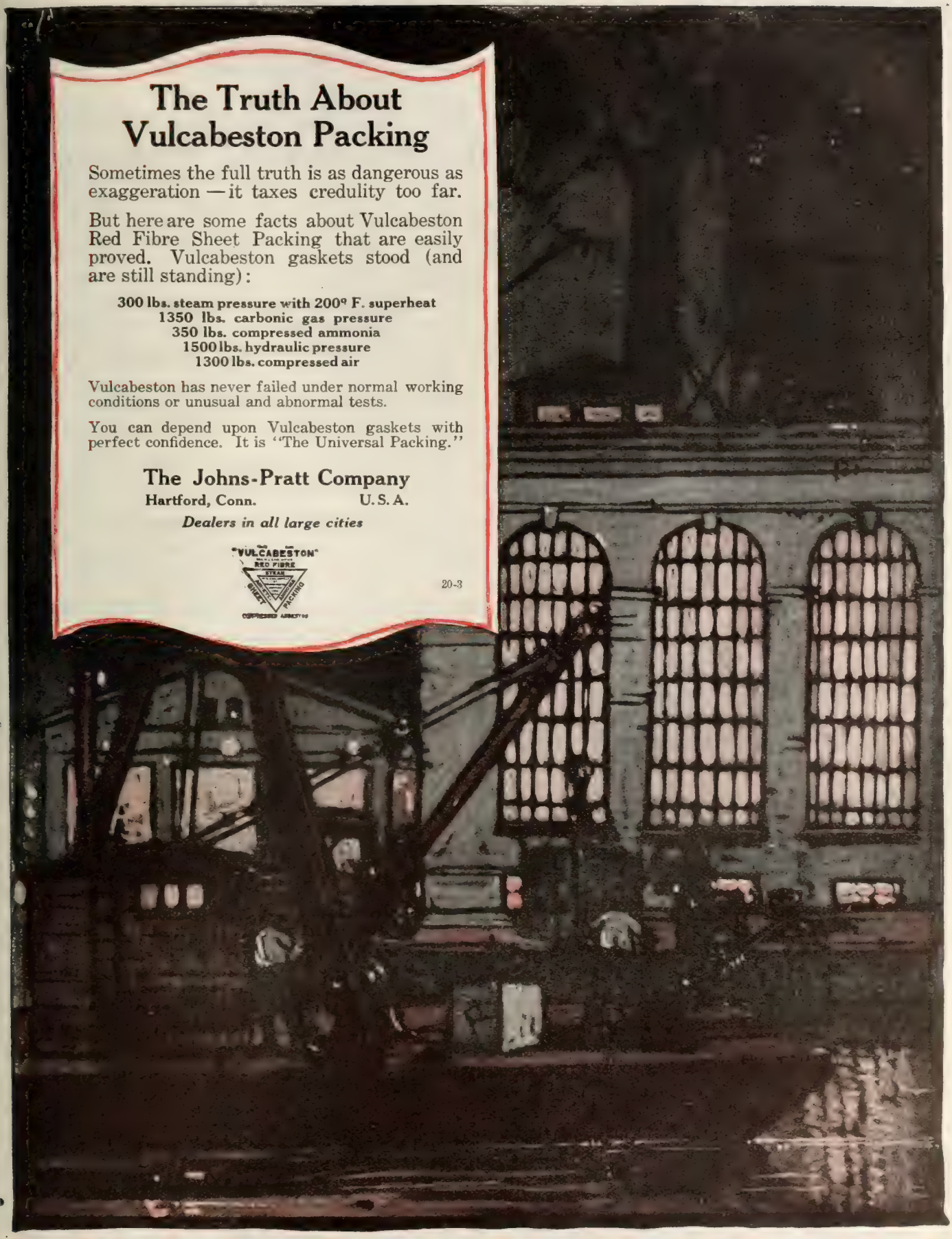
Practical booklet on furnace linings sent free.

Canadian Distributor:

International Chemical Co.

44 Lombard Street

TORONTO, ONT., CANADA



The Truth About Vulcabeston Packing

Sometimes the full truth is as dangerous as exaggeration — it taxes credulity too far.

But here are some facts about Vulcabeston Red Fibre Sheet Packing that are easily proved. Vulcabeston gaskets stood (and are still standing):

300 lbs. steam pressure with 200° F. superheat
1350 lbs. carbonic gas pressure
350 lbs. compressed ammonia
1500 lbs. hydraulic pressure
1300 lbs. compressed air

Vulcabeston has never failed under normal working conditions or unusual and abnormal tests.

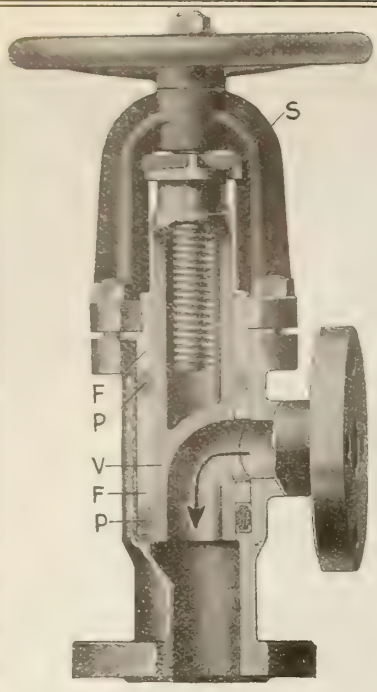
You can depend upon Vulcabeston gaskets with perfect confidence. It is "The Universal Packing."

The Johns-Pratt Company
Hartford, Conn. U. S. A.
Dealers in all large cities

"VULCABESTON" RED FIBRE STEAM SHEET PACKING COMPRESSED ASBESTOS

20-3

VULCABESTON



OPERATION

In closing valve, shoulder "S" on plunger "V" engages the loose follower gland "F" compressing packing "P" above and below the port, making an absolutely tight valve.

YARWAY
Seatless Blow Off Valve
formerly the
SIMPLEX

Has eight important features

1. It is seatless.
2. It is simple. There is but one moving part besides the wheel and spindle.
3. Friction is reduced to a minimum.
4. Packing is protected from the blow-down and rarely needs replacing in less than two or more years, generally much more.
5. When closed, the packing is automatically compressed, making the valve absolutely tight. And the packing will not work loose.
6. Packing remains stationary in body and does not have to pass the port or opening, a feature afforded by no other valve.
7. The port opens slowly, thus avoiding danger to workmen and boiler tubes from shock of sudden opening.
8. Passageway is clear and unobstructed. There are no pockets to gather sediment.

You can try a YARWAY Seatless Blow-Off Valve on one of your boilers for 60 days. You are not required to keep it unless this trial convinces you that you cannot afford to be without it. Write to-day, stating size of blow-off line and whether you want angle or straightway, flanged or screwed.

YARNALL-WARING COMPANY
7604-20 Queen Street Chestnut Hill, Philadelphia

Canadian Representative : A. McLELLAN, 103 St. Francis Xavier Street, Montrea

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
TORONTO

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

And all for Two Dollars

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

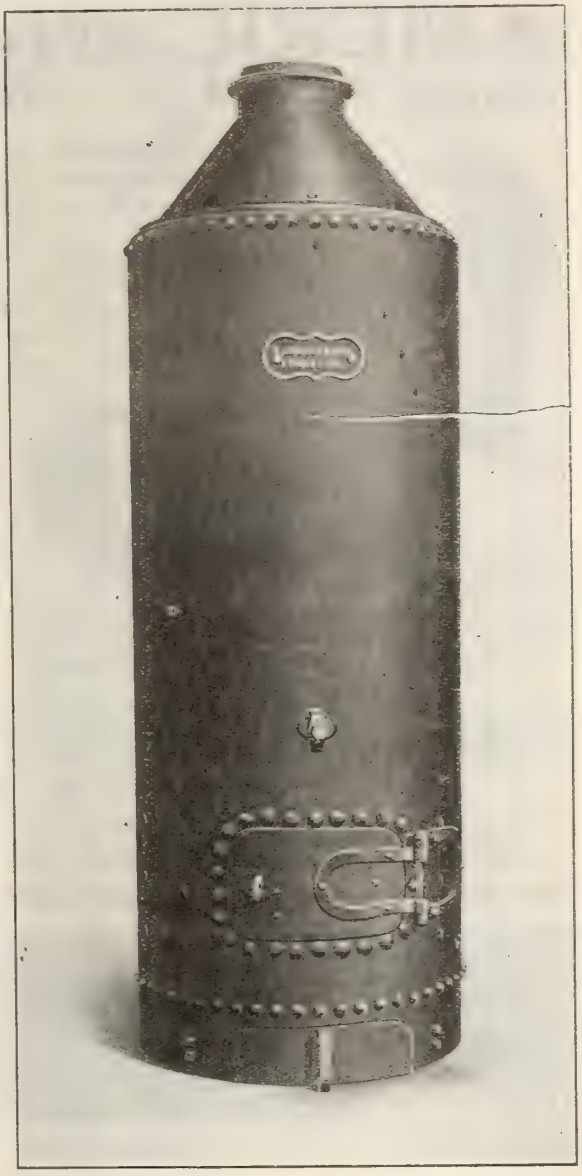
Valve Engineering Company
160 King Street West, Toronto

Power House Equipment

"Sold on a Service Basis"

M. J. Keane, for 19 years associated with the Leading Lines in Power Plant Equipment, is now located in Toronto, representing

Penberthy Valves and Injectors,
Steam Traps and Separators,
Vanstoned Pipe and Bends,
Asbestos and Rubber Sheet Packing
Flexible Metal Hose
"Witwyte" Packing, "Spando" Packing
Etc., Etc.



UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:
Connelly Water Tube (Patented)
Return Tubular
Upright
Locomotive

We specialize in the making of
Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

E. Leonard & Sons, Ltd.
Head Office and Works:
LONDON, CANADA

Established 1834

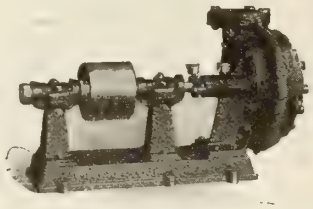
LEONARD

AMERICAN-MARSH PUMPS

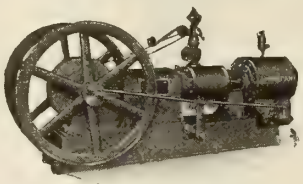
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

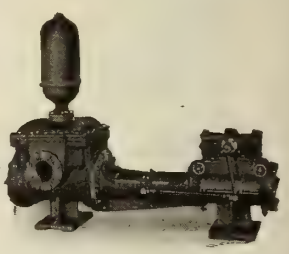


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

New Truths and Old Fallacies
Announcement

For some time hereafter we shall devote our advertising space to discussing white metal alloys used for lining bearings — generically termed Babbitt Metals.

We are conscious of the limitation of our knowledge in this connection, but shall, nevertheless, attempt to clarify this somewhat hazy subject for the benefit of those who have had less opportunity to study it.

We make no pretense of undertaking this from altruistic motives, as, of necessity, many of the figures and facts that will be presented come from tests of Magnolia Metal in comparison with other Babbitt metals, both in laboratory tests and in actual service, showing conclusively the superiority of Magnolia Metal; and we shall also point out the reasons for this superiority.

At first glance some of our ideas may appear radical in their departure from long established customs, but they are supported by a strong array of figures and facts which, we think, will leave but little room for dispute and we shall try to make the presentation in a logical, unbiased way, as free of technicalities as possible.

We invite criticism, corrections and contribution of ideas, as by collaboration we may thus evolve a practical working basis; or, at least, form the ground-work upon which others, better qualified, can build.

A great deal of important work has been done already in connection with white metal alloys, but in a detached way, not usually in relation to babbitt metals, because that was outside of the scope and experience of most investigators.

Continued next month.

For copy of complete article:

"New Truths and Old Fallacies"

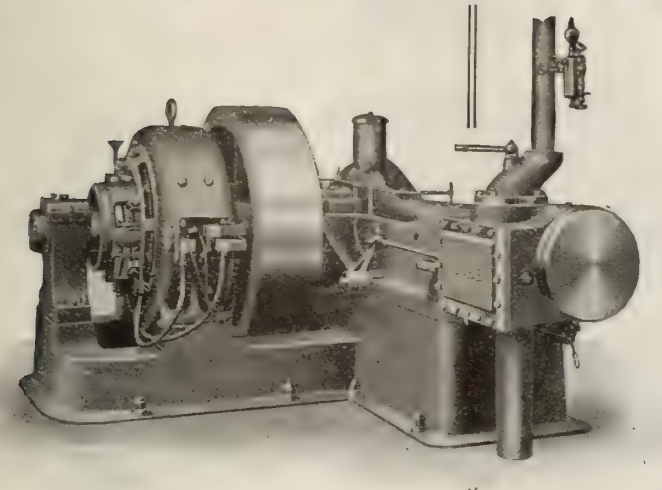
Address our Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:
Montreal: 225 St. Ambrose St.

ROBB POWER PLANTS



Engines and boilers of all kinds, designed in accordance with the most modern approved practice, and constructed with the accurate workmanship that results in long life and reliability.

We can equip your power plant with the most economical machinery.

Consult us freely on any power plant work. All enquiries given careful consideration.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office
Phone Westmount 6800

Toronto Office
20 Victoria Street

Why Don't You Save Too!

"We figured that after the installation had been in three or four months it had more than saved its entire cost."

So writes a prominent user of Bowser Oil Storage. Their equipment has been in use thirteen years with no operating troubles or upkeep cost.

If you are not using Bowser Storage Systems for your oils you are losing money every day.

BOWSER ESTABLISHED 1885

Systems Do Save

You can save the Bowser Way. Our literature shows how. Write for it at once.

BOWSER COMPANY, LIMITED
68-68 Fraser Avenue
TORONTO, ONT.

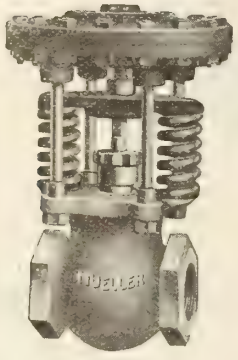
LONDON
32 Victoria St. S.W. 1
HAVANA
Lonja del Comercio 427
PARIS
5 Rue Denis-Poisson
SYDNEY
6 Castlereagh Street

MADE IN CANADA

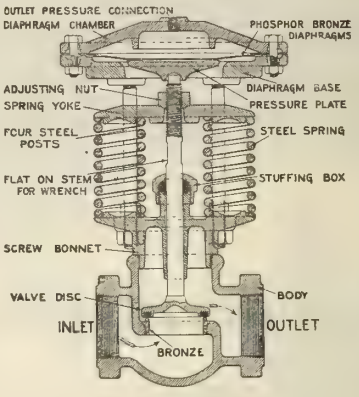
MUELLER

Reducing and Regulating Valve and Pump Governor

For Steam and Oil; Single Seat; Direct Operated



No. A5120
Code—*Ranchero*



This valve is for protection against abnormal rises in initial pressure and where a reasonable variation in the delivery pressure is not objectionable.

For pump governors, power purposes and blower engines it is unexcelled.

It operates most efficiently where the initial pressure is constant and the required reduction is not too great.

Regulators of this description are suitable for pressures up to 150 pounds. For pressures in excess of 150 pounds, submit specifications.

WE MAKE MUELLER

Basin and Bath Trimmings, Bibbs, Sill Cocks, Ferrules, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps; Regulators and Reducing Valves for Water, Air, Steam and Oil; Bubbling Fountains, Gas Cocks, Globe, Angle and Check Valves, Etc. Forgings in Brass; Castings in Brass, Bronze and Aluminum; Specialties for Automobile Companies, including Bronze Bushings, Gasoline Cocks, Etc.

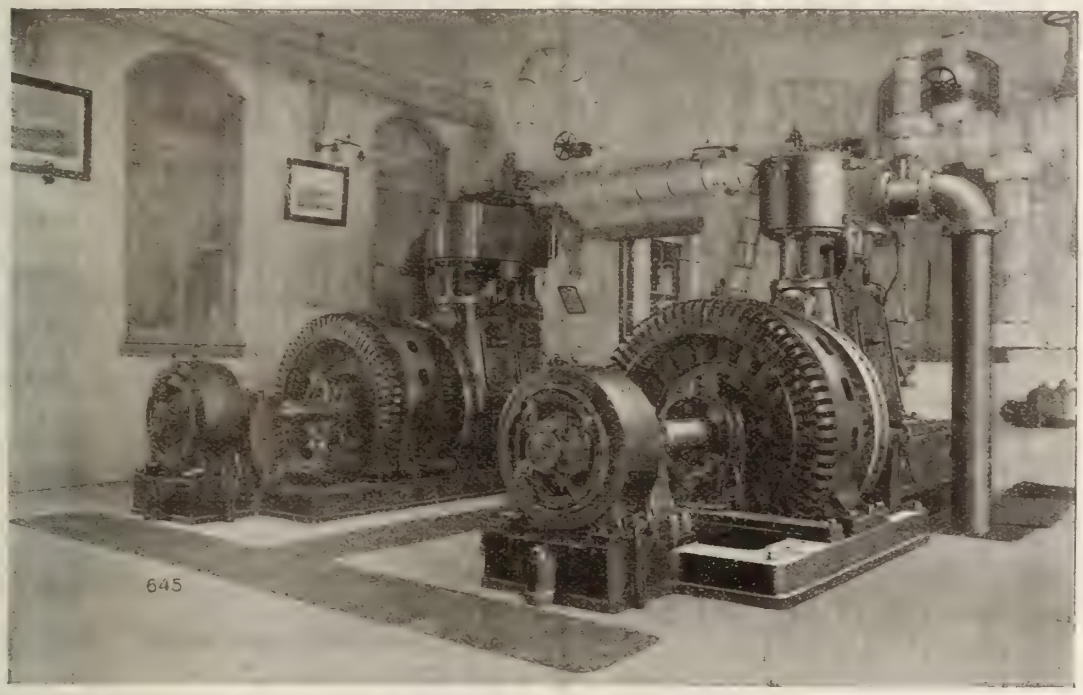
H. MUELLER MFG. CO., LTD.
SARNIA CANADA

Are you on our Mailing List

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS

Belliss & Morcom, Ltd.

Engines and Air Compressors



Bellis Engines at Verdun, P. Q., Waterworks.

We are prepared to supply and instal Steam, Gas, Diesel Oil Engines, Steam and Exhaust Turbines. We have Engine Generator Sets ready for delivery.

Send Us Your Enquiries For

Steam Engines
Gas Engines
Oil Engines
Diesel Engines
Steam Turbines
Air Compressors
Condensing Plants
Centrifugal Pumps
Boiler Feed Pumps
Water Wheels
Water Meters
Hydraulic Presses
Hydraulic Pumps
Hydraulic Accumulators
Pressure Filters
Gravity Filters
Water Softening Plants
Refuse Destructors
Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

"MEAD-MORRISON"

CANADIAN M M Co. CANADIAN M M Co.

HOISTING MACHINERY

Manufactured in Canada

Furnishes dependable service and is selected because of its efficiency, durability and minimum cost of maintenance.

HOISTING MACHINERY

FOR QUARRY MEN, CONTRACTORS, BRIDGE BUILDERS; RAILROAD, DOCK, SEWER AND SUBWAY CONSTRUCTION; DREDGING, LOGGING, HAULING, ERECTING AND DRIVING SHIPS, DOCKS, COAL WHARVES, MINES, ETC.

Send us your enquiries for Hoists—Steam or Electric

Clam Shell

and

Orange Peel Grab Buckets

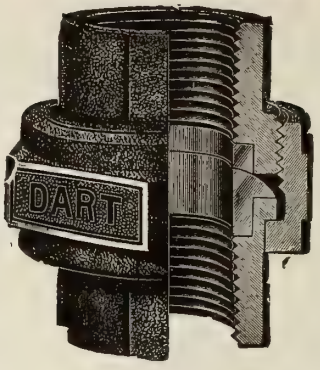
Contractors for complete Coal Handling Plants

CANADIAN MEAD-MORRISON CO.
LIMITED
ENGINEERS MANUFACTURERS & CONTRACTORS

Works WELLAND, ONTARIO

General Sales Offices 285 BEAVER HALL HILL, MONTREAL

Mr. Buyer---



Do not condemn all ground joint unions because you have had trouble with some said to be "just as good" as the "Dart"

You know what the imitations did. Now put a genuine "Dart" on that joint and it will prove to you that there is a vast difference in unions and also prove, that there is a decided advantage in using "Dart"

These unions are guaranteed to give satisfaction any failing will be replaced two for one or your cost, money refunded.

Judge for yourself, you take no risk - Know what using Dart Unions will mean to you.

Jobbers throughout Canada sell them.

DART UNION CO. LTD. TORONTO

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

Like Taking An Elevator

is the ease with which a valve can be readily closed or opened by means of this adjustable sprocket rim. It matters not whether the valve be near at hand or out of reach, a simple pull on the chain quickly does the trick.

Write for descriptive booklet.

Babbitt Steam Specialty Co.
New Bedford, Mass.

Western Distributors:
Jenkins Bros., 300 W. Lake St., Chicago, Ill.
Canadian Agents:
Engineering Specialties Co., Ltd., Toronto, Ont., Canada.

93-14

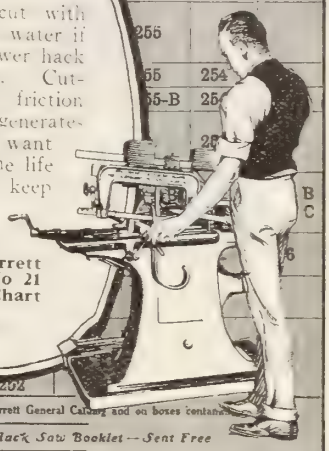
Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Hand Frame	No. of Blade for Power Machine			
		Light Machine	Medium Machine	Heavy Machine	Extra Heavy Machine
Light Angle, Channels, Tee Iron, Ornamen			262		
Heavy A, Channe, Tee Iro			255		
Light S			55	254	
Heavy			55-B	25	
Steela, Condu, Brass				25	
Solid S, Cold R, Machin					B C
Tool St, Cast Iro					6
Brass					
Sheet Meta, Tubing, Less than 18 gag					
Over 18 gage	102	202			

COOL YOUR BLADE.

Flood the cut with compound or water if you use a power hack saw machine. Cutting means friction and friction generates heat—if you want to prolong the life of the blade keep it cool.

Get a copy of the Starrett Catalogue No 21 "CD" and Chart "CD" 42-987



Numbers above are those given in the Starrett General Catalog and on boxes contain

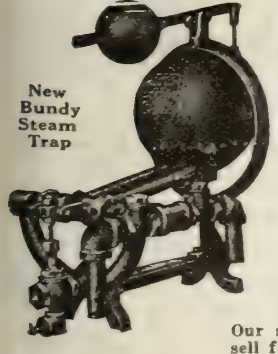
Get the Starrett Hack Saw Booklet—Sent Free

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS

MASON STEAM SPECIALTIES for Service

Least Trouble!
Fewest Repair Bills!

There's a reason for MASON efficiency. The Mason steam specialties include the following well-known lines:



New Bundy Steam Trap

Mason Reducing Valves (Genuine)
Mason Pump Governors.
Mason Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Evaporators and Distillers.
Reilly Multi-screen Feed Water Filters.
Reilly Multi-coil Feed Water Heaters.

Our salesmen are practical engineers. They sell from experience, not from catalog. Profit by their advice.

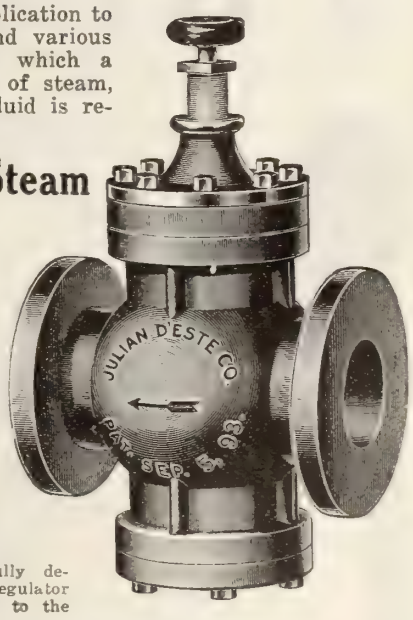
The Mason Regulator & Engineering Co., Limited
Formerly H. L. Peiler & Co.
Montreal Office and Factory—135-153 Dagenais St.
Toronto Representative—The Arthur S. Leitch Co., 1002 Kent Bldg.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip or leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

MANUFACTURED BY THE
JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 83 BARCLAY ST., NEW YORK CITY; 174 N. MARKET ST., CHICAGO, ILL.

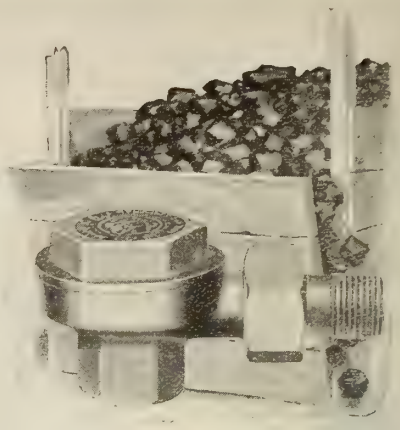
The trap that keeps the radiator hot

Any kind of a boiler will shove the steam up to a radiator. But it takes a mighty good trap to let all the air and water out without letting steam into the return line.

The Dunham Trap has been doing it since 1903—and doing it so well that you don't see many old-style traps nowadays. Everybody is busy pushing thermostatic disc traps. But do not forget that the Dunham was the FIRST radiator trap of this type.

The **first** of its kind—and the **best** of its kind according to many, many engineers, and to architects and heating contractors who know that quality counts above all else.

Our new booklet, "Data on Dunham Heating" telis some heating facts in an interesting way. May we send you a copy?



The Dunham Radiator Trap

The DUNHAM HEATING SERVICE

Made in Canada

C. A. DUNHAM COMPANY, Limited, Toronto, Ontario

HALIFAX OTTAWA VANCOUVER MONTREAL WINNIPEG CALGARY

London: 64 Regent House, Regent Street, W. 1

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company

Roxbury (Boston,) Mass.

UEHLING WASTE METER

COMBINED

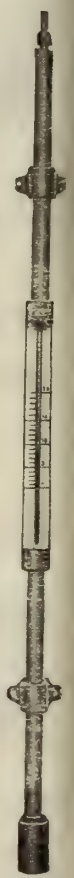
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO_2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.



CO2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company

2 Empire Building **New York City**

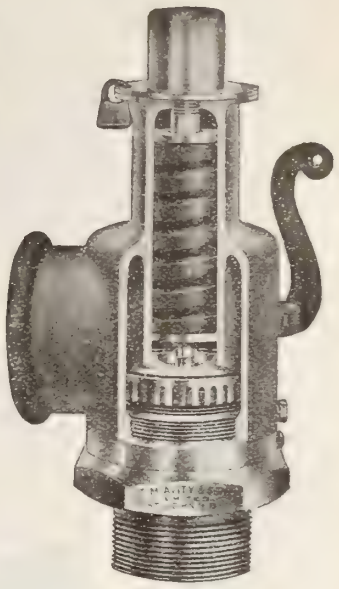
SAFETY AND *SERVICE*

"McAVITY"

Improved Brass Pop Safety Valves

INCORPORATE A HIGH FACTOR OF SAFETY WITH A NEVER FAILING SERVICE THROUGHOUT THEIR LONG LIVES

Approved by their Governments for use in Ontario, Alberta Saskatchewan, British Columbia



¾" to 2"

MADE BY *T. McAVITY & SONS, LTD.*

ST. JOHN, N.B., CANADA

MONTREAL TORONTO WINNIPEG VANCOUVER

KIELEY

Traps
Separators
Regulating Valves
Back Pressure Valves
Pump Governors
For Every Service

Reliable STEAM, WATER and AIR

SPECIALTIES

Simple and sturdy in design, low cost of operation and accuracy in regulation—these are the advantages that accrue when you equip your plant with KIELEY Specialties. We can supply all your requirements promptly. Write for catalogue of the full KIELEY line.

THE ARTHURS, LEITCH CO., Kent Building TORONTO

Say Good-bye to Funnels Use this "All-WAY" Oiler

Combination Filler and Funnel

This Filler eliminates the necessity of the use of a separate Funnel. With the Flexible Spout any part can be readily reached.

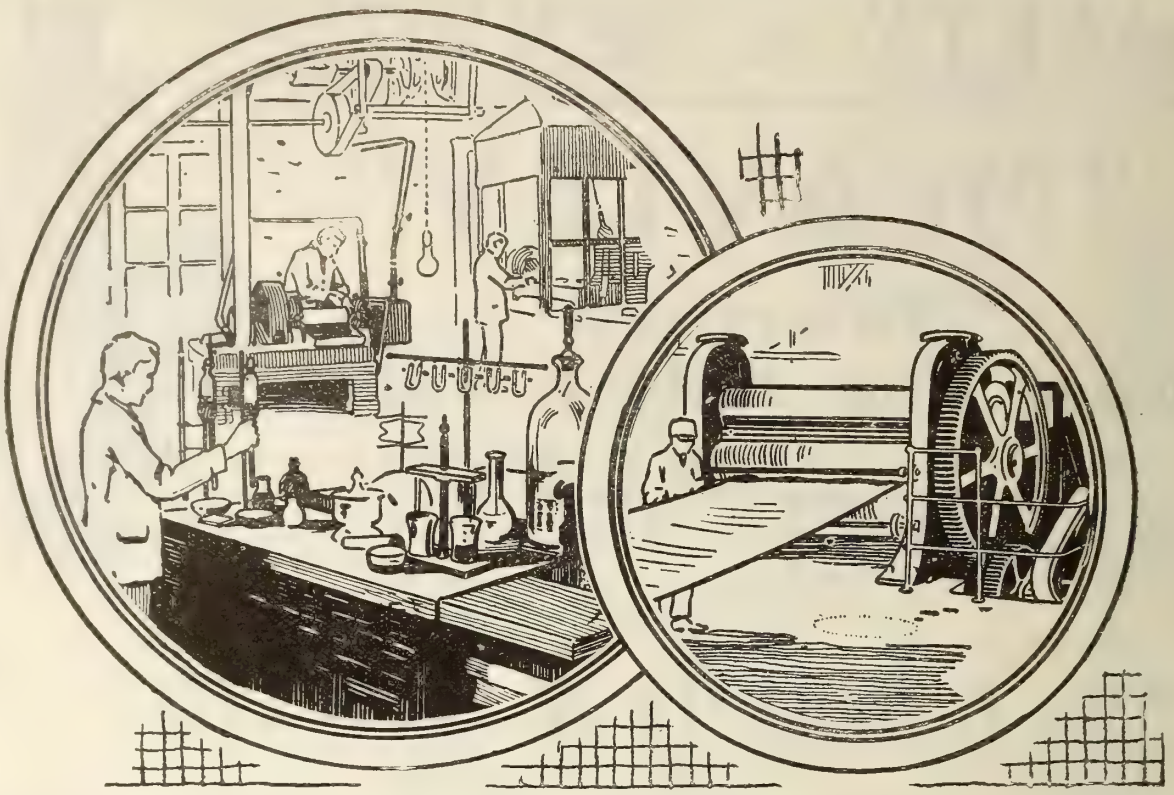
Saves much inconvenience and avoids dripping of oil.

If your dealer cannot supply you, write us.

We also manufacture the well-known "All-Way" Oil Can. Saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY

196 King St. West Toronto, Ont.



The Quality Standard That Produces "Plus Service" Belting

The only sure way to get satisfactory service is to buy products of known worth.

In Dominion Rubber System Belting, the worth is known because every ounce of material—each individual operation and each finished belt must test up to the highest quality standard ever made for belting.

From the time the materials come into our factory until the belt is running on your pulleys, there is no chance of your getting any thing but "plus service" belting.

This is the result of over fifty years of belt making experience and research by the oldest, largest and most completely equipped rubber organization in Canada.

The rubber that goes into Dominion Friction Surfacing Belting is not a mere waterproofing substance—our chemists have given it a far greater value by making it into a friction compound that prevents practically all power wastage on the pulleys.

"Plus service" includes the free technical advice of our belting engineers who are ready to help you with your transmission and conveying problems without placing you under obligation to us.

A phone call, wire or letter to our nearest branch places all of our facilities at your disposal.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Service Branches:

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

JEFFERSON

Underground

Take a trip underground—listen to the music of the pumps—"CHUG, CHUG, CHUG" — twenty - four hours a day, and you'll realize the importance of dependable unions. The failure of a single union might cause serious consequences involving loss of life and heavy damages.

JEFFERSON UNIONS will render perfect service as long as the pipe line holds out. Once you put a JEFFERSON on the line, you can say "Good-bye" forever to pipe line troubles.

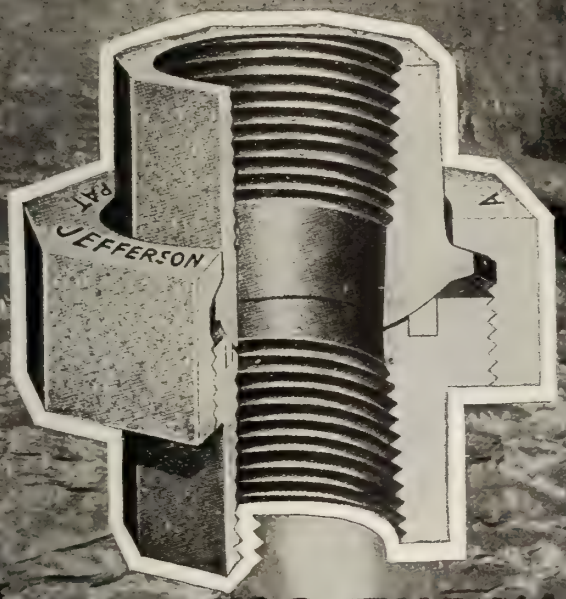
Insist on genuine JEFFERSON Unions – the name on the nut protects you from the "Just-as-good" variety.

Talk over unions with your jobber. He has JEFFERSONS in stock and can tell you why JEFFERSONS always make good.

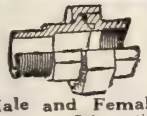
Write for our catalog "UNIONS"

Jefferson Union Co.

Lexington, Mass.

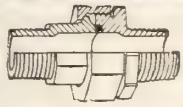


"LOOK FOR THE NAME ON THE NUT"



Male and Female Union Takes the place of an all-female union and a nipple. Makes a short connection.

Union Elbow, all female. Takes the place of a straight union, nipple and an elbow. Also made male and female.



All Male Union. Saves two pipe joints between two female threaded parts.

Why you get

better service from LUNKENHEIMER "VICTOR" GATE VALVES

THE disc is a solid wedge, seating on rings which are threaded into the body in exact alignment with the disc faces; the disc is guided by ribs cast in the body, and travels to practically a closed position before coming in contact with the seatring faces. "Dragging" of the disc across the seatring faces is thereby eliminated, preventing the wear so prevalent in valves employing loose parts.

When wide open the top of the disc seats directly beneath the stuffing box, relieves the packing from pressure and permits repacking while pressure is on.

The gasket between the body and bonnet flanges is an exclusive Lunkenheimer feature. It consists of a seamless copper wire partly embedded in a groove in the body flange; will not blow out and is practically indestructible.

Bearings are bronze bushed and all parts, including the seatrings, are renewable.

Inside Screw Stationary Stem and Outside Screw and Yoke Rising Stem types for working steam pressures up to 350 pounds.

Installing Lunkenheimer "Victor" Gate Valves means permanence and satisfactory service.

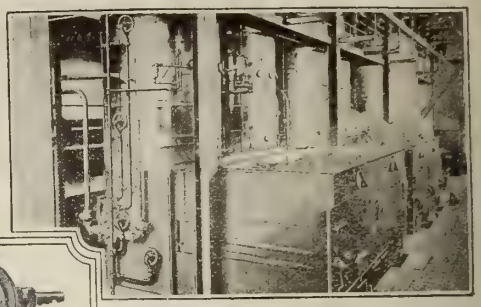
THE LUNKENHEIMER CO.
"QUALITY"

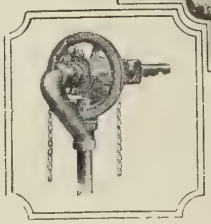
Largest Manufacturers of
High Grade Engineering Specialties
in the World
CINCINNATI

WRITE FOR DESCRIPTIVE LITERATURE

NEW YORK
CHICAGO
BOSTON
LONDON

6-15-43





Can Any Evidence Be More Convincing than Repeat Orders?

Repeat orders are the highest expression of confidence. It is significant that to-day, eighteen years after their manufacture began, over 60 per cent. of all Diamond Soot Blower business consists of re-orders from former purchasers.

Every American industry of any prominence contains many representative members who almost invariably purchase Diamond equipment whenever they put in additional mechanical soot blowers. To mention a few prominent purchasers:

	Number of Orders	Number of Boilers Equipped
General Electric Company	26	60
Ford Motor Company	11	26
Solvay Process Company	15	53
Brooklyn Edison Company	16	56
Armour & Company	16	53
General Motors Company	12	34
Du Pont Powder Company	22	115

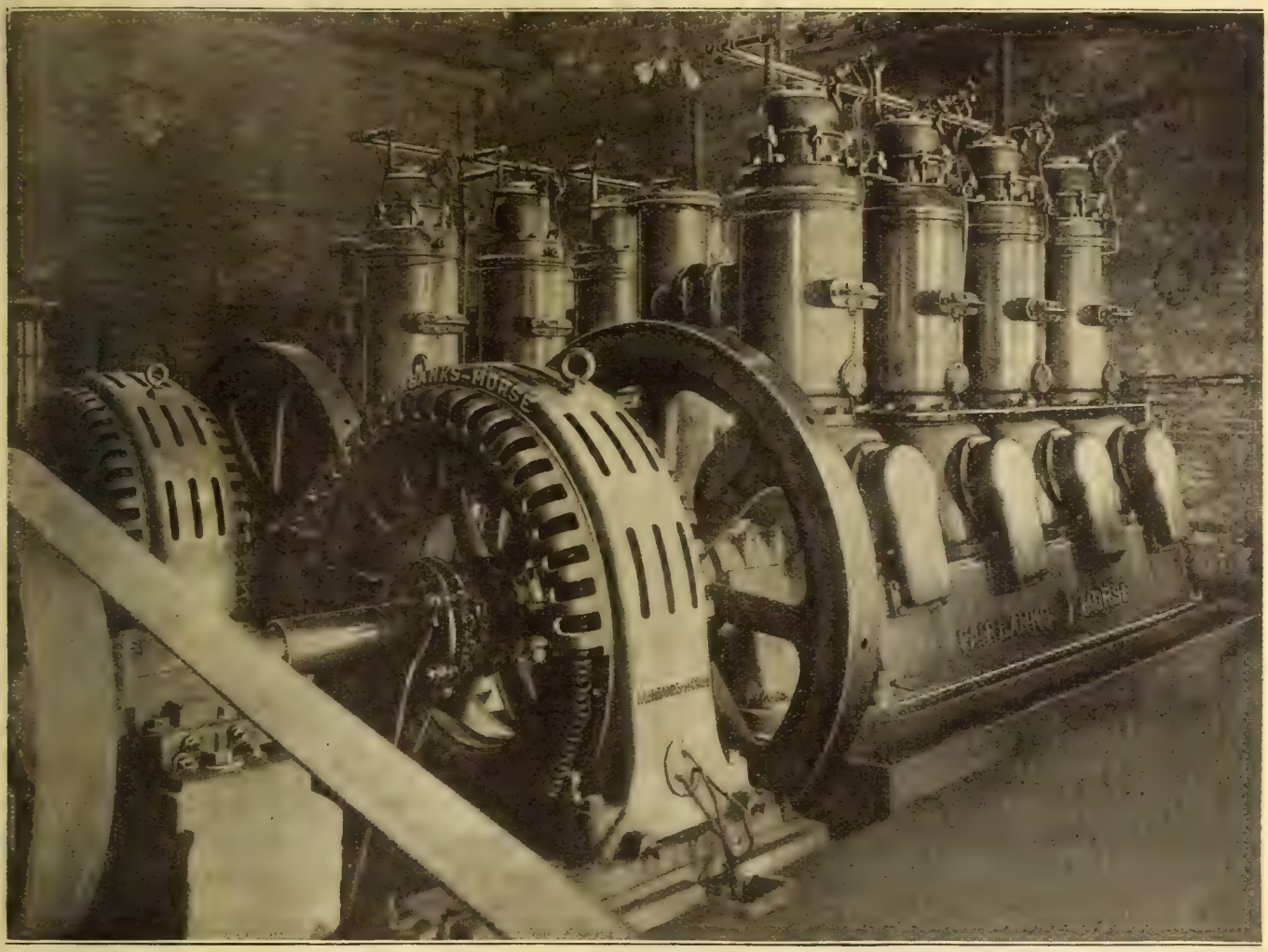
These seven concerns within a period of a few years placed 118 orders to equip a total of 397 boilers. There is nothing casual or accidental in this record. The market superiority in design and construction of Diamond equipment —the high and uniform quality of the service rendered—and the notable savings effected in fuel and labor are the underlying causes of these large purchases just as they are the foundation of the largest soot blower business in the world.

If your boilers are not equipped with Diamonds, ask for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ont.

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



FAIRBANKS-MORSE
ELECTRIC POWER MACHINERY

Each of the units shown above consists of a 200 H.P. Semi-Diesel Oil Engine and a 170 K.V.A. Generator.

Our smallest plant is a 1½ H.P. 9 K.W. Automatic Suburban Lighting Outfit.

Fairbanks-Morse Electrical Machinery covers the entire range between the above sizes.

Our experience is at your service.

The Canadian Fairbanks-Morse Co. Limited

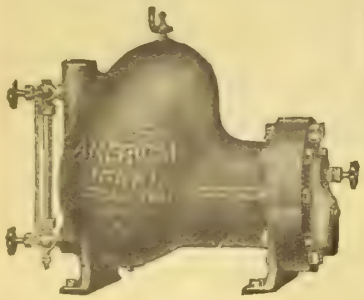
"CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS"

FAIRBANKS-MORSE QUALITY F M 100%

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON
WINDSOR WINNIPEG SASKATOON CALGARY
VANCOUVER VICTORIA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Complete Steam Trap Service



means:

Removal of all excess condensation without loss of steam, No maintenance expense.

This service is given by the AMERICAN IDEAL STEAM TRAP.

Saving Steam is saving Coal.

Saving Coal is saving Money.

Saving Coal is more vitally necessary now than ever before.

Write for our Trap Booklet.

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
"TRADE MARK REGISTERED"

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

SAVE
TROUBLE and EXPENSE

by using the packing that gives the longest service under hard conditions, —
"PALMETTO."

ASK ANY ENGINEER WHO USES

TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

and you will find him enthusiastic over its great lasting qualities and because the quality can be depended upon to be always the same.

If you don't know "Palmetto," let us send you a working sample to test under your own conditions.

TWIST for valves.
BRAIDED for rods.

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St., New York

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

A $2.10 Valve For 20c.

That's literally what it amounts to when you replace a worn-out disc with a new one in a Pratt & Cady Renewable Disc Globe Valve. For this makes an old $2.10 valve *as good as new* at a cost of only 20c.

PRATT & CADY
Renewable Disc Globe Valves

can be renewed in a few minutes without removing them from the pipe line. All that is necessary to replace a worn disc is to unscrew the bonnet and slip a new asbestos disc onto the end of the spindle. A simple job that anyone can do.

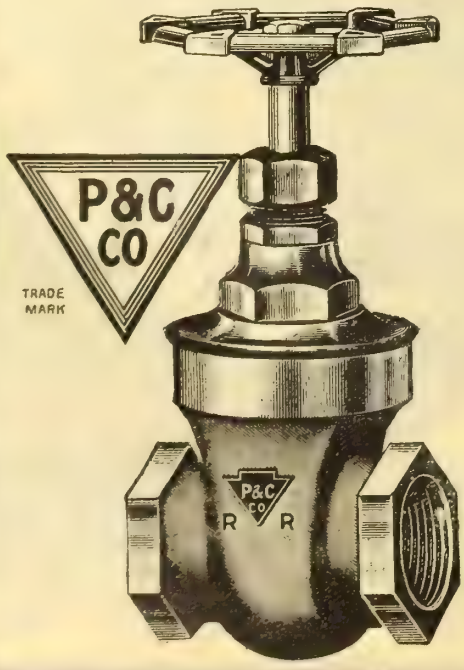
Here is one solution to the high cost of maintenance.

Why not let us send you our valve Book? It's free for the asking.

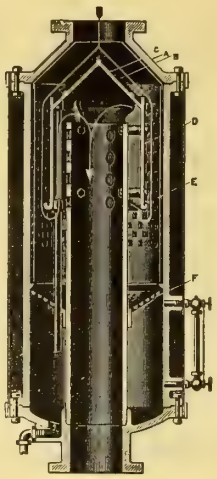
PRATT & CADY CO., INC.
HARTFORD, CONN.

Manufacturers of Valves, Asbestos Packed Cocks, Feed Water Heaters, Hot Water Generators, Hot Water Service Heaters and Power Pumps.

Canadian Representatives:
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED, Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver.



III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

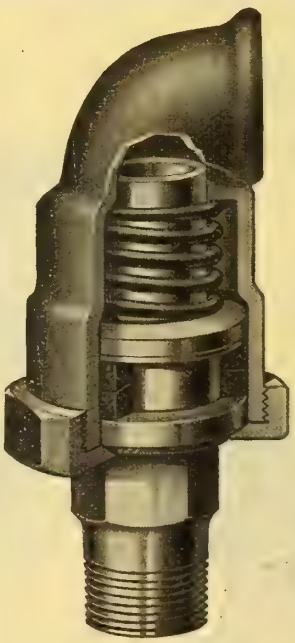
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

METLSKIN

prevents boiler-scale

by a process which is mechanical, rather than chemical. It forms a minute, grayish-white coating which keeps scale-forming solids from adhering to the boiler metal, and, therefore, these solids must settle to the mud-drum, whence they may be discharged through the blow-off.

METLSKIN is distinctly **not a compound,** nor does it contain any soda ash, graphite, kerosene, or tannin. It works by expansion, without harm to anything save boiler-scale itself.

The Two Months' Test

may be adopted by any reputable concern troubled with scale. METLSKIN will remove the old incrustation safely, but gradually, will ultimately produce clean boilers and then **keep them clean.**

Send a post card for terms and full details.

NOPORO

air-proofs boiler-settings

by maintaining an air-tight seal on the exterior surfaces of the brickwork. After a thorough application, by means of a trowel, NOPORO forms a covering that looks and feels very much like coarse, black grain leather. The surface may be whitewashed after an interval of 6 to 8 days, while the material below the surface retains its plasticity. It will not peel, check, or disintegrate, and will **stay put** for years. No further attention need be given it.

An Immediate Saving

may be effected, since NOPORO promptly prevents the entrance of cold-air into the furnace chamber. That means better fuel-combustion, less firing, less coal. NOPORO pays for itself from the first.

Mail a card for prices and descriptive folder.

METLSKIN CO., Inc. Sole Manufacturers ROCHESTER, N.Y., U.S.A.

Exclusive Canadian Distributors

CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John **Montreal** **Quebec** **Ottawa** **Hamilton** **Toronto** **Windsor**
Winnipeg **Calgary** **Vancouver** **Victoria** **Saskatoon**

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES

WHY Williams'?

For the same reason you are using modern machinery, high class workmen and the best of material. **Because they pay.**

Experienced mechanics, everywhere, are using Williams' Wrenches because they know the tools are dependable and **they like them.** Williams' Wrenches have correct balance as well as sturdy strength—they "feel" right—they fit the hand like an old glove.

Good tools, correctly designed and made, are of paramount importance in the power house. Remember, when you specify Williams' Wrenches, you ask for the best.

We make 40 standard styles in about 1000 sizes with openings from 3/16 to 7⅝". Ask for our new Wrench Booklet.

J. H. WILLIAMS & CO.
"The Wrench People"

78 Vulcan St.
Buffalo, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask., Agents for Saskatchewan, Manitoba, Alberta and British Columbia.

78 Richards St.
Brooklyn, N.Y.

SALE OF MILITARY AND OTHER GOVERNMENT STORES

Equipment and Supplies for Hospitals, Institutions, Bunkhouses, Camps, Dining-Rooms, Kitchens, etc.

Bedsteads, Furniture, Hardware, DryGoods, Rubbers, Overshoes and other Footwear, Blankets, Sheets, Pillows, Baskets, Woodenware, Brushes, etc.

CONSTRUCTION EQUIPMENT AND MACHINERY—AMBULANCES.

The Stores are located at various places throughout Canada

Instead of or in addition to sales by sealed tender

PRICE LISTS WILL NOW BE ISSUED

for most articles—the goods being offered in lots for purchase by wholesale houses, jobbers, and the trade generally.

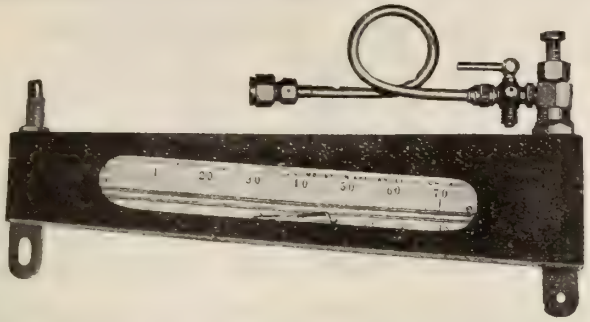
TRADE ONLY SUPPLIED

except that arrangements previously announced for sale to returned soldiers and sailors and widows and dependents of same through the G. W. V. A. and similar organizations and to hospitals and philanthropic institutions will be continued.

SALES WILL CEASE IN MARCH. Any balances left will be cleared by public auction shortly thereafter. This advertisement will not be repeated. Those interested should therefore apply AT ONCE for price lists and other information to the

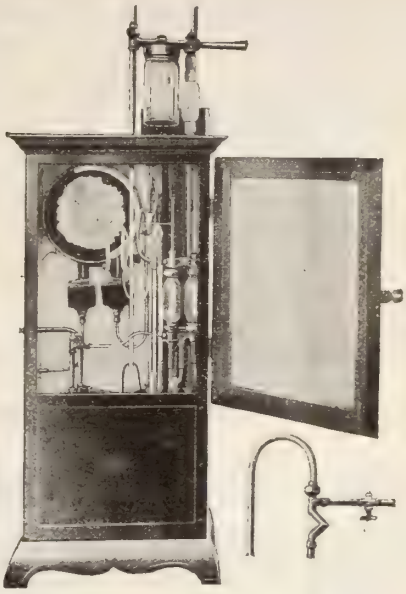
SECRETARY OF THE WAR PURCHASING COMMISSION, BOOTH BUILDING, OTTAWA

February, 1920



The Hays Draft Gage

The Hays Differential Draft Gage indicates the draft over the fire, the draft in the last pass, or the drop in draft between the last pass and the furnace. There is practically no maintenance expense connected with its operation. Tubes will not break.



The Hays Automatic CO_2 and Draft Recorder

The exact reason why 30 to 50 per cent. excessive amount of fuel is consumed in your plant is shown by the Hays CO2 and Draft Recorder. With these appliances installed, your firemen can fire intelligently; they will work with accurate facts before them instead of groping in the dark.

FUEL is Scarce and High in Price

You Can't Afford to Waste It

Excess or insufficient air, leaky boiler setting, leaky baffles, holes in the fire, fire too thin or too thick, draft too weak or too strong—these are some of the faults which waste your fuel and they all can be prevented by adopting

HAYS COMBUSTION EFFICIENCY APPLIANCES

You can't locate losses by guess work. Hays appliances lift furnace attention from guess work to exact knowledge. They indicate exactly where fuel is being wasted. Then your engineer is in position to stop it.

Hays Improved Gas Atomizer

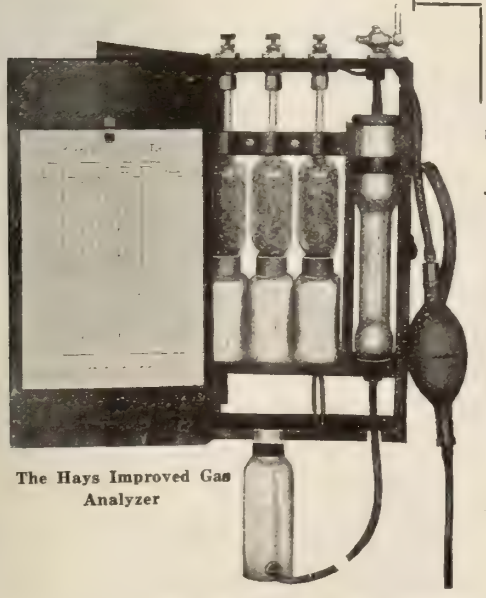
For testing boiler furnace gases, producer gases, casing-head gas, exhaust from internal combustion engines, gases from sulphur burners, nitric acid gases, chlorine gas, etc., etc.

For the Small Plant as Well as the Big Plant

Small plants are very apt to consider that Hays Apparatus is only for big plants. This is not the case. Small plants can reap the greatest of benefit from Hays equipment. They can secure 100% efficiency.

HAYS SERVICE—Just what Hays Combustion Efficiency Appliances can accomplish in your plant may be put up to our Service Department. Their service costs you nothing.

Let us send you complete literature describing and explaining Hays Apparatus. It will prove to you that you need Boiler Efficiency Appliances—by giving you countless sound reasons for equipping immediately with Hays Apparatus.



The Hays Improved Gas Analyzer

The Jos-W-Hays Corporation

Combustion Efficiency Appliances

Michigan City, Indiana

General Representatives for Canada
Stephen H. Payne, 30 Church St., New York
REPRESENTATIVES IN CANADA:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto
Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal
Wm. Goold, 701 Merchants Bank Bldg., Winnipeg

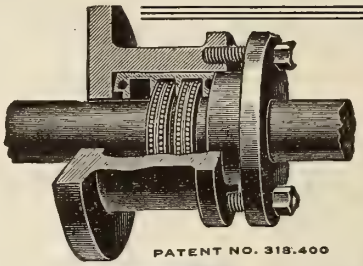
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,088
" "	775 193	" "	905,103
" "	775,194	" "	934,629
" "	791,300	" "	979,208
" "	805,680	" "	1000,75

Why not Buy the Best, when in market for Packing?

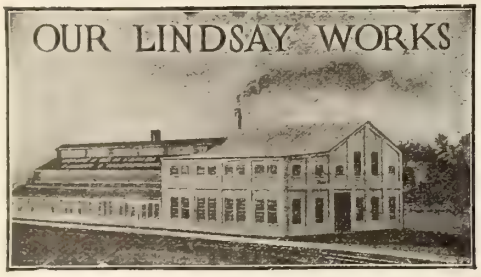
HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

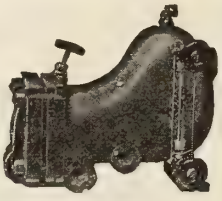
HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



McDANIEL IMPROVED STEAM TRAP

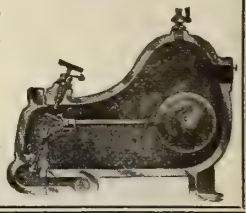
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

The Simplest and Best Cleaner on the market is

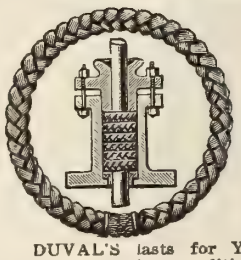
PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up. Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

DEPARTMENT OF LABOUR

Ontario Government

Minister:
Hon. W. R. Rollo.

Deputy Minister:
W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a STATIONARY steam plant of 60 B.H.P. or over, in the Province of Ontario, must hold a Stationary Engineer's certificate from the Board of Stationary & Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers.

After January 1st, 1920, the Certificate issued by the Board will be of four grades, viz., First, Second, Third, and Fourth. Application forms for graded certificates will be mailed upon request after the above-mentioned date. The certificates now issued by the Board will be graded into Third and Second-Class upon renewal, same being classified from the information contained in the renewal application which will be sent to each certificate holder.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse-power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a certificate is liable to the penalties set forth in the Act respecting Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1st, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request. The B.H.P. and other information contained in these forms is to be used for statistical purposes. A Registration Certificate will be issued to each applicant. All applications, or requests for same, should be mailed to the Chairman.

W. C. MCGHIE, CHAIRMAN OF BOARD

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., c. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

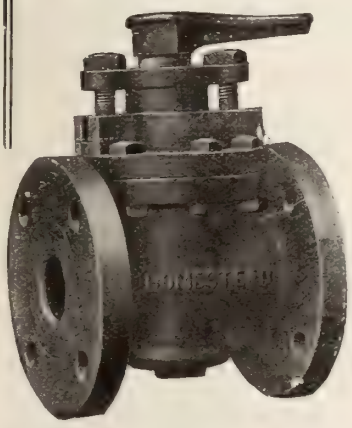
All communications should be addressed to the Steam Boiler Branch, Department of Labour Parliament Buildings, Toronto.

D. M. MEDCALF, CHIEF INSPECTOR OF STEAM BOILERS

No Time Lost When You Use HOMESTEAD QUARTER-TURN VALVES

Adopt Them!

Many a break-down and shut down may be avoided by using Homestead Valves. They are rendering more than satisfactory results to thousands of satisfied customers, who back up their experience by ordering more "Homesteads" whenever they are in need of tight, efficient and positive acting valves.



You should adopt "Homesteads" for all classes of severe service. They are all constructed with the Patent Homestead Process which makes them seatless while the pressure is passing through and which permits their being operated easily and safely.

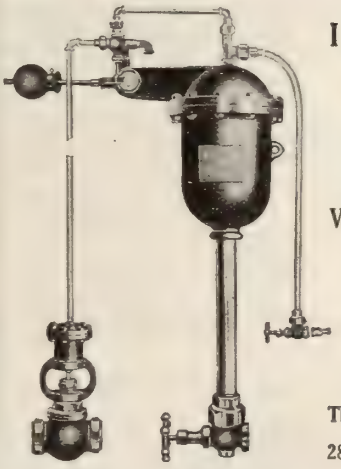
Order your requirements to-day.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

CRANE FLANGED FITTINGS

CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver,
Sales Offices: Halifax, Quebec, Ottawa, Calgary



Insure Constant Level

The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gage, the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way.
They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers, and they feed continuously with perfect uniformity.

Write for full particulars

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Iriam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

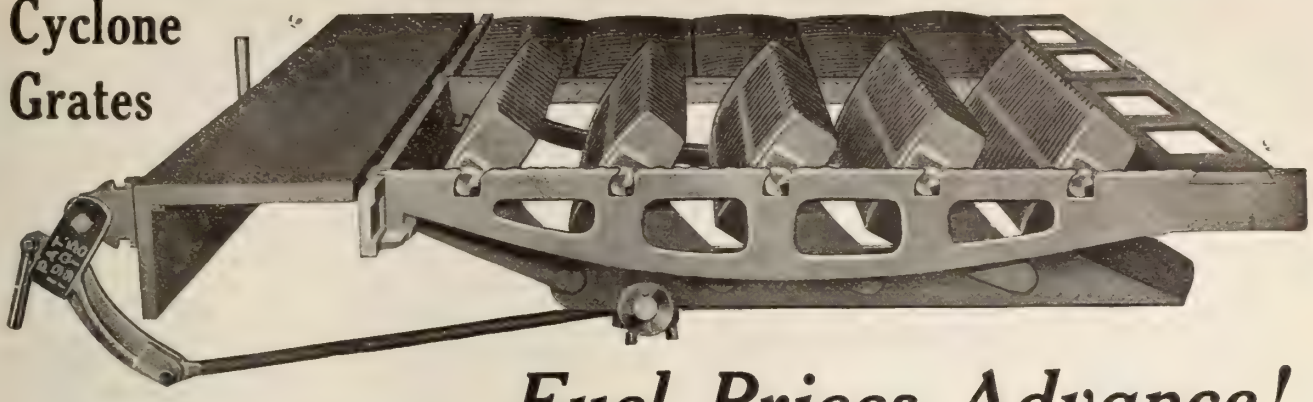
CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que

Cyclone Grates



Fuel Prices Advance!

Put in On Trial Basis

You take no chances in putting Cyclone Grates to the test. We are prepared to install them on a trial basis for 30 days. Write for our proposition and let us explain the principle of the grates in detail. Our trial offer is genuine; take immediate advantage of it; every day you miss having Cyclone Grates in your furnaces means lost money.

You have seen this heading in the newspapers from time to time, and you will see it again. You need the coal and you will have to pay the high prices — but you won't feel the effect if you install CYCLONE SHAKING AND DUMPING GRATES.

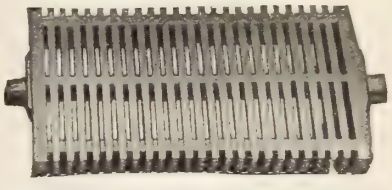
CYCLONE GRATES give you more heat units with less coal. They burn hard coal or soft coal of the cheapest grades and give maximum results. They get the most heat out of screenings. Cyclone Grates give 60% air space and 90% underdraft. No clinkers, no waste.

Enquiries Gladly answered.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G. 2660 Toronto, Ontario

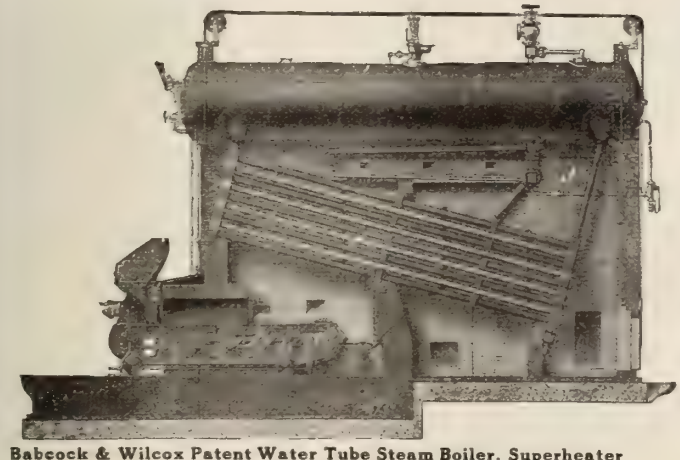


AGENTS:

ST. JOHN, N.B.: F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator and Engineering Co., Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. CALGARY: The Western Foundry and Metal Co. WINNIPEG: Vulcan Iron Works.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, TRADERS BANK BUILDING

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd. George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Montreal General Tool Co., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton, Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg. Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co. Windsor Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS

MacLean Publishing Co., Toronto.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk, Con.

MAC GOVERN & COMPANY INCORPORATED POWER MACHINERY

D. C. UNITS
125 VOLTS

Generator K.W.	Make	R.P.M.	Engine Cyl. Dimensions	Make
7	General Electric	1800	6" x 6"	Goldie & McCulloch
7½	Fairbanks-Morse	350	8" x 10"	Fairbanks-Morse.
7½	Westinghouse E.&M.Co.	1200	6¾" x 10"	Jacobson Machine.
10		225	19" x 16"	
10	Westinghouse	370	6" x 7"	Junior Automatic
12½	Commercial Elec. Co.	340		J. B. Alfree
15	Western Elec. Co.	800		Fuller Co.
15½	Ft. Wayne	950	8" x 7"	Westinghouse.
16	Ft. Wayne	1250	8" x 7"	Westinghouse Jr.
16	Ft. Wayne	1250	8" x 7"	Westinghouse.
17	W. E. & M. Co.	1125	9½" x 14"	Jacobson Machine.
17½	Westinghouse	375 400	8" x 7"	Westinghouse.
18	E. & C. Elec. Co.	275	2 cylinder	National Meter Co.
20	Gen. Electric	360	9" x 7"	General Electric.
25	United Electric Co.	325	8" x 10"	Robb-Armstrong.
25	Westinghouse	320 350		Goldie & McCulloch.
25	Westinghouse	375	6½" x 8"	
25	Westinghouse		8" x 10"	Westinghouse.
30	Westinghouse	352	9-15" x 9"	Westinghouse.
30	Can. Gen. Elec. Co.	300	9" x 10"	Robb-Armstrong.
35	Ridgway	300	9" x 10"	Ridgway.

Generator K.W.	Make.	R.P.M	Engine Cyl. Dimensions	Make
49	Allis-Chalmers	285	11" x 12"	Bruce McBeth.
50	General Electric	275	13" x 12"	Armington-Sims.
50	Thresher	250		Buckeye.
50	Westinghouse	125	11" x 12"	Westinghouse.
60	General Electric	250	12" x 12"	Watertown.
62½	Westinghouse	320	10" x 18"	We.tinghouse.
75	Westinghouse	275	13" x 14"	Erie Ball.
75	Commercial Elec. Co.	275		J. B. Alfree.
100	General Electric	250	17" x 15"	Harrisburg.
100	Westinghouse	225	10" x 19" x 16"	Buckeye.
100		260	17" x 16"	
100	General Electric	275	14" x 14"	Ridgway.
125	Allis-Chalmers-Bullock			Robb-Armstrong.
125	Bullock	250	18" x 15"	American Ball.
125	General Electric	250	17" x 16"	Ridgway.
150	Crocker-Wheler	225	18" x 17"	Harrisburg-Fleming.
150				Belliss & Morcom
150	Crocker-Wheeler	200		Harrisburgh Corliss.
175	General Electric	180	16" x 24"	American Diesel.
185	General Electric	230		S. M. Jones.
200	Can. Western Elec.		16" x 24"	Robb.

MacGOVERN & COMPANY, Inc.
285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, **Plants: Lincoln, N.Y., and Linden, N.J.**

Buyers and Sellers of New and Used Machinery

A CONTINENT-WIDE SERVICE

When Buying Thermometers
There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

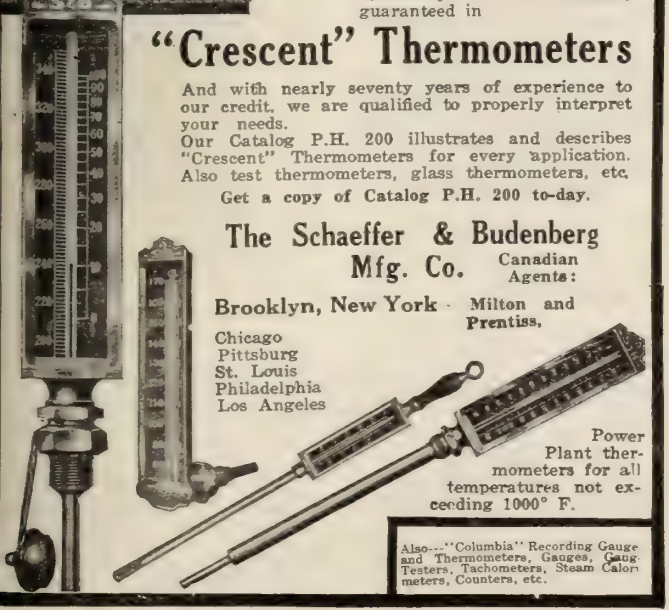
And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.
Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co. Canadian Agents:

Brooklyn, New York · **Milton and Prentiss,**

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles



Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gang Testers, Tachometers, Steam Calorimeters, Counters, etc.

In Bulk

SAFETY PLASTIC
METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

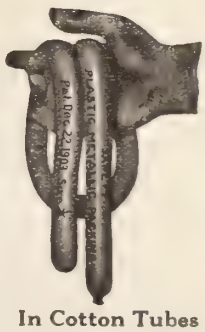
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Garco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Garco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Qne.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

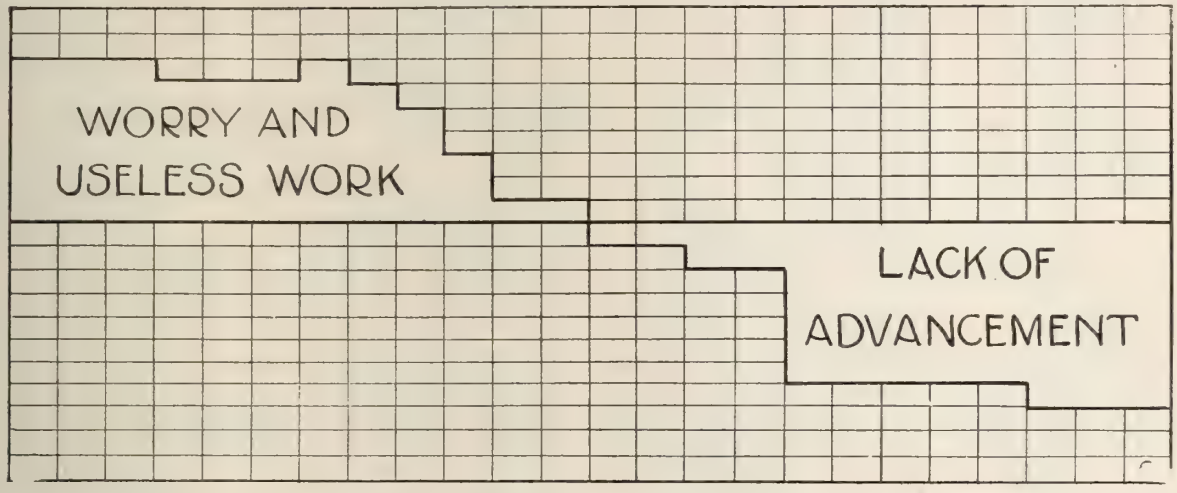
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the *C.A.S.E.* Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.
Beveridge Paper Co., Ltd., Montreal.
MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, AIR
E. J. Philip & Sons, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.
METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
METERS, GAS
E. J. Philip & Sons, Toronto, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.
METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
MIXING VALVES
Crane's Limited, Montreal.
MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.
OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.
ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, PISTON
Garlock Packing Co., Hamilton Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.
PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, VALVE STEM
Crane, Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.
PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.
PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co, Montreal
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.
PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.
PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

Business Dry? Not Much!

DON'T you remember wondering, when you were a little Tad, what fun those great big chaps of twenty or so had? They didn't go "bobbing"—they didn't spin tops. Then you remember, perhaps, how, at twenty or so you rather pitied the old fellows of thirty-five or fifty who didn't dance (in those days) or do anything much.

But now, at thirty-five, fifty, or even sixty, you find there is plenty of interest in life. The form of fun may change, perhaps the ideas of what constitutes fun—but fun, interest, there still is.

Business is Rightly Called a Game

Business is the interest—the fun—for many of us. We enjoy playing ourselves and we enjoy reading about the play of others.

This is why THE FINANCIAL POST, dealing with business, is bright, entertaining, a welcome week-end guest in some eight thousand homes.

Consider some of the articles in a recent issue:

A sketch of George Sumner, the newly appointed head of Montreal's Board of Trade—a man who is at work every day at 8 a.m., but who has found time to become an expert photographer and art critic. Peter McArthur's new suit—dealing with the farmer writer's boasted purchase of an all wool suit for $45; speaking of the comparative value of this with one he could have bought prior to the war, and showing what he would have to pay for each in eggs and wheat.

A $4,000,000 stock offering coming for new movie chain.

Canada proposes to pick and choose her immigrants.

The Financial Post Editorials Have a Kick Behind Them

"Marse" Henry Watterson, the famous Democrat Editor, tells in his reminiscences of being criticized for himself criticizing the Democrat party. Marse Henry replied in his paper by quoting:

"Things have come to a hell of a pass
when a man can't wallop his own jackass."

THE FINANCIAL POST is willing to wallop anything—but it doesn't wallop just for the fun of walloping. It wallops to achieve something.

Consider Some Recent Editorials:

"Give Drury a Chance"

An editorial describing the "sniping" by the daily press at the farmer Government—admitting certain mistakes of inexperience but calling for fair play; instancing how J. K. L. Ross, heir to many millions, was put, by his father, in a position where he could make mistakes in order that he might win through to success.

"Foolish Defiance of Canadian Law"

A scoring of the Fort Francis Pulp & Paper Company for refusal to admit the sheriff, and in other ways prejudicing the public against the pulp and paper industry as a whole.

S. R. Parsons Now Butts Into Insurance

An editorial telling of the Canadian Manufacturers' Association's mutual insurance schemes which went wrong, and pleading for a big man to manage the C.M.A. "The most useful and necessary institution in all Canada."

There's life in each issue of THE FINANCIAL POST. It will help you keep informed on important financial and business matters. It is a paper for the leaders of thought in each community, be they rich or not. Fill in and send to us the attached coupon. Annual Subscription $3.00.

SUBSCRIPTION PRICE $3.00 PER YEAR (52 ISSUES)

THE FINANCIAL POST

Montreal 143-153 University Ave., TORONTO **Winnipeg**

THE FINANCIAL POST OF CANADA, 143-153 University Ave., Toronto.

Please enter me as a regular subscriber, commencing at once. I am enclosing / will forward $3.00 to pay for my subscription for the first year.

Name .....

Address .....

Please write plainly.

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
n. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
Defender Automatic Reg. Co., St. Louis.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

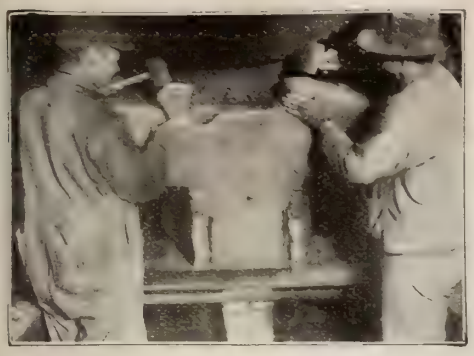
TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.



D
Plibrico is easily moulded to fit any place.

PLIBRICO Keeps the Heat Where It Belongs

PLIBRICO keeps the heat in the furnace, because it forms a jointless, one-piece lining in your front door arches, entire fronts, side walls, arches, bridge walls, etc. This lining is gas and air-tight, saves fuel while at the same time greatly reduces your furnace upkeep, will last longer, give better satisfaction and can be more easily repaired than a lining constructed of fire brick or fire clay.

PLIBRICO is also unexcelled for baffle construction and repairs.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico, Supply Co., Ltd., Toronto. Canadian Representatives.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Trade Mark
Reg. U.S. Pat. Office

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P.Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

When Writing to Advertisers
Kindly Mention Power House

WATER

WE-FU-GO AND SCAIFE

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont
J. C. Wilson Mfg. Co., Ltd., Belleville.

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

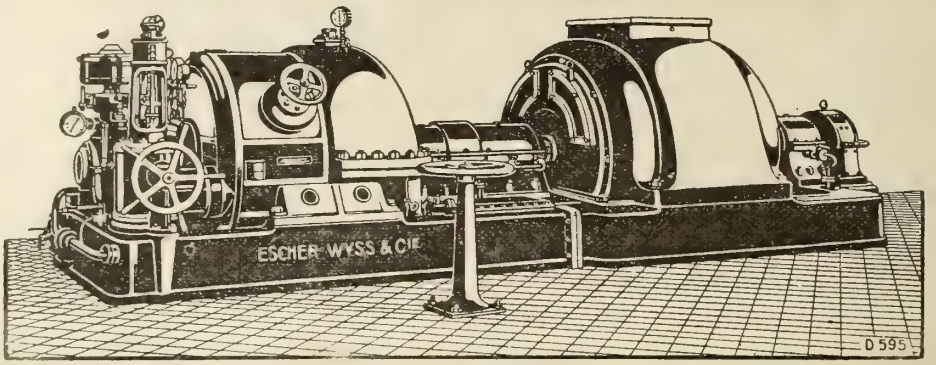
WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

23/19

Don't clog your mind wheels up with the mud of unreliable out-of-date reading. Get the latest technical information on Power House Equipment by reading POWER HOUSE, Canada's only paper devoted entirely to the practical engineer's interests

$2.00 SUBSCRIPTION PRICE Send in yours TO-DAY $2.00

THE MACLEAN PUBLISHING COMPANY, LIMITED - 153 UNIVERSITY AVENUE, TORONTO

INDEX TO ADVERTISERS

A
All-Way Oiler Co. 61
American Steam Gauge & Valve Mfg. Co. 66
American Steam Pump 54
Armstrong Cork & Insulation Co. 13

B
Babbitt Steam Specialty Co... 59
Babcock & Wilcox 75
Badger & Sons, E. B. 49
Betson Plastic Fire Brick Co... 50
Boving Hydraulic Eng. Co..... 72
Bowser & Co., S. F. 55
Busch-Sulzer Bros.—Diesel Engine Co. 13

C
Can. Assoc. Stationary Engrs.. 79
Can. Consolidated Rubber Co... 62
Can. Fairbanks-Morse Co..... 65
Can. Link Belt Co. 15
Can. Johns-Manville Co..... 7
Can. Mead-Morrison, Ltd..... 58
Can. Steam Boiler Equipment... 75
Chaplin-Fulton Mfg. Co..... 73
Classified Ads 44
Coppus Engr and Equip. Co.... 2
Carling Turbine Blower Co.... 49
Crane, Limited 73

D
Darling Bros. 83
Dort Union Co. 58
D'Este Co., Julian 59
Department of Labor..... 73
Diamond Specialty Co..... 64
Direct Separator Co..... 68
Dominion Coal Co..... 72
Dunham & Co., C. A..... 60
Durabla Manufacturing Co..... 66

E
Electric Welding Co. 73
Economy Fuse Co. of Can., Ltd. 49
Empire Manufacturing Co..... 3
Escher, Wyss & Co. 84
Engr. and Mach. Works of Can. 46

F
Foyle, W. & G..... 44
Frick Co. 11
Financial Post, The 81

G
Garlock Packing Co. 6
Goodyear Tire and Rubber Co.. 8
Goldie & McCulloch Co..... 16
Greene, Tweed & Co..... 67
Green's Economizer, Ltd..... 52
Gutta Percha and Rubber Co... 47

H
Hays Corporation, Jos. W..... 71
Holmes Metallic Packing Co.... 72
Homestead Valve Mfg. Co..... 73

J
Jeffrey Manufacturing Co. 50
Jefferson Union Co. 63
Jenkins Bros. .....Front cover
Johns-Pratt Co., The..... 51
Jointless Fire Brick Co..... 83
Jamison Cold Storage Door Co. 12

I
Inglis Co., John...Inside back cover

K
Kellogg & Co., E. H..... 45
Kerr Engine Co. 14

L
Laurie & Lamb .....72 and 57
Leitch Co., The Arthur S..... 61
Leonard & Sons, Ltd., E..... 53
Linde Can. Refrigeration Co... 10
Lincoln Electric Co. 9
Lunkenheimer Co. 64
Long, J. T. 45

M
MacGovern & Co. 77
Magnolia Metal Co. 54
Mason Regulator Co. 53
Mason Regulator and Eng. Co.. 59
McAvity & Sons, T. A..... 61
Metlskin Co., Inc. 69
Morrison Brass Mfg. Co., James Outside back cover
Murphy Iron Works 9
Mueller Mfg. Co., H..... 56

N
Norwalk Iron Works Co..... 14

P
Penberthy Injector Co..... 5
Philip & Sons, E. J..... 56
Pilley Packing and Flue Brush Manufacturing Co. 72
Pratt & Cady Co., Inc..... 68
Pyro Products Co.Inside front cover

R
Robb Engineering Co..... 55

S
Sanford Riley Stoker Co..... 9
Scaife & Sons Co., Wm. B..... 83
Schaeffer & Budenberg Mfg. Co. 77
Schmidt Co., B. L..... 11
Starrett Co., L. C..... 57
Sturtevant & Co., B. F..... 4
Steel Mill Packing Co..... 77

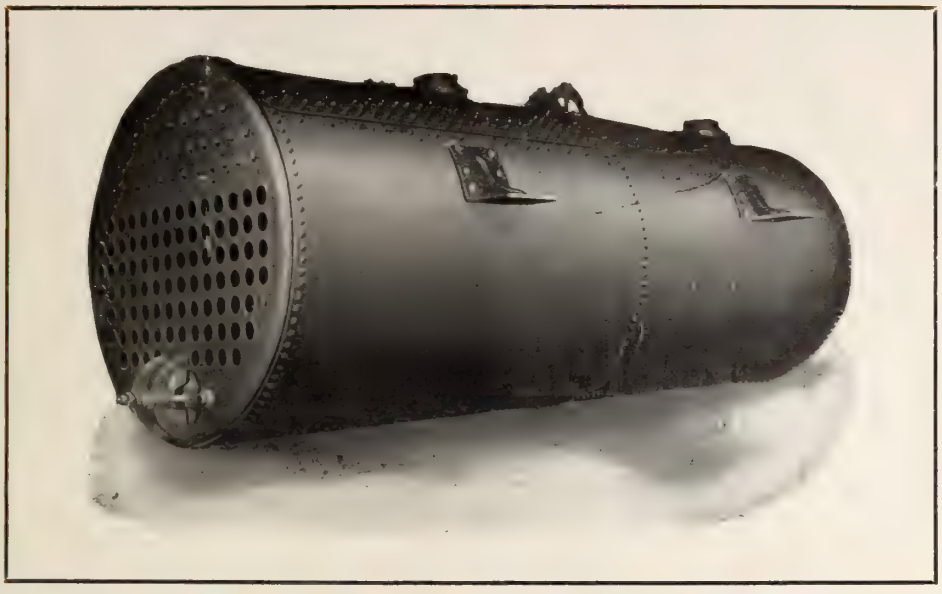
T
Trimont Instrument Co. 60

U
Uehling Instrument Co. 60

V
Valve Engineering Co..... 53
Victoria Foundry Co. 73
Vilter Manufacturing Co. 13
Voorhees Rubber Co., Ltd..... 66

W
Wall, W. J..... 45
Waterous Engine Works Co.... 1
Watson & McDaniel Co..... 72
Williams & Co., J. H..... 69
Williams Co., Franklin 68
Wilson Mfg. Co., J. C..... 73
War Purchasing Commission... 70

Y
Yarnall-Waring Co. 52
York Manufacturing Co..... 12



INGLIS BOILERS

TANKS AND ENGINES

Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and service in Canada for over a half-a-century. Always reliable!

Write us for prices and specifications.

The John Inglis Company

LIMITED

ENGINEERS AND BOILER MAKERS

14 Strachan Avenue — Toronto, Canada

Representatives in Eastern Canada:
JAMES W. PYKE & CO., LIMITED
232 St. James St., Montreal

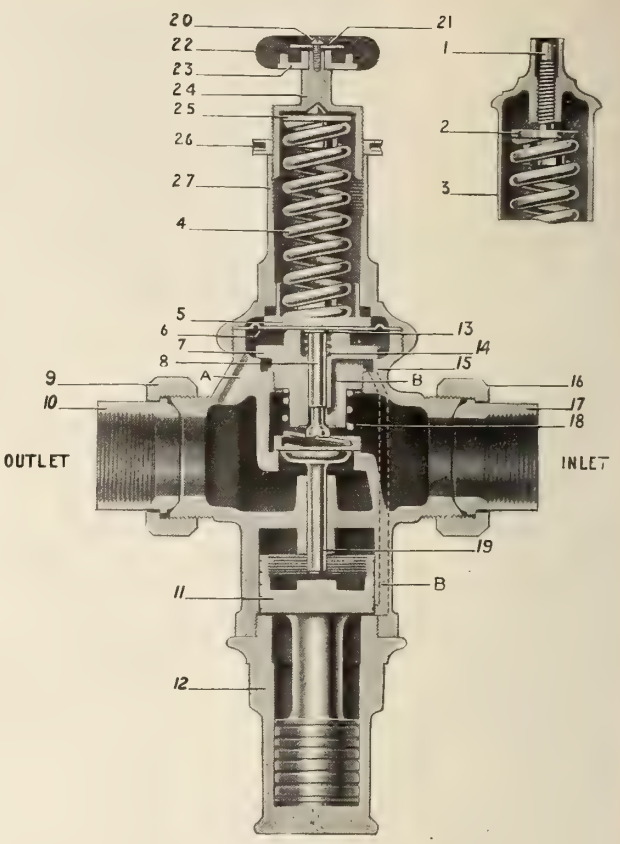
Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

MORRISON'S

J.M.T.

solves the problem

Since the appearance of this valve there has been no "problem" of pressure reduction of steam and air. The J.M.T. valve does all that a pressure reducing valve can do. **A sudden change in the low pressure demand, or variations in flow and pressure on the high pressure side have no effect on the even, low pressure maintained.** Safety and dependability are fundamental features. Made in sizes and with reduction ranges to suit every requirement, and sold with the well-known Morrison guarantee.



METHOD OF OPERATION

J.M.T. Reducing Valves are controlled by the variation of the reduced pressure acting through the port A, (shown in the cross-section) on the diaphragm 6. This diaphragm is resisted by the spring 4, which is adjusted to the desired pressure. This construction allows the diaphragm to be raised by an increase of the reduced pressure and forced down by the spring 4, when the reduced pressure is decreased. In use the diaphragm is balanced between these two forces, the slightest change of reduced pressure causing a movement of the diaphragm.

The auxiliary valve 8 is held in contact with the diaphragm by the auxiliary valve spring 14, and moves up and down freely with the diaphragm. As soon as valve 8 is open steam passes through into port B and under piston 11. By raising piston 11 main valve 19 opens against the initial pressure, because the area of valve 19 is only one-half of the area of piston 11, steam is thus admitted to the system. When the pressure on the low pressure side reaches the required point, which is determined by the spring 4, the diaphragm is forced upward by the low pressure steam which passes up through the port A to the under side of the diaphragm 6, allowing valve 8 to close, shutting off steam from piston 11. Main valve 19 is now forced to its seat by the initial pressure, shutting off steam from the system and pushing piston 11 down to the bottom of its stroke. Steam beneath piston 11 exhausts freely around the piston (which is fitted loosely for this purpose) and passes off into the low pressure side.

In practice the main valve does not open or close entirely with each slight variation of pressure, but assumes a position which furnishes just sufficient steam to maintain the desired pressure. Piston 11 is fitted with dash pot 12, which prevents chattering or pounding.

These valves can be furnished for ranges of reduced pressure as follows: 5 to 50 lbs., 50 to 140 lbs., 140 to 300 lbs.

Each valve when shipped from our factory has a tag attached stating the range of reduced pressures for which the diaphragm spring is suited. For other pressures a suitable spring will be furnished.

Note—Diaphragm spring 4 is the only one in the valve that needs to be changed to obtain the different ranges of reduced pressures.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St., W., Toronto, Ont.

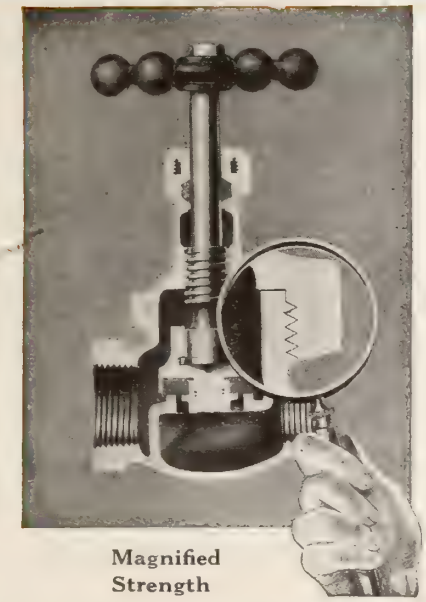
POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 6. Publication Office, Toronto—March 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year



Magnified Strength

TRADE PENBERTHY MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY

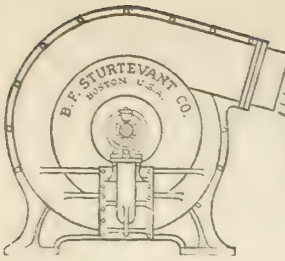
Penberthy valves are **NOT** just ordinary valves. The feature of "the outside bonnet construction" (see cut above), will convince you of that fact. This feature is a modern progressive idea of the **correct** way to **MAKE** a valve **SAFE** and **RELIABLE.** It is not found in the ordinary valve which has not kept pace with new and practical ideas of valve construction.

When you examine the careful and painstaking workmanship and finish of every part of the valve you are also convinced of the fact that "Quality First" **IS FIRST** in the minds of the makers of Penberthy brass valves.

Specified by the best Engineers

MANUFACTURED BY

PENBERTHY INJECTOR COMPANY, LIMITED - - WINDSOR, ONT.



Sturtevant

REG. U.S. PAT. OFF.

PUTS AIR TO WORK

BURN LESS AND CHEAPER FUEL

HAVE you given the same careful consideration to the operating cost of your boiler room as you have to the other departments of your plant? Because the boiler room does not come under your eye as frequently as the financial statement does is not a fair reason for letting it run day in and day out without giving it some consideration. To-day no one item of expense affects your profit and loss account more than the coal bill.

There is enough coal for you, not the kind you usually buy perhaps, but enough of cheaper grades, like hard coal screenings, to keep the boilers working. Your stack may not draw well enough to burn this cheaper fuel but a

Sturtevant

MECHANICAL DRAFT SYSTEM

will. It will not only burn this cheaper coal while the present shortage exists but it will place you in a position to continue using this fuel year in and year out. The system pays for itself in actual fuel saving as well as making you independent of embarrassing shortages. These are not untested theories; they are facts, practically proven in many boiler plants using the Sturtevant System.

ASK US TO SEND CATALOG 236-U

B. F. STURTEVANT CO., OF CANADA, LTD.
HEAD OFFICE AND WORKS: - - GALT, ONT.
SALES OFFICES: TORONTO AND MONTREAL

Power Plant of Union City Gas and Electric Co., Cincinnati, Ohio

What is your Equipment Doing?

The Weston Model 310 Portable Wattmeter is the ideal instrument for checking switchboard models or to accurately measure the load of any particular circuits.

This instrument and the kindred models—370 Ammeter and 341 Voltmeter—are suitable for use on either A.C. or D.C. circuits. The accuracy of this group is within ¼ of 1 per cent. of full scale value on D.C. circuits and on A.C. circuits with any frequency up to 133 cycles in any wave form.

Write our nearest house for further information and recommendations on these or any other Weston instruments.

Northern Electric Company
LIMITED

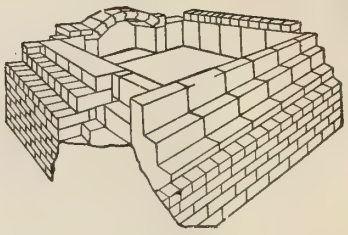
Montreal Quebec Toronto Winnipeg Calgary Vancouver
Halifax Ottawa London Regina Edmonton

Reduce Your Boiler Room Upkeep

Gates Patent Arches and Furnace Linings

eliminate costly repairs. Their close-fitting joints offer no projections for the formation of clinkers—no possibility of costly air leaks.

Gates Arches and Furnace Linings are easily installed and are so designed that when any part becomes fused a handy man can replace them in half the time it takes to repair a standard firebrick job. Apart from the saving in time and labour and the elimination of continual Furnace repairs, your saving in fuel alone would soon pay for the installation of Gates Arches and Linings.



We specialize in all kinds of POWER PLANT BRICKWORK

Boiler setting, Furnace building and Oven work are our specialties. Our engineers are at your service. Call on them at any time for any information you may require — without obligation to you.

GATES REFRACTORIES, Limited

St. James Chambers, Church and Adelaide Sts., TORONTO 382 St. James St., MONTREAL

The most

EFFICIENT BABBITT

known to modern science for high speed motor bearings.

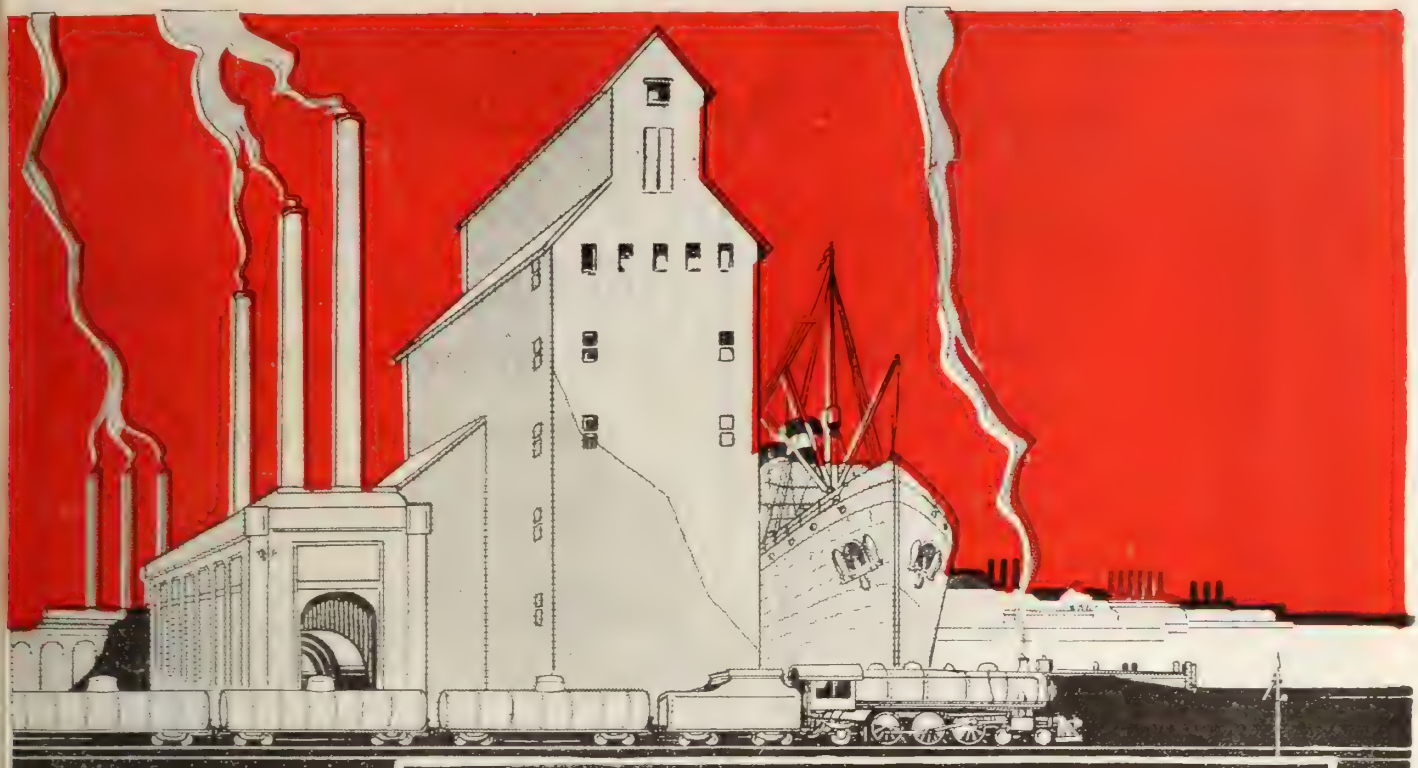
The Master Mechanic of an electric railway company states : "Dynamo Genuine is the best metal we have ever used."

Largest makers of white metals in the world.

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

POWER HOUSE, March 20, 1920, Vol. XIII., No. 6. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Arlo Compressor Oil

Reduce Your Overhead

THE proper use of selected lubricants is a sure means of reducing overhead expenses and of eliminating unnecessary operating costs. *Perfectly-lubricated machinery gets less wear and lasts longer.* Repair bills are smaller and fewer; depreciation is kept at the lowest possible figure when lubricants are chosen with an eye to mechanical needs and service conditions.

Imperial Lubricants are designed to meet definite needs and conditions. Made from the best crudes they are formulated and designed for real service. They are Canadian-made and readily obtainable everywhere in Canada through our extensive distribution system.

There is a "just right" grade of lubricant for each type of machinery and for each moving part—railroad, marine, power plant, factory and mill. The right use of Imperial Lubricants will reduce your overhead.

Imperial Lubrication Engineers are at your service for consultation. Their co-operation and recommendation for better lubrication are part of Imperial Oil Service.

Write us at 56 Church Street, Toronto, or at any of our branches, for an appointment or for further information.

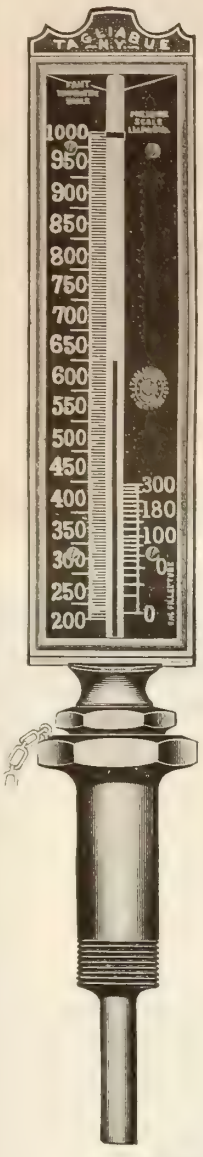
IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

TAG

Thermometers for the Power Plant



Exact knowledge of the temperature in your steam pipe is necessary if a power plant is to be operated on the most economical basis. Inaccuracy in this respect leads to waste.

In the TAG line of Industrial Thermometers there is just the thermometer you need, made especially for the power plant.

Power plant Thermometers are illustrated and listed in our catalog PP-405, together with several other types of apparatus of interest to the engineer.

We'll see that you get this catalog if you will write us.

THERMOMETER GUARANTEE

Accuracy—Absolute and Constant.

Construction—Highest Grade Workmanship.

Material—Most Durable for the Particular Purpose.

Insurance—Against Loss by Breakage in Transit.

The insurance clause means that we shall assume the burden of obtaining redress from the transportation company if the customer will notify us of breakage immediately upon receipt of goods, and will co-operate with us in obtaining the necessary evidence.

C. J. TAG LIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark
Reg. U.S. Pat. Off.

"MEAD-MORRISON"

CANADIAN MM CANADIAN MM

Hoisting and Conveying Machinery

Manufactured in Canada

For half a century "Mead-Morrison" machinery has been recognized as standard equipment because of the DEPENDABLE SERVICE it renders at continuous top-notch speed.

Among the numerous Canadian purchasers of complete "Mead-Morrison" labor-saving plants are:—

Canadian Pacific Railway
Canadian Northern Railway
Canadian Government Railways
Grand Trunk Railway
Canada Cement Company
Steel Company of Canada
Montreal Light, Heat & Power Co.

and many large coal companies and manufacturing concerns.

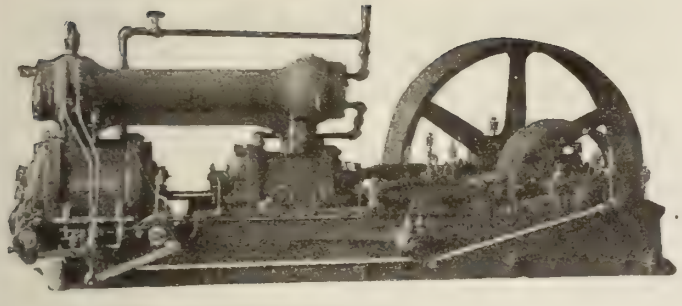
HOISTING MACHINERY
AND
LABOR SAVING PLANTS
FOR ALL PURPOSES

May we assist **you** with your material handling problems?

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

NORWALK
AIR & GAS · COMPRESSORS

Pre-Eminence



Norwalk 100-lb. Air Compressor

in any field signifies a superiority for the attainment of which undoubted high merit is necessary. Norwalk Compressors—with forty years of experience in compressor-building behind them, thorough in design and construction, painstakingly tested, economical in operation and consistently dependable day after day and year after year—have a merit which justly entitles them to pre-eminence in the field of air and gas compression.

Requests for bulletins on Air, Oxygen, Hydrogen, Acetylene or Carbonic Acid Gas will receive prompt response.

THE NORWALK IRON WORKS COMPANY
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

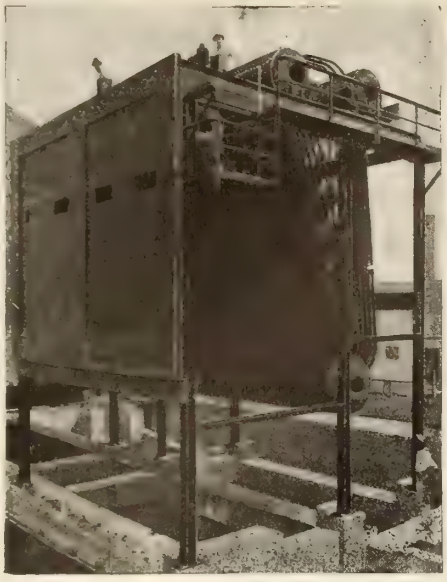
Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA



Connelly Water Tube Boilers (Patented U. S. & Canada)

are of the 4 drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crow bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4000 H.P. and 300 lbs. pressure. 100,000 H.P. in successful operation.

E. Leonard & Sons Ltd. Head Office & Works
LONDON, CANADA

Branches

1790 St. James St., Montreal, Que. 62 Water St., St. John, N. B.

AGENTS

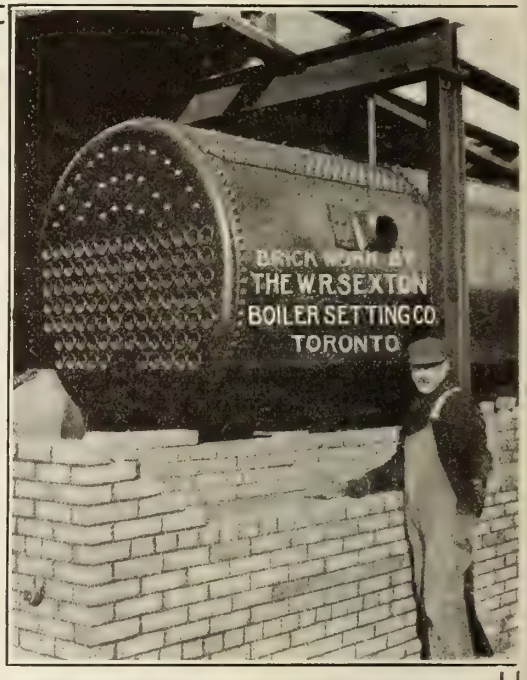
E. J. Philips & Sons, 103 Hamilton Trust Bldg., Toronto, Ont.
Wm. W. Hicks, 567 Banningt St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. Johns, Nfld.

Established 1834

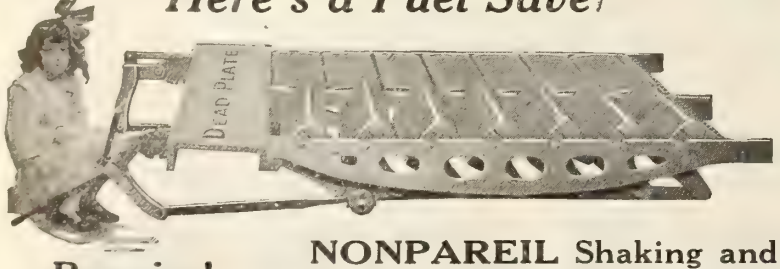
LEONARD

If It's FIREBRICK WORK
See SEXTON

It will pay you to see "Safety-First" Sexton for all your Firebrick Work—building in boilers and general repairs —Sexton has gained a reputation for doing the work with rare efficiency. The work done by Sexton lasts longest, many of the largest plants in Canada are ready to back up this statement.



Here's a Fuel Saver



Repairs!

Grate Bars supplied, and Repairs made to all kinds of Shaking Grates and all classes of Boilers.

NONPAREIL Shaking and Dumping Grates

Does a saving of 10% in your fuel expenses interest you? Then get in touch with "Safety First" Sexton and get him to show you how NONPAREIL SHAKING AND DUMPING GRATES will do this. This is no idle claim, but a fact that is being proven every day by numerous users. Write, 'phone or wire for details. If convenient, **"Safety First" Sexton** will call on you personally.

THE W. R. SEXTON BOILER SETTING CO., 127 D'ARCY STREET TORONTO

ESTABLISHED 1900 **PHONE COLLEGE 682**

If you don't know where to get it —write us

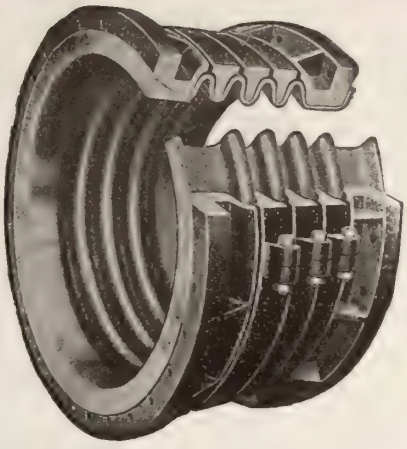
See if it is listed below:

Controllers for Temperature, Pressure or Time.
Meters for Measuring Steam, Water, Air or Gas.
CO_2 Gas Analyzers—Hand Type.
Water Filters—Pressure and Gravity.
Thermometers for every use.
Gauges—Vacuum, Pressure and Compound.
Furnace Efficiency Indicators.
Hydrometers.
Steam Traps—Tank Type.
Separators—Steam or Oil.
Oil Filters.

Steel Tanks—Stacks—Plate Work.
Return Tubular Boilers.
Connelly Water Tube Boilers.
***Manufactured by* E. Leonard & Sons, London, Ont.**

Write us for information on above.

E. J. PHILIP & SONS
57 Queen Street West - TORONTO



The BADGER SELF-EQUALIZING EXPANSION JOINT

is a one-piece joint, thus eliminating the necessity of frequent renewal of packing; it is properly designed, and manufactured from material with sufficient elasticity to stand the repeated changes in shape, and it absolutely controls the expansion and equally distributes it on all corrugations.

Write for our new book today

E. B. BADGER & SONS CO.
75 PITTS ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES

WHY Williams'?

For the same reason you are using modern machinery, high class workmen and the best of material. **Because they pay.**

Experienced mechanics, everywhere, are using Williams' Wrenches because they know the tools are dependable and **they like them.** Williams' Wrenches have correct balance as well as sturdy strength—they "feel" right—they fit the hand like an old glove.

Good tools, correctly designed and made, are of paramount importance in the power house. Remember, when you specify Williams' Wrenches, you ask for the best.

We make 40 standard styles in about 1000 sizes with openings from 3/16 to 7⅝". Ask for our new Wrench Booklet.

J. H. WILLIAMS & CO.
"The Wrench People"

78 Vulcan St.
Buffalo, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask., Agents for Saskatchewan, Manitoba, Alberta and British Columbia.

78 Richards St.
Brooklyn, N.Y.

Mr. Jos. W. Hays, *Author*

Mr. Joseph Harrington
Chicago
Formerly Advisory Engineer, National Fuel Administration for State of Illinois

Mr. Fred R. Low
New York City
Editor of Power

Prof. S. W. Parr
Urbana, Ill.
Department of Chemistry, University of Illinois

Mr. Arthur L. Rice
Chicago
Editor, Power Plant Engineering

W. L. Abbott,
Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill.

Mr. David Moffat Myers
New York City
Formerly Advisory Engineer, National Fuel Administration

These Men are America's Leading Combustion Experts

Every step of the training has their careful censorship, giving you the fruits of their broad and successful experience.

Hays School of Combustion
1108 State-Lake Bldg.
Chicago, Ill.

Better Jobs— Bigger Salaries

Let These Men Show You How to Get Them

Are you interested in sure and rapid advancement to a really worth while position in one of the best paying professions in the country today? If you are it will pay you well to read this announcement. It tells how you, with or without previous training, can prepare yourself in a short time for an attractive position that insures a lucrative salary and an assured future.

Remember—this profession is a new one—unlike all others, it is still uncrowded—and the demand for trained men far exceeds the supply. That's why your services will be in demand when you have acquired the necessary training. That's why you can count every effort a sure and wonderfully profitable investment.

Easy to Learn— No Experience Necessary

In most professions, to become proficient, long periods of intensive study, followed by years of hard training, are necessary. In this new profession—Combustion Engineering—the necessary training can be acquired in a few short months. Why? Because all the knowledge and experience—all the scientific research and experiments—all the labor and study of seven of America's leading Combustion Engineers have been condensed and classified to such a remarkable extent that what formerly required years of study can now be learned in a fraction of that time.

This training from the very first can be applied to the practical every-day problems of any power plant. At some point in the course you must spend some time in power-plant work if you have not already had the experience. That may prove to be your field or you may make it the stepping stone to an executive position. In either case your services will increase in demand and value as you progress in the training.

America's Leading Combustion Engineers Teach You

On this page are photographs of our educational staff. Probably you know some of these men personally. At least, all or most of them, are known to you by reputation.

Jos. W. Hays is the author. His reputation as a writer on Combustion Efficiency is world wide. In this course he has surpassed himself. Every lesson, every chapter, is written in such an interesting, comprehensive way, that the reading of the course is as pleasant as it is profitable.

Associated with Mr. Hays as reviewing and advisory editors are **I. E. Moultrop, W. L. Abbott, Jos. Harrington, Fred R. Low, David Moffat Myers, Prof. S. W. Parr and Arthur L. Rice.** These names alone are proof positive of the thoroughness and completeness of the course.

Especial attention has been given to make this course easily understood by everyone. It is stripped of all unnecessary technicalities and is written in a way that you can quickly grasp and understand. It is prepared especially for the man on the job—the busy man in office or boiler room who can commence putting his knowledge into practice the moment he starts the course.

Send for this FREE BOOK—TODAY

To enable you to get a better idea of just what this course is—just what it covers—why it is a guide to a better job and a bigger salary—why it enables *you* to cash in on the big salary awards that fall to the Combustion Expert—to make all these things clear to you, we have prepared the book "Opportunities for the Combustion Expert." Send for a copy of this book today. It's free.

Mail the Coupon

Simply fill in the coupon and mail it to us. We'll send you a free copy of "Opportunities for the Combustion Expert" by return mail. Time is valuable. Get started today while the opportunities are greatest. Mail the coupon—Now.

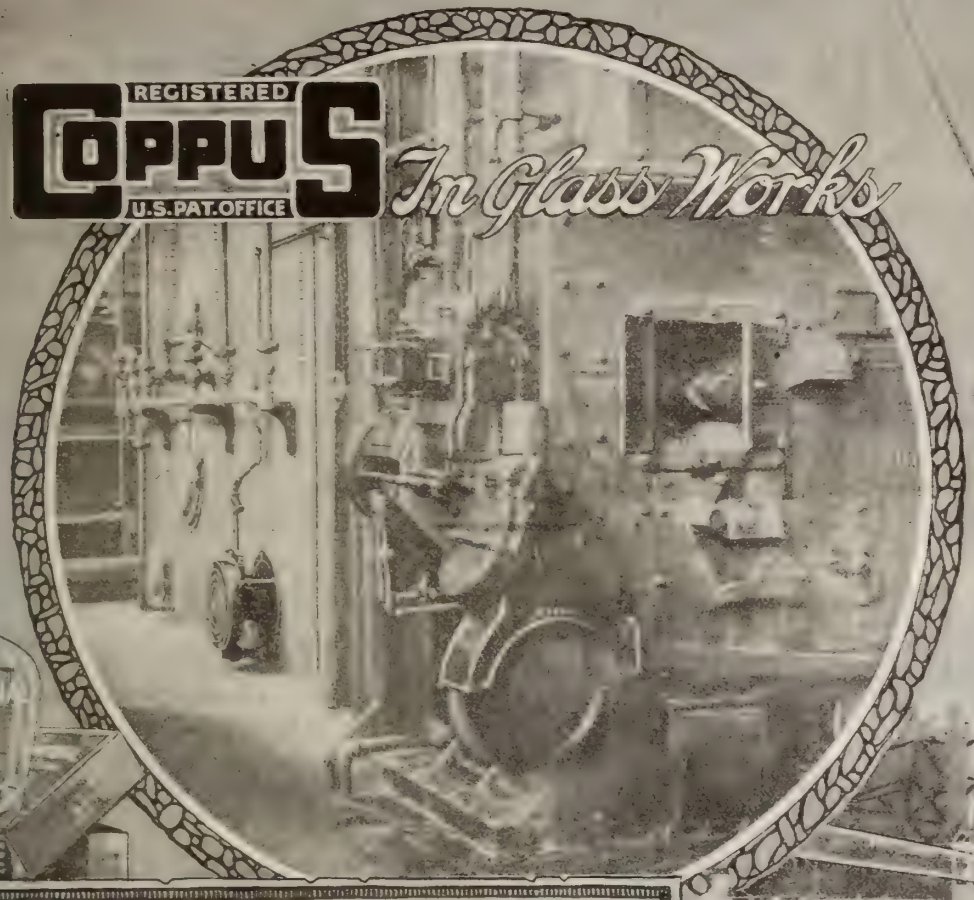
HAYS SCHOOL OF COMBUSTION
109 North State St., Chicago

Without obligation, send me a free copy of "Opportunities for the Combustion Expert and details of the Hays Course.

Name.....
Street.....
City..... State.....
Firm.....
Position..... P.H.3-20

REGISTERED COPPUS U.S.PAT.OFFICE

In Glass Works



In the Glass Division Power Plant of the National Lamp Works out in Cleveland, Ohio, they burn gas coal screenings and producer tar—difficult fuel to burn economically. Yet with the 4-18" COPPUS Tubo Blowers which they operate, full steam pressure is maintained in their 4-250 H.P. Stirling Boilers—and cheap fuel is efficiently burned. Without these Blowers, one of which is shown above, additional boilers would have been necessary last fall. With their aid, however, the heavy plant load is easily handled.

Before the National Lamp Works installed COPPUS Blowers a careful investigation satisfied them that for efficient operation, low steam consumption, and sturdy dependability, COPPUS Blowers stand in a class by themselves. And after practical proof that COPPUS Blowers are all that is claimed for them, Mr. Bretz, Plant Superintendent, expresses himself as "highly pleased with them." In the National Lamp Works, as in thousands of plants in every industry, COPPUS Blowers have proved profitable investments.

Why not find out exactly how and why "COPPUS EQUIPMENT CAN SAVE YOU MONEY." Write us and our engineers will help you solve your combustion problems. If you haven't a copy of Blower Catalog write for one to-day.

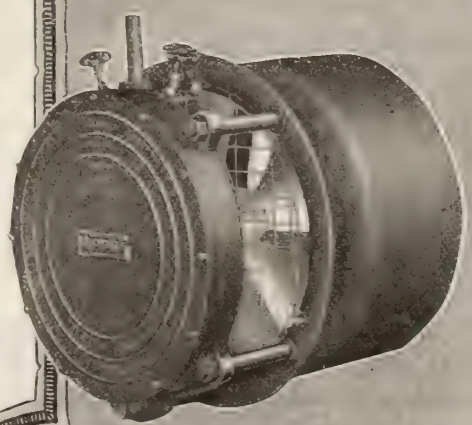
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

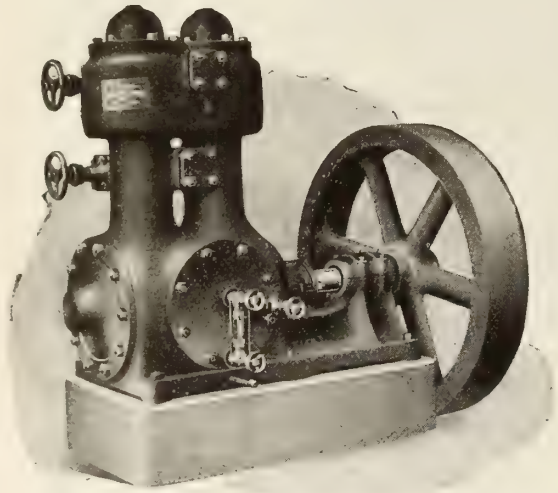
341 Park Ave., Worcester, Mass.

Agents for Montreal—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver—Frank Darling & Co., Limited, 342 Homer Street. Agents for Toronto—Arthur S. Leitch Co., 1001 Kent Building. W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta



COPPUS TURBO BLOWER

Mechanical Refrigeration



BETTER Than Ice

When saving in operating cost and saving in foodstuffs are taken into consideration, the superiority of **MECHANICAL REFRIGERATION** over refrigeration by ice is beyond comparison.

But any Refrigerating Plant, to be a success and, therefore, profitable to its owner, must be properly designed and installed to meet existing conditions.

Refrigerating installations by the York Organization are based on over 30 years' experience in building Refrigerating Machinery exclusively.

From the standpoint of service, economical operation, low upkeep cost and small amount of attention required, York Enclosed Refrigerating Machines are the best available.

INFORMATION AND PRICES ON APPLICATION

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

The Annual Refrigeration Number of Power House

will be issued on April 20th. This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the
REFRIGERATION NUMBER

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

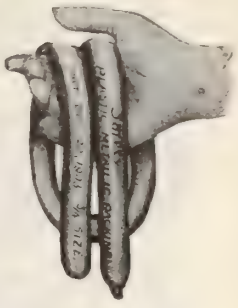
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

The "COLE" SYSTEM

of Heat Transmission and Condensation Drainage

is

SAVING THOUSANDS OF DOLLARS
EVERY YEAR FOR USERS

Can We Show You How These Savings Are Made?

First Cost Greatly Reduced — Installation Greatly Simplified

Upkeep Cost Almost Nil

Literature will be furnished upon request

GEO. W. COLE, LIMITED

2002-4 Dundas Street West, TORONTO

Montreal, Que. *Winnipeg, Man.*

HEATING BY HOT WATER & HOT WATER SUPPLIES

Instantaneous Heater, with connections for Fresh and Salt Water and Steam

HIGHEST EFFICIENCY GUARANTEED

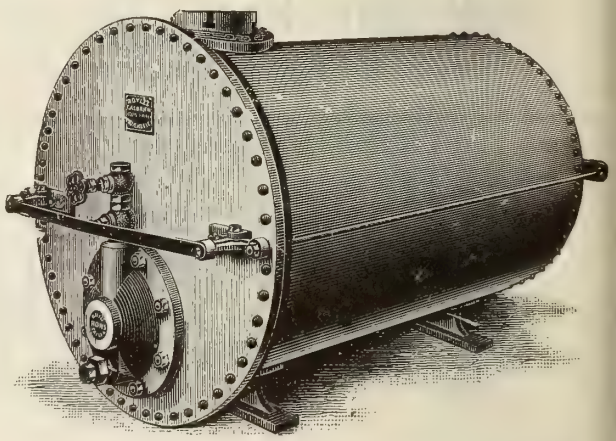
ROW'S PATENT CALORIFIERS are strongly recommended for heating water in bulk for supplying a number of Baths and Lavatories. Also for HEATING CIRCULATIONS for PUBLIC INSTITUTIONS, HOTELS, etc.

ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

ROW'S PATENT
CALORIFIERS
FEED WATER HEATERS
RADIATORS

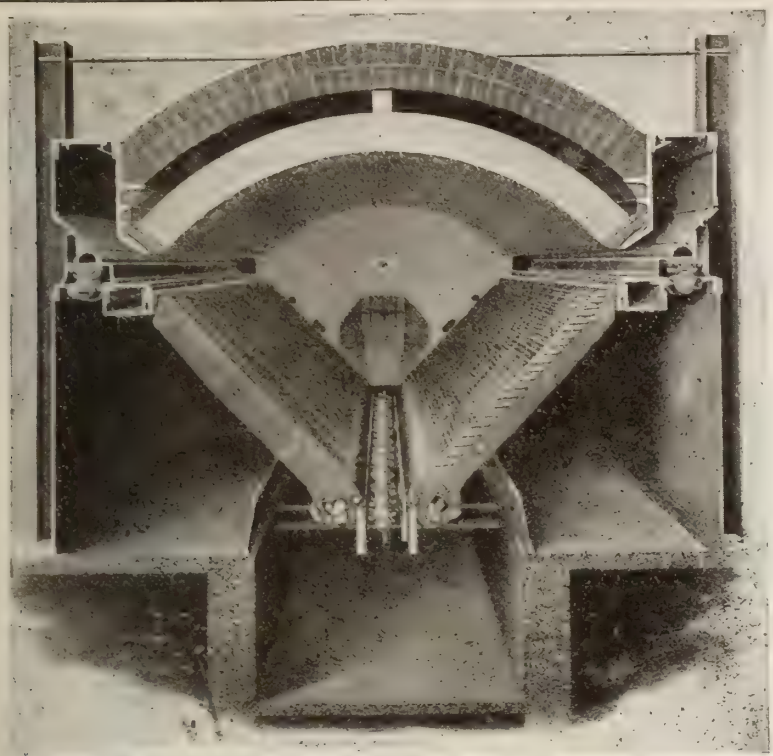
Suitable for Hot Water or High Pressure Steam

STEAM and GAS KETTLES
EVAPORATORS
CONDENSERS



PATENT CALORIFIER. STORAGE PATTERN

ROYLES LIMITED, ENGINEERS AND SPECIALISTS **IRLAM, MANCHESTER** ENGLAND



Cross section showing the construction and operation of the Murphy Automatic Furnaces. As the fuel progresses downward the alternate movement of the grates ¼" to base and ¾" below the surface of the stationary grates breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder.

Over 6000 Boilers

Murphy Furnaces have been relied upon by power users in every field for 44 years to furnish continuous, efficient and economical combustion service—to burn any available fuel—and to automatically remove all ash and refuse.

To-day **over 6,000 boilers** in all sections of the country are fired by

MURPHY AUTOMATIC FURNACES

They are being used in practically every line of industry—from hospital to industrial and central station service.

Write for our catalog showing how **Murphy Furnaces** can be installed under any type of boiler.

For information on the Riley Underfeed Stoker for large boilers see advertisement in last issue or send for catalog HR-3.

Murphy Iron Works

Detroit, Mich., U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

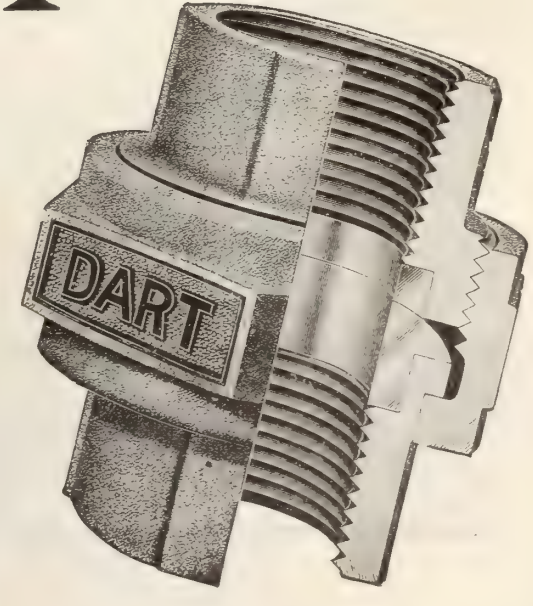
DART

UNION PIPE COUPLING

No Replacement Cost

REDUCES EXPENSE

No Upkeep Cost



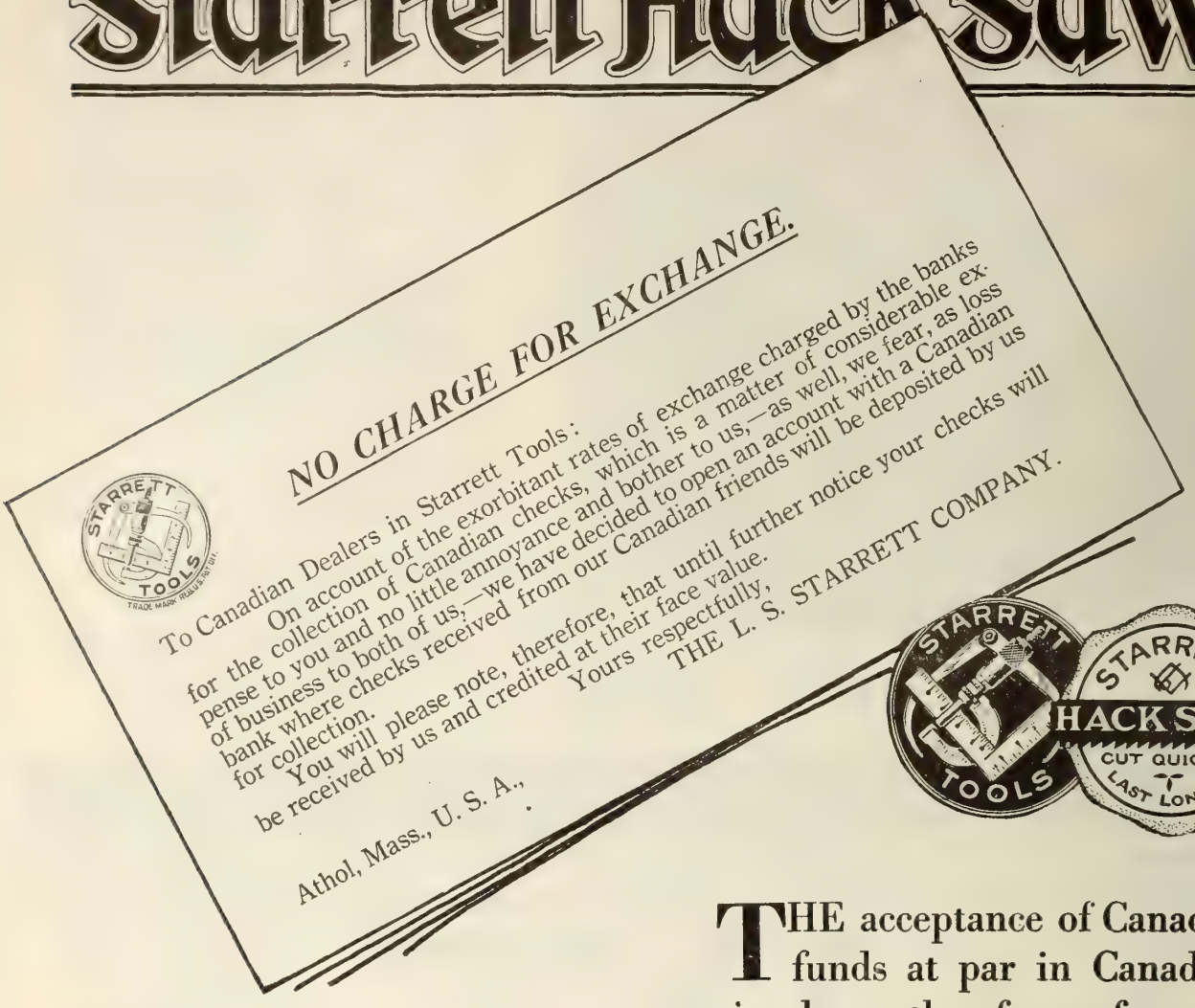
The joint is **BRONZE TO BRONZE.** This does not allow rust or corrosion. There is no deterioration.
HEAVY IRON PARTS will not stretch or pull apart.
USE AGAIN AND AGAIN—the "Dart" is always efficient.

YOUR JOBBER WILL SUPPLY YOU

Manufactured by

DART UNION CO. Limited, TORONTO, CAN.

Starrett Hack Saws


NO CHARGE FOR EXCHANGE.
To Canadian Dealers in Starrett Tools:
On account of the exorbitant rates of exchange charged by the banks for the collection of Canadian checks, which is a matter of considerable expense to you and no little annoyance and bother to us,—as well, we fear, as loss of business to both of us,—we have decided to open an account with a Canadian bank where checks received from our Canadian friends will be deposited by us for collection.
You will please note, therefore, that until further notice your checks will be received by us and credited at their face value.
Yours respectfully,
THE L. S. STARRETT COMPANY.
Athol, Mass., U. S. A.,
STARRETT TOOLS
TRADE MARK REGISTERED
STARRETT TOOLS
STARRETT
HACK SAWS
CUT QUICKER
LAST LONGER

THE acceptance of Canadian funds at par in Canada is simply another form of expression of the policy that has governed The L. S. Starrett Company for 40 years in its relations with those who sell or use fine tools.

THE L. S. STARRETT COMPANY

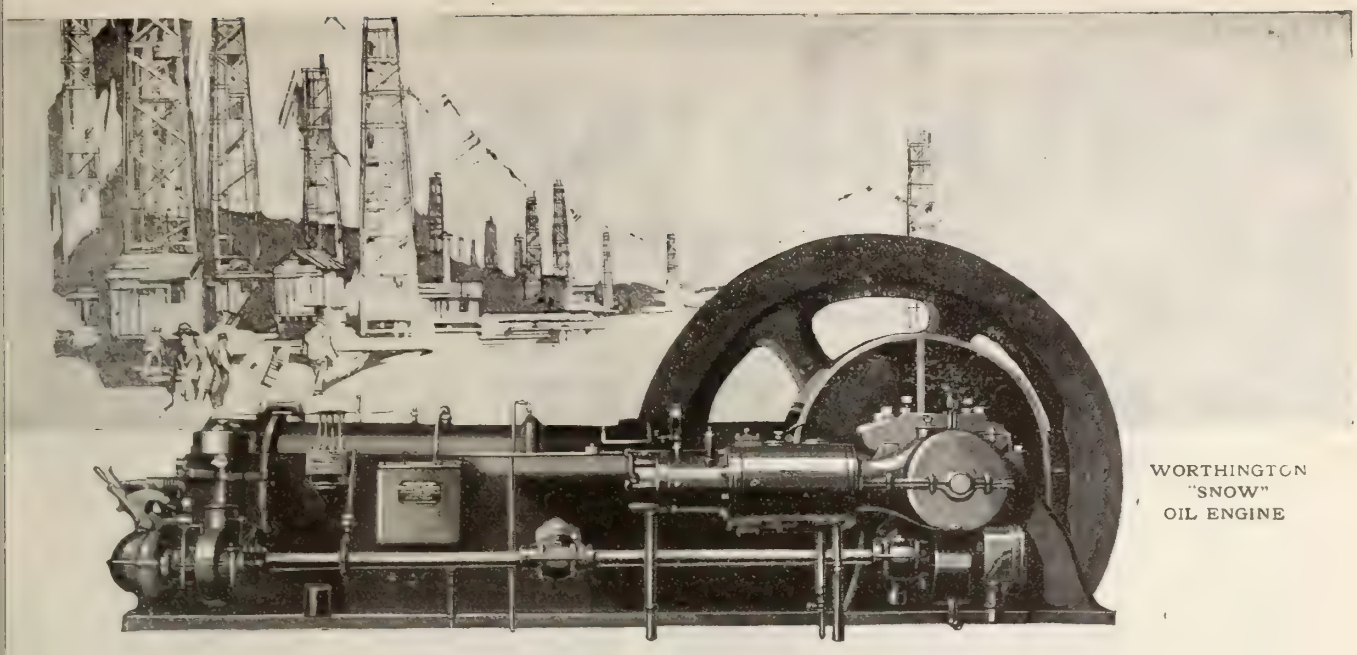
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled

ATHOL, MASS.

STARRETT CATALOG No. 21 "CD"
will be sent free
to any address on request.

42-26

Starrett Tools



WORTHINGTON "SNOW" OIL ENGINE

More Power from Less Fuel

Worthington "Snow" Oil Engines

WORTHINGTON "Snow" Oil Engines are of the high-compression cycle type. The heaviest and cheapest crude oils can be used as fuel without sacrifice of efficiency. And the consumption of fuel and lubricating oil ceases immediately when the engine is stopped.

These two features are desirable in all installations and are a necessity in those where additional power is required at short notice and where shut downs are at frequent intervals.

Longevity and durability are attained by reason of utter absence of sudden pressure changes and resultant freedom from knocks and pounds.

Worthington also manufactures a complete line of oil-line pumps.

Worthington "Snow" Engines may be used for any service where stationary power is required and are obtainable in single, twin, and three cylinder units, suitable to a variety of prime-mover purposes.

Worthington Pump and Machinery Corporation

Executive Offices: **115 Broadway, New York City**

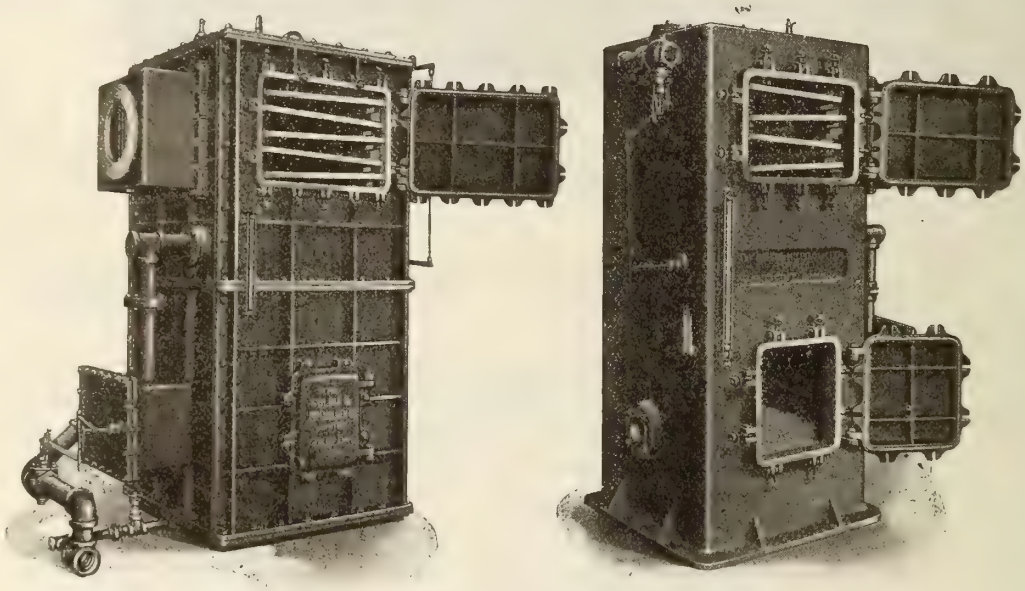
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Epping-Carpenter, *Pittsburgh, Pa.*
Laidlaw Works, *Cincinnati, Ohio.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*

MODERN AND DEPENDABLE POWER EQUIPMENT



Showing the Sectional and Solid types of G. & McC. Cast Iron Open Feed Water Heaters.

The solid type is built in sizes up to 500 horse power, while the sectional type is built in sizes ranging from 600 to 5000 H.P.

They form a combination of Feed Water Heater, Purifier and Oil Extractor of the open or Exhaust Steam Type and will most effectively extract oil and grease from the exhaust steam.

They will deliver the feed water at almost boiling temperature and at the same time will take out any scale forming matter that can be precipitated at this temperature.

WE BUILD

STEAM ENGINES, STEAM TURBINES, RETURN TUBULAR AND WATER TUBE BOILERS, PUMPS, CONDENSERS, HEATERS, TANKS, STACKS, etc.

We can help you with your power problems, our catalogs and the advice of our Engineering Department will be sent free on request.

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Works, GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Bank of Hamilton Bld'g.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig, 400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Re the Ontario Graded Certificate Act

Correspondence

Clearing Up a Misconception

THE following letter emphasizes the fact that the work carried on by the Board of Stationary Engineers and that by the Department of Education are entirely separate and distinct, and that the syllabus of instruction issued by the Department of Education for the use of its instructors is not an outline of the subjects to be learned, but only a guide to the instructors. The Editor.

Regarding the item headed "To Stationary Engineers," on page 98 of your issue of February 20th, the writer is quite in agreement with the editor in feeling that what is required at the present time is constructive rather than destructive criticism of the recent regulations respecting stationary engineers. If these regulations are too adversely criticized, it is possible the Government will feel we do not know what we do want, and will repeal these regulations, which would leave us as badly off as of old; but if we can point out practicable improvements which could be incorporated in these regulations and which would be of real value in licensing engineers, we will likely get the regulations amended in time to the satisfaction of the majority. In the meantime we should do nothing which would undo the good work which has been started, and we must remember that the Board of Examiners are human and will enforce the regulations with common sense and discretion.

Regarding the mention of the step which the Department of Education has taken to help engineers, there seems to have been some misunderstanding in this matter. It appears that this department of the Government has sent out to various night-class instructors a list of subjects which might be taught for the various grades of examinations, and some of these instructors have intimated to their classes that this list was sent out by the Government (not mentioning which department), and therefore must be the official syllabus of work required for the various examinations. When these classes have heard this and have seen the lists, they naturally conclude that the standard of the list is far too high and that too much is expected of them. The only official list so far sent out by the Board of Examiners, or the Department of Labor, is the 1919 copy of the regulations relating to the examination of engineers. Undoubtedly this is the cause of some of the adverse criticism we have seen and heard. Doubtless anyone who knew all the work outlined in the above syllabus would be able to pass the various examinations; but there is no doubt they will also pass knowing very much less than is outlined by the Education Department.

The instructors in the technical schools and night classes are practical engineers, and no doubt take THE POWER HOUSE, and will be greatly assisted in their work by reading the opinion of engineers on the kind of work that should be taught; but letters pointing out defects without suggesting remedies are useless to them.

There is much truth in the substance of the letter of "Justice II" in the above issue, viz: There are many engineers who believe themselves first-class, because they have operated for years without serious trouble, but who are really not all-round engineers and would be lost in case of trouble or if called on to handle any kind of work they had not done before. This is the class of men who constitute the majority of those who are afraid to try the examinations, or who think that first-class certificates should be granted without examination.

Personally I am of the opinion that the grading of plants should be more like that suggested by Mr. Noble in the above issue. Also in line with Mr. Stones' letter in the same issue, I feel that a practical engineer should not be required to memorize great quantities of technical information, but should know where to find that information and how to apply it to his work. This means that for the technical part of the examinations, especially the higher grades, he should be allowed to use approved handbooks, mathematical and steam tables, and mathematical instruments, as with the use of these he can save much time on examinations, which he can apply to the engineering features instead of working out areas of circles, etc., which he has probably been able to do since he was a boy.

CY. LINDER.

Is the Second-Grade Plant Too Small?

IN REPLYING to a suggestion offered in the March 5th issue of POWER HOUSE this correspondent misses the distinction between the first and other classes of certificate. The first grade examination is distinctly stated to be a highly technical one and of a theoretical nature. The requirements for this grade of engineer insofar as practical experience is concerned are met by the length of experience required. On the other hand, the lower grades of certificates are not of this nature, and any examination questions asked the applicant for them will be of a practical nature. For this reason it would seem that the purpose to be met is also different in the different grades. The first-grade man should, under the Act, be capable of design, inspection, and everything properly belonging to the consulting branch of the profession, while the second-class certificate is intended to apply to the operating engineer in particular and should ensure his competency for the position. Therefore the size of plant should be taken large enough to ensure his receiving fair and just treatment. The desirability of the first-class certificate should be affected in no way by a change in plant size requirements.

The questions asked are impossible of answer at the present time and will remain so until the Act comes fully into operation and the information is available. There are and will be no first-class engineers except those who pass examinations.

The Editor.

Sir—In your editorial note preceding the letter signed "Anonymous" you make the statement that 2,000 H.P. is a good standard for second-class engineer's certificate. Before I start my editorial warfare, I would like you to answer three questions, viz: (1) How many plants are there in the Province of Ontario from 2,000 H.P. upward? (2) How many first-class engineers are in favor of raising the requirements for second-class certificate? and (3) How many second-class engineers?

My reason for asking these questions are: If you raise the standard of the second-class certificate as suggested, you are taking away the ambition of many engineers to fight for the very much coveted first-class certificate. No doubt this assertion sounds rather vague, but weigh in the balance the number of plants above 2,000 H.P. and the number of first-class certificates, and I am afraid you will find the second-class engineer is in the majority. This does not leave any field for the first-class engineer to work in.

I would like to make a few remarks on the letter of our friend "Anonymous," but please ask him to come out in the open. The war is over and there is no further need for camouflage. He has my sympathy in his fight to try and be an engineer. I myself, since my apprentice days, have had some rough roads to travel; but, nothing venture, nothing win, and the peak of the hill came rather late in life. I grant that the board expect a lot for their money, but those men who framed the laws — surely they are men who understand the game. I dare venture to state that there is not an engineer in Ontario twelve months from date who won't know the questions and answers of the grade they wish to pass for, and it not only raises the status of the engineer, but compels him to learn something they never would have learned before. I only wish the Province of Quebec was just as difficult, although in the old days, before our present regime of absurdity was inaugurated, my examination for boiler inspector took me eight days' sittings at five hours a day. I don't wish to take up too much space; our friend, the editor, may call me to account; but I feel I must now make a few comments on all letters in POWER HOUSE during the seven years I have been a subscriber to POWER HOUSE. Quebec has been a myth in its pages. I am afraid I don't agree with "Anonymous" in saying it does not take any more trouble to look after a 1,000 H.P. than a 300 H.P. Please remember that as the H.P. grows so does the responsibility, and, I am afraid, in many cases so does the grey hairs. His remark on the meanness of employers extracting the limit: Please remember, employers don't employ us for charity. We are a necessary evil, and it behooves us to be as near perfect as possible. The employer knows the laws, pays the standard wage — or should do — therefore he should get the standard man. If he employs a man to take charge of his plant, with a lower certificate, take it for granted he is studying the financial end of it, and it is from such as these we look to our engineers' laws to protect us.

I am glad he is working under a good chief. We all like to work under a good man, and if they are well trained we can always sit at the master's feet and learn something day by day, which will fit us to be good men also when the time comes for us to take his place. Now, "Anonymous," be of good cheer; give our editor a chance to make good his word in the many articles he has promised us; and, please, study them, and you in time to come will say, "I never thought I could learn so much in so little time."

The old bone of contention comes to the fore again: The chief operating engineer versus the consulting engineer. I don't think all the highly competent engineers will be driven into the consulting field; that branch in a few years will be extinct, because in the years to come every competent chief engineer will be his own employer's consulting engineer. The majority of employers in times gone by had the wool pulled over their eyes by the high-sounding words and great promises of the college consulting engineer, and the poor chief engineer got wrinkles and many grey hairs trying to do what the consulting engineer said could be done, until the employer began to think quietly, and say to himself, "What is wrong?" and when he found out a vacancy occurred. Mind, I speak from experience. What the engineer of the future will have to do will simply be to prove to the employer that the consulting man is a negligible quantity around his plant. In some of my later letters I may deal with a few vagaries of these same benighted gentlemen.

Now, Mr. Editor, I hope I have not tried your patience too much by my wail from Quebec; but I am in the field for a good argument, and I am the man from Missouri, so please show me where I am wrong.

HENRY WRIGHT.

Graded Certificates Are Satisfactory

THE writer below is quite satisfied with the graded certificate and is of the opinion that it will eventually raise the standard of stationary engineering.

The Editor.

I have read with much interest the comments on the Act which have appeared in POWER HOUSE, and I am very much surprised at the fault some engineers have found with it. We all know that everything has to have a beginning, and I am sure it is a step in the right direction, as it places the engineer in various classes, which is only just. We all know that engineers are not all good, nor all poor, so the only fair way to get a proper distinction is to grade them.

When a man has followed the business for a number of years and then cannot measure up to the proper standard he should drop out of line and make room for the man that has qualified and made a study of his business. This latter man is the one who should be given first place. We all know men who, while holding a certificate, should be out on the farm instead of being in charge of a steam plant and it is to be hoped that the graded certificate will weed out some of this class of would-be engineers.

A READER.

Man's Memory is a Treacherous Thing

THE use of textbooks for examination purposes is deprecated, but the use of a list of formulæ, likely to be encountered, has many good features, according to Mr. Carmichael.

The Editor.

I have read the various letters published in your paper with much interest. There seems to be a good deal of objection to parts of the new Act, and I think it is to be expected. No such Act as this can be perfect at the start, and it will probably be some time before such imperfections can be ironed out by amendment. One prominent objection refers to the fact that all engineers have to write the examination for the first-class certificate, and some of them for the second also, the objection being that men who, although knowing their business from coal pile to exhaust, cannot remember formulæ and such as they used to do. Others say that men who are now holding first-class positions and have held them successfully, should be granted the first-class certificate. Still another group would like to be allowed to use the textbook at examinations.

Dealing with the last first: I have written examinations using textbooks and have found them of very little use. An examiner can easily set a paper in such a way that the textbook will be of little use. It leads to lost time, and besides he considers himself justified in setting the most difficult paper he can.

The second group certainly have right on their side, but if we grant these certificates where are we going to stop, and how are we going to stop the objections of those who have not been granted certificates? The easiest way is the examination, and I think by following my suggestions dealing with the first objection most of the opposition to the examination route will disappear. These are as follows:

Very few men can remember a string of formulæ and they should not be required to do so. If an engineer understands and can apply a formula and has the textbook, that is quite enough. There are a few formulæ which are used so frequently that they will always be remembered. Now, if on examination the candidate is given a sheet with all formulæ likely to be required, he should recognize any one of them as a casual acquaintance at least. This will do away with all the time lost looking for it in "the book," and a man's mind is not cluttered up with a lot of stuff better stored in its proper place.

The first-class examination will probably be difficult enough, anyway, but having passed it you have a certificate worth while and one which, like a university degree, gives you a certain standing anywhere.

A. D. CARMICHAEL.

What is a Wop?

THE writer, in a pleasant way, takes exception to Mr. Noble's definition of the untrained engineer, and points out that the man with only practical experience may yet consider his position in the engineering field as one of dignity.
The Editor.

The probability is that this letter may never be published, for various known reasons. Firstly, being an initial effort in this direction, it may appear too crude for insertion; and, again, like all its predecessors, it may never be sent. We shall hope for whatever seems best. The reason underlying this effort is that a certain umbrage has risen within me through a recent statement made by your very esteemed contributor, Mr. James Noble. This gentleman is convinced that any man who doesn't understand the theoretical or technical side of engineering is a mere "wop," or laborer. Sir, our dignity is outraged; our profession (God save the word) is betrayed. As a matter of fact, if his assertion is correct, then the majority of the plants in Ontario are run by "wops." I imagine that, to the greater number, the deciphering of mathematics or formulas is about as easy as the reading of, say an American newspaper. It would certainly be interesting to know where those details would be acquired. Certainly not in the little schools amongst the woods where the bulk of our present generation got the three R's castigated into them. Then, whereas mathematics may appear simple to those who have obtained the fundamental principles in their youth, they appear immensely difficult to acquire in late life. But I would suggest that is not the end. We have men in any quantity who are ignoramuses regarding those things, but who would be mighty hard to beat around engines or boilers. As a case in point, if we have that type of man — trustworthy, ingenious, and probably with a long and meritorious record — are we to classify those individuals in the category complained of? Sir, there are no "wops" in this line of work. They have a complete right to the designation of engineer, be it good, bad or indifferent. As may have probably been remarked, the lines of inconsistency are peculiar. In reference and as an illustration, a mere girl goes to an institution for a short time and emerges with the "dignity" of a graduate nurse. Or if you can cram a young fellow through his examinations from which he may probably emerge with the title of Doctor, after which he don't require to renew it every year, but can make his fortune if it's only by making up bottles of colored water with abbreviated Latin inscriptions on the labels (which are usually copied), or makes good money writing prescriptions for booze in favor of deserving patients suffering from thirst. Still, he's a doctor, mind. But for the man in charge of a plant with all its varying phases, its manifold worries and its never-ceasing vigilance, unless he have the gift of technical education there is no dignity in his calling. He remains for all time a mere "wop." Sir, this letter is long; it is probably wearisome; but I should like to see a few letters from the many wops in Ontario if it was only to show that, in spite of their manifold educative disadvantages, they could still say in relation to their jobs: "My foot is on my native heath — my name's Macgregor!" With apologies,

A "WOP."

The "Wop" Defined

THE word wop as applied to the engineering fraternity, or at least to a certain portion of it, has aroused some little resentment, and in this letter Mr. Noble defines his position and makes clear just what was meant by the use of the term.
The Editor.

For the information of Mr. Henry Wright, whose letter appears on page 102 of the March 5th issue of POWER HOUSE, you might print the following. His definition of the meaning of the word "wop" as a fool is altogether wrong.

A "wop" may be described as a man without ambition; a man who is so well satisfied with his present job that he has no wish or desire to go any higher. He may be a man who is too careless or too lazy to study. He may have a quart of brains under his hair, but lacks the energy to work them any more than absolutely necessary to earn enough coin to buy food and a few other essentials.

He may be a man who believes that his own small amount of one lifetime's experiences equals that of thousands who have put their experiences into print, primarily to earn some good money, principally because they have a whole-hearted wish to help others who may not have had their particular experience. Therefore a wop is a wop.

Mr. Wright is somewhat inconsistent in his expressions. He mentions a splendid (does this mean an efficient and capable man, or does it refer to his character?) mechanical engineer absolutely devoid of technical education. I fail to understand how any man can be an engineer, either directing, designing, erecting, operating, consulting or assisting, or any other kind, without some technical knowledge. I can assure Mr. Wright that I have considerable technical and practical knowledge, and have yet to see the man who has too much of these things in combination.

Mr. Wright states that the majority of engineers do not take the trouble to study. I expect he is referring to the men in the Province of Quebec. If he had visited as many engineers in Ontario power plants as I have he would remark that the majority of engineers — in fact, every one of them — do study theory to a considerable extent. After talking with some hundreds of Ontario engineers I have failed to find one of them very much lacking in technical knowledge.

Further along in his letter Mr. Wright states: There is no chief worth a row of pins if he has not considerable technical knowledge. If Mr. Wright finds amusement in the troubles of the Ontario engineers who have a very difficult examination confronting them, his idea of amusement is different from mine. Some of our engineers may have difficulty in putting their thoughts clearly into writing, but they deserve credit for having the nerve to try. Believe me, the Engineers' Examining Board in Ontario will see that the law is carried out, no matter what their private opinion may be. It will not be "scamped," as it apparently is in Quebec Province, according to Mr. Wright's letter. Your correspondent does not believe in allowing second or third-class men to handle plants larger than the average cheese factory outfit. He should consider that in this Province large plants can not be handled by men with fourth-class papers, or no papers at all, as is done in Quebec, according to his information. I infer from his letter that he is up in years. I am in the same position, but we should consider the young fellows. If they are not encouraged to look ahead to a chief's position in a few years, they are apt to drop into a rut, or drop out of the engineering game altogether — in fact, become "wops" so far as engineering is concerned.

JAMES E. NOBLE.

The Crossley Cold Starting Oil Engine

This Engine Has the Advantages of the Diesel Engine as Regards Fuel Consumption and Starting Up From Cold and Also Possesses Other Advantages Not Shared by the Diesel Type—We Are Indebted to "Motor Ship and Motor Boat" for the Following

NOTHING is more satisfactory at the present time than the number of new features that are being introduced in the design of oil engines, and the completely novel types of motor which are in some cases being constructed. Generally speaking, users and many engineers are not fully aware of the importance of the changes being made, and particularly in one direction, in which what might almost be termed a revolution is being effected. This lies in the development of an oil engine which shall have the advantages of the Diesel engine as regards fuel consumption and starting up from cold, and shall, moreover, be a simpler type, costing less to build and being easier to run, whilst still being able to utilize any fuel which can be satisfactorily burned in a Diesel engine.

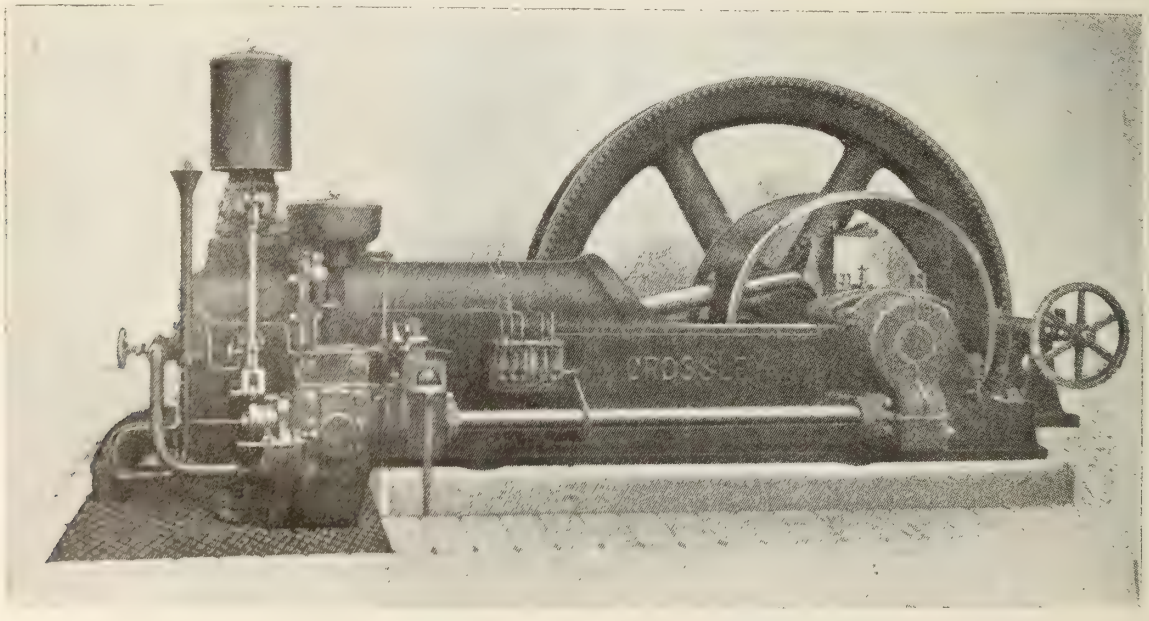
It may be asked how these advantages can be attained, for it is clear that if they are attained, the new type of engine becomes an extremely serious competitor to the Diesel motor. The answer is that by taking an ordinary oil engine of the four-cycle type of which so many thousands have been built by various manufacturers in this country, fitting a specially-designed combustion chamber (in which very efficient mixing of the fuel with the air gives perfect combustion), and increasing the compression pressure of this motor to a reasonable extent, it will be possible to produce an engine with all the advantages just outlined.

It need hardly be said that this new development will have a very important influence upon marine oil engine construction, and particularly from the point of view that the cost of manufacture will be largely reduced. The type is now being built on a large and standardized scale of production by Messrs. Crossley Bros., of Manchester, for stationary work, and although the motor which we are about to describe is of the ordinary horizontal land design, the manufacturers now have under consideration several sizes of marine engines for which producer gas and crude oil will be used. Exactly the same features will be incorporated in the engines as those which are now being dealt with in the stationary motor, and all the principles of operation will remain unaltered. We therefore make no excuse for describing an essentially stationary set, and hope at no distant date to give fuller details of the first marine engine built by this well-known firm.

It is interesting to know that Messrs. Crossley's first attempts at ignition by heat of compression were made as early as 1905, when an engine was constructed on these lines with an entirely water-jacketed combustion chamber, and in which the oil was injected directly into the water-jacketed combustion chamber by means of a cam operated pump and without the aid of injection air. The difficulty in those days was to obtain sufficient power and sufficiently clean working with residual oils to make the engine a commercial article. As Mr. Webb, their chief engineer, put it, we flirted outrageously at times with all kinds and combinations of methods of fuel spraying, governing, compression, turbulence, combustion chambers,, etc. (especially the etc.), but it was some years before all the details began to be perfected and the way made clear to obtaining high power, clean running, cold starting, low compression, simplicity and fool-proof parts and, above everything, reliable automatic working under all conditions.

The new engine was satisfactorily passing from the experimental into the manufacturing stage when the war broke out. The delay in production caused thereby was utilized still further to develop the principles on which the engine was built, and to put in hand designs and patterns for larger sizes.

The Crossley oil engines are made under the Crossley-Webb patents and are constructed for use with refined, crude and residual petroleum oils and with tar oils. They are of the four-cycle type, and are manufactured in various sizes from 10 b.h.p. to 130 b.h.p. per cylinder. The following description applies to all sizes except in minor particulars. The illustrations, which are taken from the drawings of the engine which was tested and reported on last year by Professor Burstall, are slightly modified so as to show as many points as possible in each figure. This engine had a cylinder bore of 18.5 ins. and a



EXTERNAL VIEW OF 130 H. P. CROSSLEY ENGINE

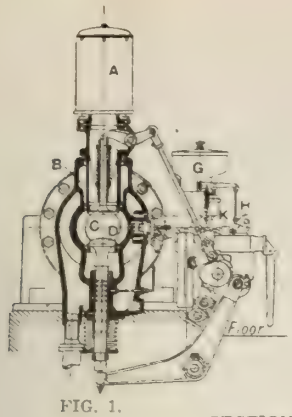


FIG. 1.

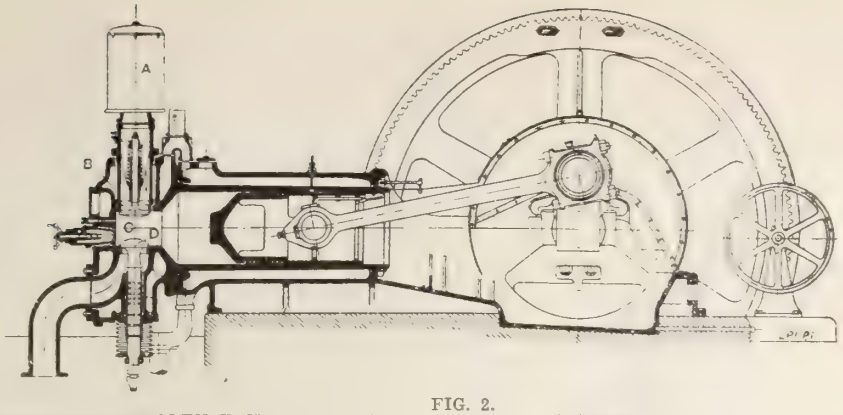


FIG. 2.

SECTIONS THROUGH CROSSLEY FOUR-CYCLE COLD STARTING ENGINE

stroke of 28 ins. and developed its normal load of 117 b.h.p. at 180 revolutions per minute.

Fig. 1 represents an end elevation of the engine in section through the combustion chamber. Fig. 2 is a front elevation of the engine in section through the cylinder. Fig. 3 illustrates the oil pump and oil control details, while Fig. 4 shows the construction of the oil heater as used for viscous oils. Figs. 5, 6 and 7 illustrate certain physical actions in the combustion chamber, and Fig. 8 is a reproduction from a photograph of the engine.

The engine works on the four-stroke cycle. On the suction stroke of the piston air is drawn through the air silencer (A), air valve (B) and combustion chamber (C) into the cylinder. Towards the end of the compression stroke of the piston, when the bulk of the air has been compressed in the combustion chamber (C) a charge of atomized fuel is injected by a pump (J) through the oil sprayer (E) into the compressed and heated air in the combustion chamber, where it is ignited and burned, the resulting increase in pressure driving the piston forward on the power stroke. The exhaust valve (D) then opens, and the burnt charge is driven out of the cylinder on the exhaust stroke of the piston, when the cycle of operation recommences.

Three extremely important operations, which are more of a physical than mechanical nature, take place in rapid succession during the cycle. These are illustrated by means of sketches in Figs. 5, 6 and 7.

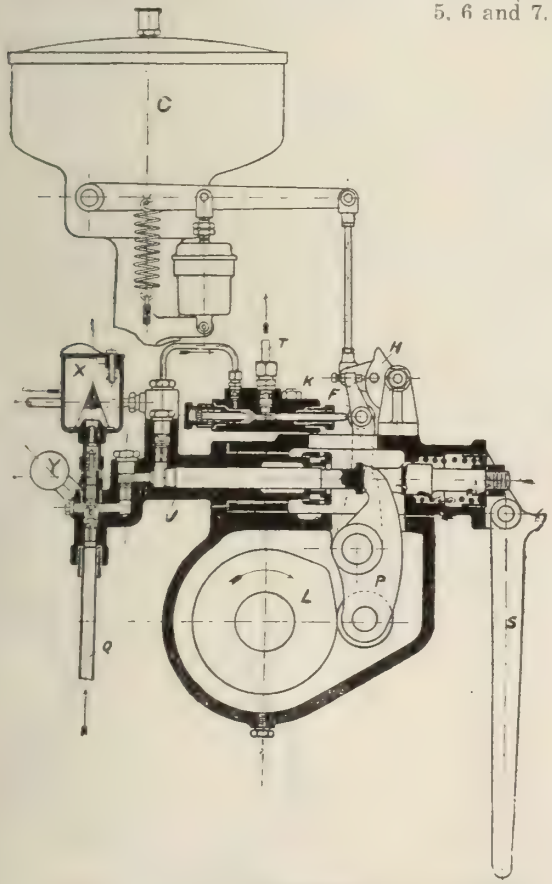


FIG. 3—PUMP MECHANISM AND GOVERNOR.

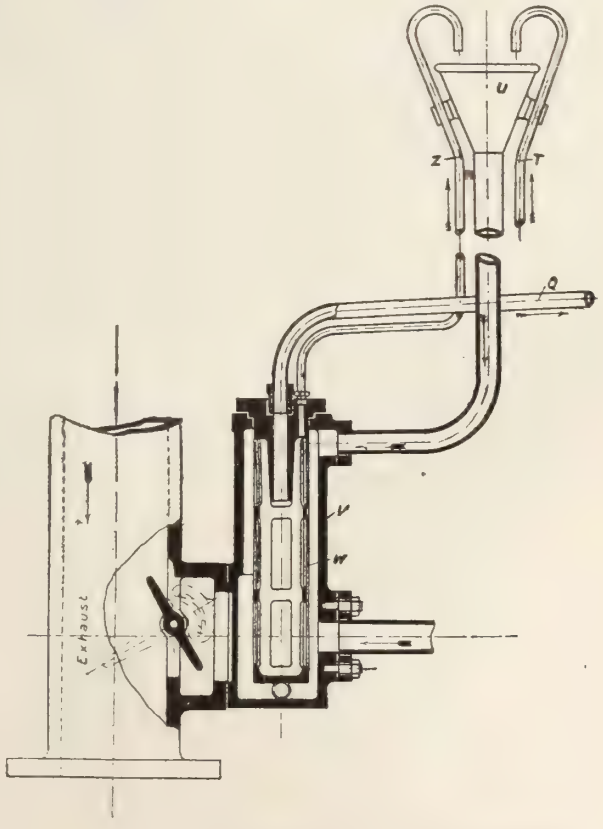


FIG. 4—DETAILS OF FUEL HEATER

1. The first of these three operations to note is the very complete scavenge of the burnt products which is effected in the well-known Crossley Atkinson manner which was introduced by the firm nearly 30 years ago. This scavenging action, which is illustrated in Fig. 5, takes place at the end of the exhaust stroke, when both the air admission and exhaust valves are open and when the inertia effects of the column of exhaust gases, passing out along the exhaust pipe, not only increases the volume of air in the combustion chamber but its cooling action also increases the weight of the contained air, thus enabling the engine to work on a cooler cycle and enabling a greater overload to be obtained.

2. The second of the three operations concerns the patent combustion chamber. It will be noticed that when the piston is at the end of the compression stroke the combustion chamber is very compact and concentrates the great bulk of the air in a very dense mass. This mass of hot compressed air is somewhat elongated in the direction in which the

oil is sprayed, the distance from the side of the combustion chamber whence the oil is sprayed to the extreme opposite side, as shown in Fig. 6, being greater than the distance across the combustion chamber. This is intentional and is done with the object of counter-

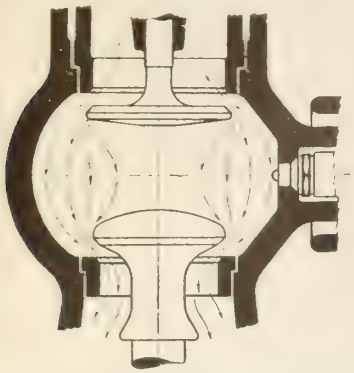


FIG. 5—ARRANGEMENT OF COMBUSTION CHAMBER AND EXHAUST AND INLET VALVES.

ing the tendency of the sprayed oil to cool the central zone of the air mass where the temperature is naturally greater. By making the chamber somewhat elongated the hottest zone of the compressed and heated mass of air is moved from the centre of the chamber to a point somewhat further from the sprayer, as indicated by a dotted circle in Figs. 6 and 7. It is claimed that this enables the degree of compression to be somewhat reduced (which is, of course, a very desirable feature) without impairing the efficiency of the engine. This claim appears to be fully justified by the fact that the engines can be started from the cold state with a compression of about 260 lbs. per square inch, which is quite a remarkable performance.

We ourselves saw the single-cylinder 117 b.h.p. engine described above started from the cold state, within a few seconds of giving the order, with compressed air at only 150 lb. pressure and from an air receiver of only 10 cubic ft. capacity. After three or four ignitions, from paraffin injected by the pump automatically, the fuel was immediately changed over to residual oil. After running for a few minutes the engine was stopped and was then restarted with residual oil (instead of paraffin) the pressure in the air received being 120 lb. per square inch.

3. The third of the three physical operations is that of the patented method of creating turbulence during combustion. It will be noticed that when the spraying of the oil into the combustion chamber is in full blast the projection or plug, shown on the end of the piston, enters the combustion chamber, as illustrated on Fig. 7, and the imprisoned air in the cylinder is forced through the space between the plug and the chamber walls, thus creating considerable turbulence in the chamber and having a marked effect in improving the processes of vaporizing the oil, of mixing the fuel with the air, and of burning the mixture. It will be noticed that the turbulence takes place mainly in the neighborhood of the walls of the chamber and that the hot "zone" is intentionally less affected until after ignition takes place.

We have dealt at considerable length with the effect of the special shape of the combustion chamber and the piston head, as we believe it is largely due to the design of this part of the engine that the somewhat remarkable results can be achieved. In our opinion, too little attention has hitherto been paid to the question of the correct design of combustion chambers in all types of oil engines, including hot-bulb and Diesel motors, and some of the poor results, both from the point of view of operation and fuel economy, that have been met with in the past, are, we feel, undoubtedly due to defective design of combustion chambers. This is more particularly the case in regard to Diesel engines in which the system of solid injection is employed, and if designers paid more attention to this point, it is possible that better results would be achieved with this system.

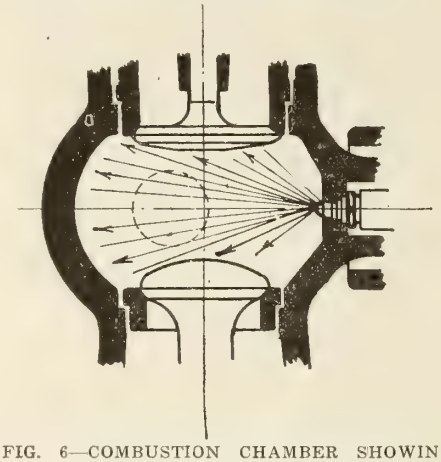


FIG. 6—COMBUSTION CHAMBER SHOWING ACTION OF FUEL UPON ENTRY.

The patent fuel pump and governor gear are particularly interesting. The plunger of the fuel pump (J) is actuated by the lever (P) from the cam (L) on the layshaft, the oil, which is drawn from the pipe (Q), being supplied to the spray valve through the pipe shown. In order to vary the amount of fuel supplied according to the requirements of the engine, part of it is by-passed through the by-pass valve (K), the amount so by-passed being controlled by the governor (G). The opening of the control valve (K) is effected through the floating lever (F), which is pivoted at its bottom end to the lever (P), operating the pump. It will be noticed that at the upper end of the floating lever it rests against a quadrant (H), which is shaped like a cam, and the position of which, relative to the floating lever is controlled by the governor (G) through vertical and horizontal levers. As the governor balls rise and fall therefore, the upper end of the lever (F) is moved to and fro, thus altering the position of the control valve plunger. When the pump plunger is actuated by the cam (L), the upper end of the floating lever becomes the fulcrum, and, the position of this being shifted by the governor, the control valve is opened at variable times, according to the load and speed of the engine.

The hand lever (S) is for priming the pump with oil before starting, whilst the cup (X) is filled with paraffin for use when starting up on cold mornings, a very small quantity of this fuel being necessary. The lever (Y) is merely a change-over lever, which allows the fuel to be drawn from the cup (X) instead of from the supply pipe (Q). Before the oil fuel passes to the fuel pump, it is taken through an oil heater, heated by means of the exhaust gases. The amount of heat can be varied by means of the butterfly valve seen in the illustration, and if no heat is required, as is frequently the case with certain oils, the exhaust gas passes straight through without impinging upon the heater. This heater is fitted with a vent pipe at the top (Z) in case the heating causes vapour to form, and there is a large strainer (W) for straining the oil.

It should have been added in connection with the description of the oil pump that the oil fuel which is by-passed through the control valve instead of passing to the spray valve is directed back to the tundish (U), and thence to the oil heater. The advantage of this is that the oil flow can always be seen, thus showing the attendant that the pump and governor are operating freely.

The starting air valve is located right at the back of the cylinder, as seen in Fig. 2, and when shutting down the engine, a screw valve is opened in the oil delivery pipe between the fuel pump and the spray valve. The whole of the oil is then delivered to the tundish so that the supply to the engine stops, and it consequently shuts down.

Comparison of the New Engine with a Diesel Motor

The fuel consumption of a 117 h.p. oil engine of this type, as tested by Professor Burstall recently, was only 0.425 lb. per b.h.p. when using residual oil with a calorific value of 18,000 B.Th.U. per lb.

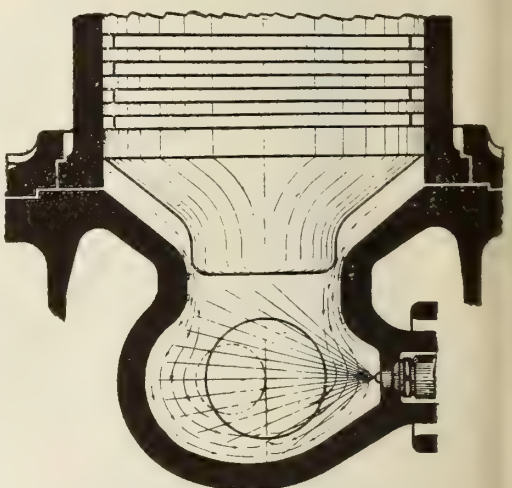


FIG. 7—COMBUSTION CHAMBER AND PISTON—SHOWING WHIRLING EFFECT CAUSED BY SHAPE OF PISTON.

The manufacturers claim the following advantages for the new Crossley oil engine as compared with the Diesel motor:

1. The maximum pressure possible in the engine cylinder is 700 lbs. against 1,700 lb. per sq. in. These are, of course, abnormal pressures.

2. The scantlings are much lighter.

3. The general design is simpler, being more simple than a gas engine and producer plant.

4. There are fewer possibilities of danger.

5. Any ordinary mechanic or intelligent unskilled man can run the engine.

6. The mechanical efficiency is 85 per cent. against 75 per cent. of the Diesel.

7. The first cost is 35 per cent. less than that of a Diesel engine.

8. The weight per b.h.p. is 25 per cent. less than the Diesel engine.

9. Accessibility is superior.

10. Lubrication is less complicated.

11. No hand regulation is necessary.

Whatever Diesel engine builders may say in objection to these claims, it is clear that the new type of engine is one which is bound to have a considerable influence on the future of the marine oil engine industry, and in particular the lowness in first cost is of the utmost importance.

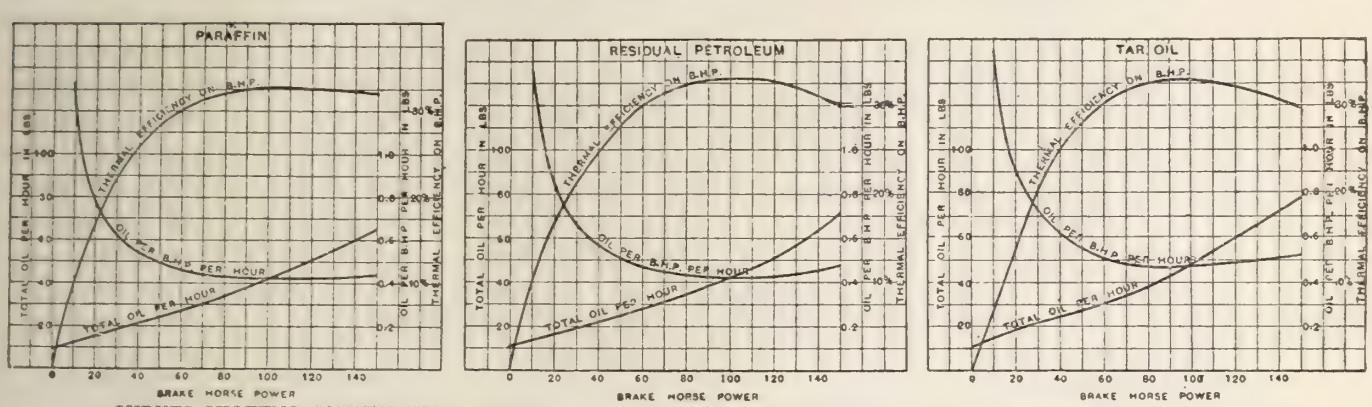
FILL UP THE BRIGHT OR THIN SPOTS

As the fuel does not burn at the same rate over the entire grate, thin spots will develop in any fuel bed. This difference in rate of combustion may be due to clinker, caking of the coal or difference in the sizes of coal.

The fireman should place the fresh coal on these thin or bright spots rather than cover the entire fuel bed. By doing so he will be able to keep the fuel bed level with little raking or poking.

NEW CATALOGUE

The James Morrison Brass Manufacturing Co., Toronto, have just issued catalogue No. 60, dealing with valves, fittings, and engineering supplies and specialties. The products of this firm are well-known to the steam, the heating and sanitary engineer, and the scope of materials and lines carried is shown in this catalogue. In its preparation The James Morrison Company have endeavored to include all the lines possible with details applying to each, in order that it may prove a complete and useful reference book for the trades in whose interests it has been issued. The standard catalogue size as defined by the Purchasing Agents Association has been closely adhered to and the convenient size of the book will be of much aid to its use.



CURVES SHOWING CONSUMPTION OF NEW 117 B. H. P. CROSSLEY ENGINE WITH VARIOUS FUELS.

THERMOMETER

By Walter L. Thompson.

3500	6330	Temperature of electric arc.
3500	6330	Carbon vaporizer.
3000	5400	Temperature attained by thermit.
2800	5072	Oxyacetylene flame.
2500	4532	Oxmium melts.
2225	4037	Iridium melts.
2231	4000	Heat in Bessemer furnace.
1710	3080	Platinum melts.
1530	2731	Wrought iron melts.
1400	2552	White heat.
1371	2500	Steel melts.
1200	2192	Orange red heat.
1100	2012	Copper melts.
1063	1981	Pure gold melts.
1050	1922	Cast iron (lowest) melts.
970	1778	Silver melts.
700	1292	Dull red heat.
625	1157	Aluminum melts.
405	762	(About) Coal ignites.
400	752	Red hot iron visible in dark.
357	674	Mercury boils.
316	600	Lead melts.
288	550	Gunpowder ignites.
215	420	Tin melts.
109	228	Sulphur melts.
100	212	Water boils.
79	174	Alcohol boils.
65	149	Fusible alloy melts.
61	142	Beeswax melts.
46	114	Paraffin melts.
44	111	Phosphorus melts.
36.8	98	Human body in health.
17	62	Mean temperature of sea.
10	50	Mean temperature of air (London).
0	32	Water freezes.
17.7	0	Mixture salt and ice.
38.8	34.3	Mercury freezes.
55	68	Greatest natural cold on earth. (Ant).
70	94	Balloon (9 miles high).
191	312	Air liquifier under normal pressure.
252	422	Hydrogen liquifies.
257	432	Hydrogen freezes.
260	436	Greatest art. cold produced by Devor.
278	49	Absolute zero.

REGULATE DRAFT BY DAMPER IN UPTAKE

Combustion or burning of coal is a chemical process in which the combustible combines with the oxygen of the air.

In order to have combustion it is necessary that a certain temperature known as the kindling temperature be reached and maintained. A fire is kindled to raise the temperature to this point; after the fire is started the heat produced by the combustion of the fuel maintains the temperature, and combustion continues as long as the proper amounts of fuel and air are supplied.

Combustion is an exact process; that is in order to burn one pound of a combustible, a certain definite quantity of oxygen is required, and a definite amount of heat is produced.

Since the oxygen required for combustion is obtained from the air, provision is made for controlling the admission of air to the fire so that the quantity can be regulated to suit the furnace conditions.

This regulation should be secured by the manipulation of the damper in the uptake or breeching, the damper being opened to increase the draft and allow larger quantities of air to enter when it is necessary to burn large amounts of fuel, and closed to cut down the draft when the demand for a heavy fire has ceased. The draft should not be regulated by opening the fire doors or by closing the ash pit doors. If the fire doors are opened the furnace is cooled off by the inrush of large quantities of excess air and heat is wasted. Closing the ash pit doors, of course, decreases the amount of air through the fire, but may also cause over-heating of the grates, and fusing of the ash on the grates into clinker. Another bad effect of closing the ash pit doors to cut the draft, without closing the uptake damper, is that excess air is drawn into the furnace through cracks in the walls or other openings in the setting.

The Khang; a Comparison Between Old and New

The Fuel Problem is One Which Concerns All of Us in Greater or Less Degree and While English Civilization May Think Itself Advanced, It Has Something Yet to Learn, Particularly as Regards Domestic Heating

By PADUS

SOME thirteen or fourteen years ago, a miners' strike in the United States, served as an excuse at least, for an increase in the price of anthracite coal to the consumer, and in particular to the Canadian consumer. I happened to know something of the conditions in the coal fields at that time, and my gorge rose at the thought, that I as a Canadian was to be compelled to pay a part of the cost of an American "Barons' and Peasants' War." I decided to stop buying American anthracite coal. It turned out to be something of a contract. I found a substitute, both cheap and effective, in gas coke, but neither cook nor furnace man, would use it, except under compulsion, and I am free to confess domestic calamities followed, and ructions were frequent and free, I persisted, and in the end no difficulty whatever was experienced in burning gas coke in an ordinary kitchen range and hot water furnace, and while it made in use more dirt than anthracite would have, it was an economical and a satisfactory domestic fuel.

Under these circumstances I was lead to give a good deal of attention to this question of domestic heating, and a great deal that the war scarcity has produced as new, is a very old story to me.

For instance "briquette," the patent fuel of the bunkers. Ten or twelve years ago, I reported on a briquetting plant and scheme for briquetting anthracite dust. The culm banks of the Pennsylvania coal region were to be purchased for a song, ground up, briquetted and turned into coal, at a four hundred per cent. profit. There was no doubt about the culm banks, in many instances they were owing to their size and position, limiting coal production, and the operators were being compelled to spend their profits in removing them. They were not made up of pure coal by any means, and had to be concentrated before they could be used. Then, after spending good money, in grinding, concentrating, binding, briquetting and handling, the product seemed to burn all right in a stove intendede to burn anthracite; up to the point where the briquette fell down in a mass of red hot dust. "Fuel consumption" stopped at this point, and gas production began. My crowd pulled out of the scheme, then and there, and I heard nothing more of it until I bought half a ton of briquettes a year or two ago, because nothing else was available, and the first night of frost, the old furnace resolved itself into a gas producer, the pipes froze, and as I couldn't buy coal, coke, peat or dry wood, I relapsed into a shelf dweller in a tabloid house or heated apartment for the winter. It would be more comfortable to hibernate, and I often wish that we had the secret of H. G. Wells' men in the moon, who put their surplus labour into cold storage, during "off time." My view of the matter is, however, that the strike, the war, etc., are not the cause of the coal scarcity. They are merely accidents that drive home the fact that the highly concentrated cheaply mineral anthracite coal deposits of the "valley" are becoming exhausted, and that these coals are no longer economical to waste, as domestic fuels. It is absurd to call the ordinary method of disposing of this almost ideal fuel, its use.

No other people ever had such a treasure, as the anthracite coal deposits of the "valley," and it has been squandered; as the white pine was squandered, as the virgin loam of the prairies is now being squandered, as the equally beautiful bituminous cooking coals are being largely squandered, and as a legacy this coal is leaving us the habits acquired in squandering it. Was it Mulvaney who asked: "Did you ever have a devil of a time and not have to pay for it Sor." The people of the winter snow regions of North America, have had a well nigh natural fuel to have a "devil of a time" with and now they will have to pay.

With ample supplies of Pennsylvania anthracite it was comparatively easy to design heating stoves and furnaces, that would keep up a continuous heat with comparatively little attention, and this was the end desired. That these appliances developed but a fraction of the heat giving resources of the fuel was a minor matter; the greatly desired thing was, that the fire should not go out, that the furnace could be kept stowed away in a corner of the celler, and the heat distributed by hot water or steam pipes, so as to produce the maximum effect in dehydrating the air in all the rooms of the house. Then, when the occupants of the aforesaid rooms felt a chill as the result of being in their turn dehydrated, the furnace draft was opened, more coal was thrown on the fire, more water was dried out of the air, more taken out of the unfortunates who breathed the air, and so on, until when the heat became unbearable, the drafts were all shut off the unhappy furnace The blazing anthracite not being allowed to get oxygen enough to produce C.O.2 produced C.O., and the resultant explosion was quite exciting, and furnished the society editor with paragraphs.

Of course, explosions did not take place every day, but the waste of coal never stopped, and even now that the cost of this waste has become apparent, it will not be stopped until about the time the coal has all been consumed.

On the American continent within the winter snow belt, the basis of domestic heating, is the slow combustion of fuel a continuous fire.

On the continent of Europe from the Rhine eastward to the Pacific, the basis of domestic heating is the Khang. The fuel is burned in such a way, that a large mass of non-conducting material is kept continuously heated.

In America we use a live coal, in Europe and Asia they use a hot brick.

The American method is based entirely on the anthracite coal of the valley; the most perfect of natural fuels. The European-Asia method uses anything that will burn, Legnite, peat, wood, brush, trash. The fuel of Seoul, the capital of Corea was pine brush.

I am inclined to think that the Khang in the form of the porcelain or soap stone stove of the North German Baltic-Scandinavian region, was much more likely to produce truly comfortable homes than the base burner or hot water furnace of North America, and it is an infinitely more economical contrivance. I am free to confess, however, that I have suffered more from cold in Scotland than I ever did anywhere else, (and I have been north of the timber line), but then, the British Islanders, had enromous resources in the most beautiful of cooking coal to waste, and if in North America we made a fetish of the radiator, in the British Isles, they made the "open fire place" an altar of Mollock, and sacrificed the immature, the weak and the aged thereon.

To add insult to injury is proverbially, to go the limit. The coal waste was surely injury enough, but when I think of how the Yankee bragged about his furnace, and the Britisher his open fire, I regret yet once again, I know not Arabic and have not the power of words to do justice to the occasion.

This is all very interesting, and to know and appreciate your neighbor's weakness and gaucheries, is almost as satisfactory as being the only man at the dining table in the saloon, the night you leave Belle Isle astern, but what are we going to do about it?

Tabloid houses, heated apartments for sooth, the conversion of a free man and a house holder into a shelf dweller, is not a remedy, it is simply shirking the disagreeable duty of tacking the problem

face to face, and it is only a solution for that very small portion of the population that can pay to be allowed to shirk.

Theoretically if tabloid houses could be built on a large enough scale to permit of the use of high pressure steam, mechanical stokers, and all the fuel economies of a good power plant, the city dweller could be kept warm economically enough, but this is a practical impossibility. In Glasgow or Edinboro, civic communities which have a common good and a civic conscience it might be tried but to think even, of such utopias in Montreal or New York, Toronto or Chicago, is out of the question.

We talk of the "stone age," and the cave dwellers. It will be lucky if our age is not called the "silly age" when men burned raw coal. The solution of all fuel trouble, is in the destructive distillations of coal in the mine, and it is not absolutely impossible that it would pay now. It certainly will in the near future. If all coal was "stilled" in the mine, the mine waste would be largely saved, the cost of mining reduced materially, and the products, gas, coke, tars, would be put to economical uses, not wasted as they now are. At present, it costs $2. to make, deliver and get paid for, a volume of gas-X, and the by-products are worth $1.00. The two dollars includes freight to the gas companies' plant, the up-keep of the gas distributing system, and the retailing expenses. If the gas works were at the foot of a mine shaft, it is quite possible, that the entire cost of distillation would be less than the value of the by-products, and the gas could be used for producing electric power that would compete with hydro power. It is quite possible, that the coal which now cannot produre economically ,the power, bunker fuel, domestic fuel, and by-products we require, would, if distilled, provide all these wants, (the bunker fuel in the form of oil) and the power would cost nothing, but its conversion into electricity at the mine heads. It is evident, however, that this system must be first tried out in a country like Great Britain or Belgium, where the distances are short, and there is a ready market for everything, power coke, bunker oil, chemicals, etc., in the vicinity of the mines, rather than in Canada where the coal is at the two ends of "the same fishing rods."

Up to the present, Canada's fuel problem has been that of New England, the winter snow region of America has been one unit, with no regard for frontier lines, but it is quite possible this must end, that the United States can no longer be relied upon for a supply of winter's fuel, and if exchange goes on falling, that the money to pay for American coal can no longer be supplied. There is Canadian coal in plenty, but it is concentrated on the Eastern and Western seaboard, and it is mainly a bituminous coal. The freight cost of supplying the coal required by Canada East of the Great Lakes from Nova Scotia, and Canada West of the Lakes from the Pacific, would be enormous, and the domestic use of raw bituminous coal present many difficulties. It would be necessary to redesign all the stoves and heating furnaces in the country, and if this must be done, it would pay to do more, to alter entirely the basis on which fuel is burned.

A great deal of wood is burned in Canada to this day, and the "'Khang" is coming into use, in a way. It is becoming quite a common thing in the rural districts to move the "big stove" into the cellar, and build a brick chamber about it, from which air pipes carry heated air to the different rooms of the house. The dirt from the stove is kept out of the house-wife's sight by this scheme, and although the brick work is generally used, as a substitute for metal work, because a metal worker is not available, still the heat is stored in the brick work while the fire is on, and given off when the fire is out. If this crude brick enclosure were developed into the "checker work" of the regenerative furnace, there would seem to be no reason why enough heat could be stored in the brick work of a furnace during the day, to keep any ordinary house comfortably warm during the night, and to prevent even the most severe frost from penetrating it. It certainly would if half as much attention was given to the heat insulation of the roof and the juncture between the earth and the building as is given to less important matters, double doors and porches for instance.

Such an appliance if in general use, would make for great economy in the use of wood as fuel.

The waste of the hard coal measures of North America has been prodigious, but hardly as great or as pitiful as the waste of hard wood. There is to-day a melancholy reminder of this waste in every creek or river that "runs red" with soil when in flood. The timber was chopped and burnt from the side of hills, and now, the water is washing the loam from these side rills to the sea, and the fertility of half a continent is being wasted.

I have before me a specification for cord wood and the hardwood forest of two counties in Ontario, were chopped to this specification in the fifties and sixties. Listen to this:

"All wood must be split from the body of the tree, to average 4 in. from scrap to point, no stick to be of unreasonable size, must be free from all crooked, crotched or knotty sticks, and cut from growing trees."

This means that about seventy-five per cent. of the wood growing on the chopped area would be left on the ground to be burnt for ashes. The cause for the specification was, of course, the desire to obtain fuel that would burn through the night. The cost of transportation was so great also, that it could only "pay" to haul the very best wood. I have burned a great deal of wood, and my judgment is, that there is little or no difference between branch and body wood or between poplar and hard maple. If the moisture content is the same, you get about as much heat per ton of wood, no matter what the wood is. A ton of poplar is very much more bulky than a ton of maple, as a matter of course.

If "Khang" the hot brick, were used instead of the iron stove, the live coal, for continuous heating, the quicker the flame, the more heat would be thrown into the brick, and it would be possible to use, faggots brush wood, straw, even for domestic heating.

The large house would require a system of heat distribution, but hot bricks will keep hot as well as hot iron, and the hot water could distribute the heat through the house, while in the smaller ouse the hot bricks would directly warm the air of the inhabited rooms.

It would appear therefore, that the "Khang" offers the most immediate and most available method of meeting the domestic fuel problem.

It would enable bituminous fuel to be burned with fair economy, or, at least with about the same degree of economy that is now obtained in power production, and that is an enormous advance on the ordinary house furnace practice of the day. If the under-feed grate is adapted, as it should be, the economy of fuel would be considerable. I have carefully considered the possibility of using powdered fuel. It would pay, but it would be practically impossible to devise an automatic fool-proof method of feeding coal dust in a small scale. There are no mechanical reasons, however, why the under-feed principal should not be applied to the modified Khang indicated.

It would make it posible to use wood, wood refuse, brush wood and straw for domestic heating, with economy and no loss of comfort.

It would make it possible to use wood, intelligent grappling with this question of domestic heating in all its bearings, and might lead to further developments.

Since Rumford's time there has been practically no attempt made by scientific investigation and research to improve our domestic apparatus, and Rumford's lessons have been completely forgotten.

I cannot close without pointing out that to burn wood raw is just as wasteful as to burn coal raw, wood distilled gives a great variety of useful products, and charcoal properly used is an ideal household fuel. A block of 300 miles square of Laurentian country would furnish Canada with all the fuel, she now buys in the form of hard coal, forever, and an enormous quantity of exportable chemicals, wood oils, etc.

HOW IT HAPPENED

Once a year the newsboys of a certain district of London are taken for an outing up the Thames by a gentleman of the neighborhood, when they can bathe to their hearts' content.

As one little boy was getting into the water a friend observed, "I say, Bill, ain't yer dirty!"

"Yes," replied Bill. "I missed the train larst year."

Autogenous Welding and the Steam Boiler

Some Examples of Fire Box Sheet Failures Are Given, Together With the Rules of the Steam Boiler and Fly Wheel Service Bureau

By T. H. FENNER, Associate Editor

AUTOGENOUS welding which has made such wonderful strides in recent years, has sometimes suffered severe set backs through wrong applications. By this we mean applications to jobs which were not suited for this particular method of repair. The failure of these repairs has destroyed the confidence of many people in the process itself, and has led to many unfair judgments. Autogenous welding, in which is included both the oxyacetylene and the electric arc process, is an excellent thing in itself, and has performed some wonderful work, cheaply and quickly. It has a field of usefulness in the steam power plant, but its limitations are better known now than formerly. A definite set of rules has been laid down governing the application of welding in boiler repair work, and should be carefully studied by all power plant engineers and owners. These are printed in full herewith, and should be kept on file for reference in case repairs of the nature mentioned should be necessary. These rules have been compiled by the Steam Boiler and Fly Wheel Service Bureau, New York, an organization which includes engineering staffs of all the large insurance companies on the North American continent.

Rules of the Steam Boiler and Fly Wheel Service Bureau

By "autogenous welding" is meant any form of welding by fusion, that is, where the metal of the parts to be joined or added metal used for the purpose is melted and flowed together to form the weld. Such welding is accomplished by the oxy-acetylene, hydrogen or other flame processes, or by the electric arc; no distinction is made between any of these processes. The general rule to govern the acceptance of such welds in insured vessels is that prescribed by the Boiler Code of the American Society of Mechanical Engineers, Par. 186, as follows:

"Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the welds."

FIG. 4—ANOTHER LOW WATER EXPLOSION IN WHICH TWO PERSONS WERE KILLED.

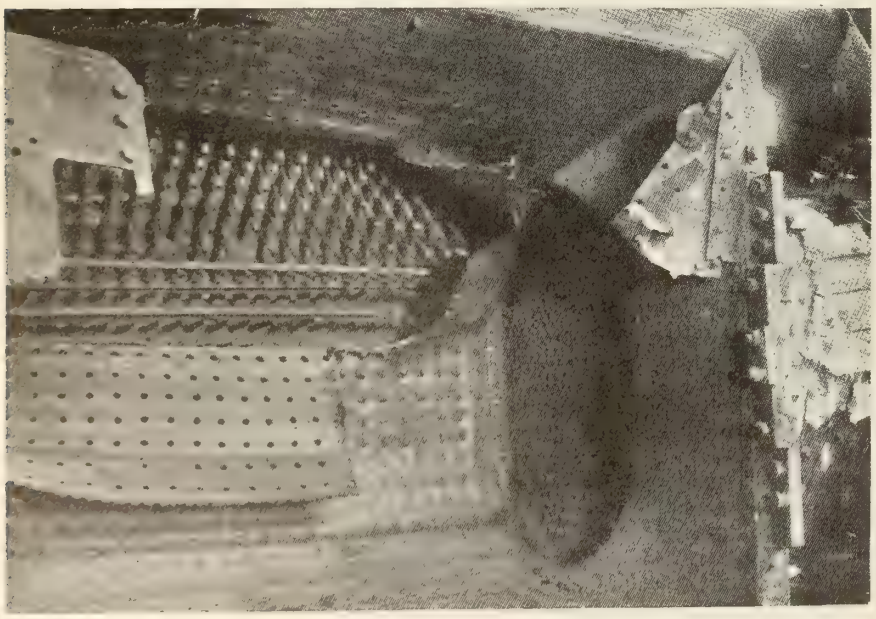


FIG. 1—RESULTS OF EXPLOSION CAUSED BY LOW WATER, IN WHICH THE WELDED SEAM BETWEEN THE CROWN AND SIDE SHEETS GAVE WAY.

The following illustrations will serve to point out where such work should be accepted or rejected.

1. Any autogenous weld of reasonable length will be permitted in a staybolted surface or one adequately stayed by other means so that should the weld fail, the parts would be held together by the stays. It is necessary for the inspector to use judgment in interpreting the meaning of "reasonable length" as given above, since it may vary in different cases. In the average case it should be not more than 3 ft. Autogenous welding will not be accepted in unsupported surface.

2. The edges of the inner and outer sheets of vertical firebox boilers or boilers of the locomotive type may be joined by autogenous welding to form the door openings, if the surrounding surfaces are thoroughly stayed. This would also apply to other openings of a similar character in such surfaces.

3. For low pressure, plate steel boilers operated at a pressure not exceeding 15 lbs. to the square inch, or for higher pressure in unfired vessels subjected to water pressure only, rectangular headers may be autogenously welded at the edges if the sheets are properly held together by stays. Autogenous welding of cracks

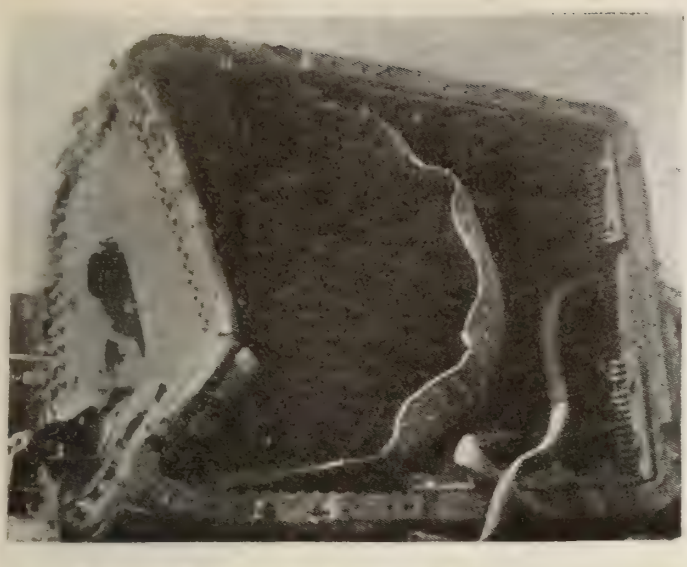


FIG. 2—FIREBOX INTERIOR SHOWING THE GENERAL CONDITION AFTER A LOW WATER EXPLOSION.

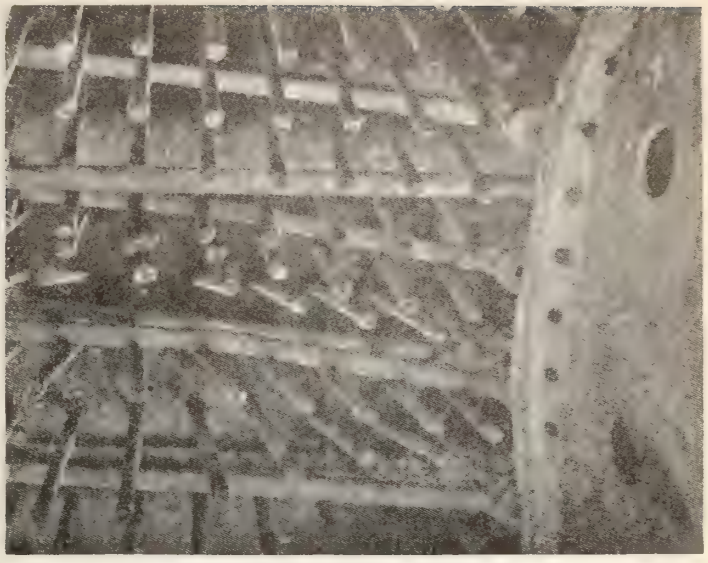


FIG. 3 THE BACK HEAD WAS STRIPPED AWAY FROM THE STAYBOLTS IN THE OVERHEATED AREA.

and fractures in cast iron boilers will not be permitted.

4. Fire cracks in girth seams extending from the edge of the plate to the rivet hole may be autogenously welded provided the cracks are properly prepaired by cutting out the metal at the crack in the form of a letter "V" to permit fusion through the entire thickness of the plates.

Similar cracks in girth seams located between the rivet holes may also be autogenously welded, provided the cracks do not extend beyond the edge of the lap of the inner plate. In the

FIG. 5—FIVE RIVETS AT LEFT END OF CROWN SHEET HELD WHILE WELDED PORTION FAILED.

latter class of cracks it is advisable to drill a hole not exceeding ⅜ in.. diameter at the end of the crack before the weld is made. Cracks extending from rivet hole to rivet hole on girth seams cannot be welded. the edge of the hole, the plate may be built up by autogenous welding under the following conditions: The original section of the metal between rivet holes and calking edge to be built up must average equivalent to ¼ of the diameter of the rivet hole and the portion of calking edge to be replaced must not exceed 30 in. in length in a girthwise direction. In all repairs to girth seams by autogenous welding the rivets must be removed over the portions to be welded and for a distance of at least 6 in. at each and beyond such portions. After repairs are made the rivet holes should be seamed before the rivets are redriven.

5. Stayed sheets which have corroded to a depth of not more than 40 per cent. of their original thickness, may be reinforced or built up by autogenous welding. In such cases the stays shall come completely through the reinforcing metal so as to be plainly visible to the inspector.

6. Where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist between the tube ligaments, autogenous welding may be used to reinforce or repair such defects. The ends of such tubes may be autogenously welded to the tube sheets. The above-mentioned repairs for tube sheets and the welding in of tubes in the sheets are not to be permitted where such sheets form the shell of a drum or boiler such as in the case of Stirling type of boiler.

7. When external corrosion has reduced the thickness of plate around handholes to not more than 50 per cent. of the original thickenss and for a distance not exceeding 2 inches from the edge of the hole, the plate may be built up by autogenous welding.

8. Pipe lines will be accepted where the flanges or other connections have been welded autotenously, provided the work has been performed by a reputable manufacturer and the parts properly annealed before being placed in position. Such welding when made with the part in place and un-annealed will not be acceptable.

9. Autogenous welding in patches in the shell of a boiler will not be

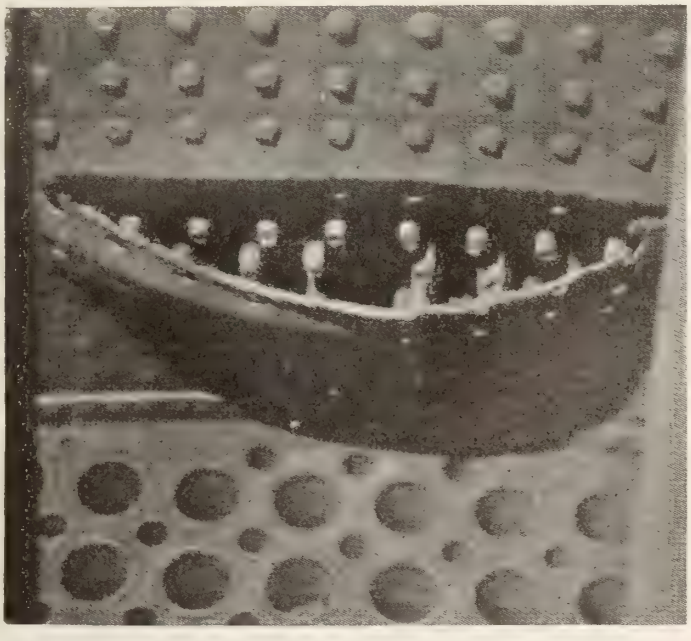


FIG. 9—FAILURE OF CROWN SHEET AT WELDED SEAM.

acceptable regardless of the size of such patches. Autogenous welding of cracks in the shell of a boiler—except those specified in Par. 4—regardless of the direction in which they may lie will not be permitted, unless such welding is only for the purpose of securing tightness and the stresses on the part i fully cared for by properly riveted—on patches or straps placed over the weld. The plates at the ends of joints may be welded together for tightness, provided the straps or other construction is ample to care for the stresses on the parts so welded.

10. Re-ending or piecing of tubes for either fire tube or water tube boilers by the autogenous process will not be permitted.

In connection with the above, we have before us the report of the Chief inspector of the Locomotive Inspection Bureau of the U.S., which contains some illuminating instances of boiler failures. The fact is brought out strongly that in the case of boiler explosions in boilers containing welded seams, 80 per cent. of these welds failed. The conclusion drawn by the chief inspector is that until the quality and tenacity of such welds can be determined in advance of their failure, they should be avoided in seams that are liable to be overheated.

An instance of the explosion of a locomotive boiler which blew up killing three people, is given. The locomotive at the time was hauling a freight train, and the force of the eplosion threw the boiler 165 feet ahead, where it rebounded and landed 230 feet from the scene of the accident.

The firebox was a new one, having been installed just two months previous to the accident. It was of the semi wide radial stayed type, the crown sheet supported by button lead radial stays pitched 4 x 4 inches. Side and crown sheets were of one-piece construction, door and flue seams being welded autogenously, without any riveting. The only riveted seams were those on the mud ring. The water at the time of the accidents was five inches below the highest point of the firebox crown sheet. The front end of the crown sheet, being three inches higher than the back end, would of necessity receive the most overheating, and would have supposedly failed first. However, it was the crown sheet seam that failed. The investigation was carried out by two Government inspectors, assisted by an assistant chief inspector, and their unanimous opinion was that the explosion was greatly intensified by the failure of the welded seam.

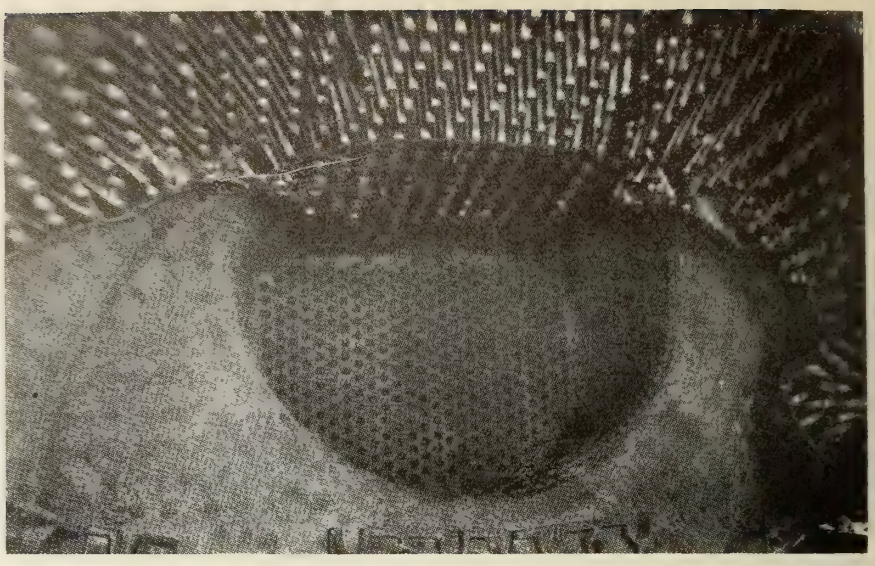


FIG. 6 WELDED SEAM IN CROWN SHEET FAILED IN THIS EXPLOSION WHILE RIVETED SEAM AT THE TUBE SHEET REMAINED INTACT.

Another case is given of failure due to low water. Some six months previous to this accident repairs had been made by putting in new radial stays, and had converted the longitudinal seams between crown and side sheets from riveted seams to welded seams. This had been done by cutting through the centre line of rivet holes and the sheets made flush. The sheets were then welded by the oxyacetylene proces, with the exception of five inches at each end. When the accident occurred these seams failed along the entire welded portion, the short riveted piece at each end remaining intact. The failure of these seams made the resulting explosion considerably more severe than would otherwise have been the case.

Another fatal accident involving the death of two people and the seriously injuring of three others, occurred through low water. The firebox in this case was a Wooten type, combustion chamber firebox, without a brick arch. The crown and side sheets were of one-piece construction ,the combustion chamber crown sheet seam being welded, and crown sheet supported by radial stays throughout. The initial rupture took place at the transverse welded seam, about 3 feet 2 inches back from the flue sheet. The crown sheet of the firebox was blown down, and carried with it part of both side sheets, which tore diagonally from each end of the transverse welded seam. The combustion chamber crown sheet remained intact, and the calking edge of the top flue sheet seam, was not sprung on either fire or water sides. This seam was two inches higher than the back end of the crown sheet.

Still another case was that of firebox boiler with crown and side sheets of firebox constructed of three pieces having riveted longitudinal crown and side sheet seams, without a transverse longitudinal welded seam. In this case the water line was ten inches below the highest point of the crown sheet. The intense heat that this sheet was subjected to may be gathered from the fact that rivet holes had stretched as much as 1⅛ inches in some cases. The sheet had pocketed between the stays to a depth of ¼ inch.

(Continued on page 143)

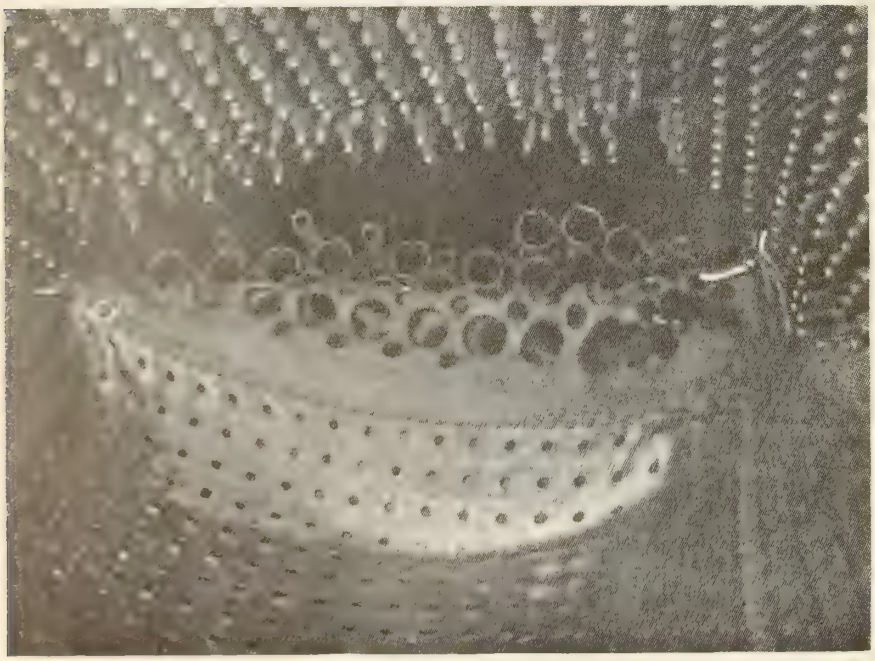


FIG. 7 COMBUSTION CHAMBER FIREBOX WITH THREE-PIECE CROWN AND SIDE-SHEETS WHICH FAILED WITH SERIOUS RESULTS.

Electrical Energy Generating Stations—III

The Third of a Series of Articles Dealing With the Design of the Power Plant. This Article Discusses the Adaptability of the Three Different Classes of Prime Movers for Different Services

By TERRELL CROFT
[Copyright; all rights reserved by the author]

THE TYPE *of prime mover which should be adopted for any specific installation* is, in general, principally a question of economics. Usually, that prime mover is the best one for a certain installation which will produce the energy in that installation at the least cost per kilowatt-hour. There are many elements which must be considered in such a determination of least cost. Some of these will be described briefly in the articles which follow. Figs. 17 and 18 show respectively the horse-power outputs of the prime movers used in central stations and industrial plants in the United States.

The Application of Steam Prime Movers should, in the case of very small installations, be restricted to locations where coal is very cheap and where water power is not available. In medium-capacity installations, say those of from 300 to 5,000 kw., steam plants may be more economical than internal-combustion-engine plants or those hydro-electric plants which require considerable capital expenditure for development. In large plants, where units of capacities of 5,000 kw., and upward may be utilized effectively, modern steam turbo generator energy generation will ordinarily prove much more economical than generation with an internal combustion engine. It will also prove more economical than hydro-electric generation

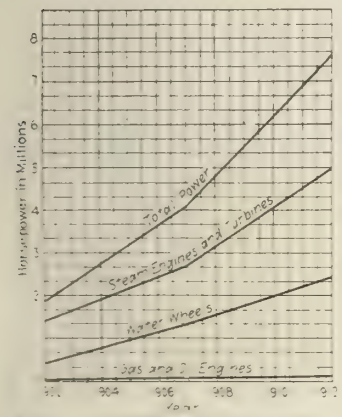


FIG. 17—PRIME MOVERS USED IN CENTRAL STATIONS. (From E. A. Lof, Coal Age, Feb. 6, 1915.)

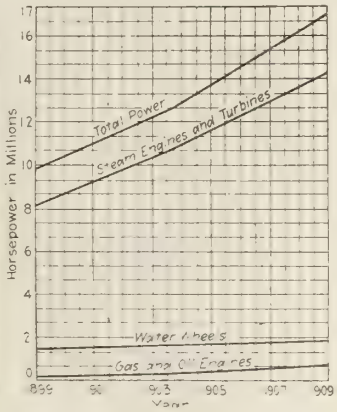


FIG. 18—PRIME MOVERS USED IN MANUFACTURING INDUSTRIES. (From E. A. Log, Coal Age, Feb. 6, 1919.)

and transmission unless the investment required to develop the hydro-electric properties is unusually small.

*NOTE**—"The progress of the steam turbine (Fig. 19) has been so great that it has practically displaced the gas engine. As the cost of the gas engine unit is probtically an unlimited supply of power. The steam turbine, the gas engine has been practically put out of the running insofar as large power plant work is concerned." "Another interesting side light in this matter is the value of the turbine as the general prime mover in competition with any thing else that could be cited. Fifteen years ago hydro-electric power developments were looked on as a choice investment worth lots of money with almost any cost of development. Water powers were developed that cost $200, $250 and $300. To-day you could not get money for an investment of that kind. The steam turbine has risen so high in efficiency and economy and decreased so much in first cost that it has driven out all possibility of developing many of these water powers. When you allow for the fixed charges, the steam turbine can make power more cheaply than the high-priced hydro-electric development." "Consider the case of Niagara Falls, where there are no dams required and where there is practicall an unlimited supply of power. The steam turbine plant can compete with Niagara power to-day, as long as the load factor of the Falls power is less than 50 per cent. The only chance for a financially successful water power development is on the basis of a high load factory."

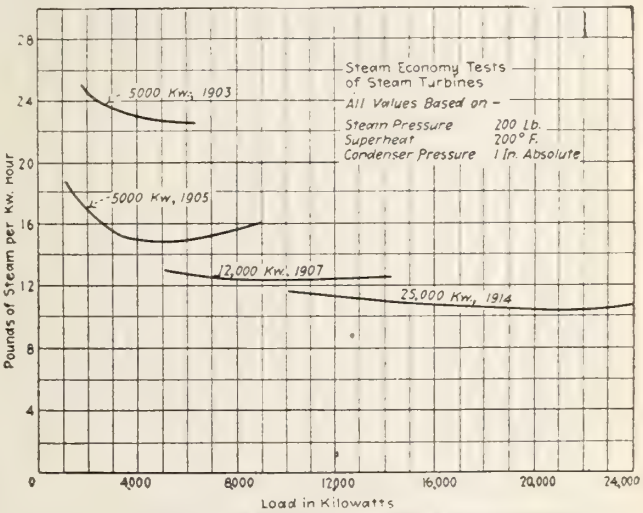

Steam Economy Tests of Steam Turbines
All Values Based on –
Steam Pressure 200 Lb.
Superheat 200° F.
Condenser Pressure 1 In. Absolute
5000 Kw., 1903
5000 Kw., 1905
12,000 Kw., 1907
25,000 Kw., 1914
Pounds of Steam per Kw. Hour
Load in Kilowatts

FIG. 19—GRAPHS ILLUSTRATING THE DEVELOPMENT IN ECONOMY OF TURBO GENERATORS. (Copyright by Samuel Insul.)

The Advantages of Large Turbo Generators are These:—It is possible to obtain as much as six times the output capacity in the same floor space, Fig 20. The first

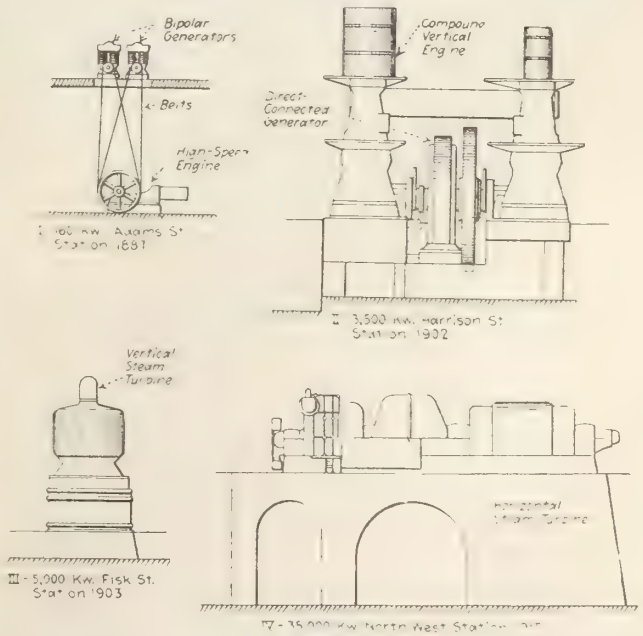


FIG. 20—FOUR TYPES OF GENERATING APPARATUS WHICH HAVE BEEN USED BY THE COMMONWEALTH EDISON CO. OF CHICAGO. (Copyright by Samuel Insul.)

*H. G. Scott, "Report of Efficiency on a 30,000-kw. Cross-Compound Steam Turbine," read before the 1916 annual meeting of the A.S.M.E.

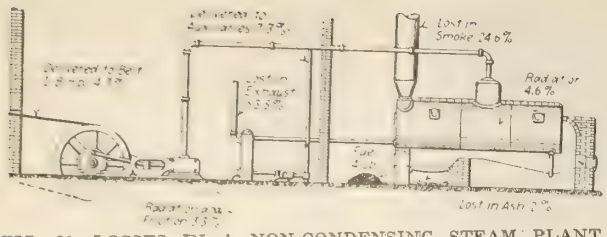


FIG. 21—LOSSES IN A NON-CONDENSING STEAM PLANT. (From "Producer Gas From Low-grade Fuels," Practical Engineer, Dec. 15, 1914, p. 1200.)

cost per kw. with the large turbo units is something like a fifth of the cost of equivalent reciprocating engine units. Furthermore, the water rates, that is, the steam consumptions of the large turbines, are in the neighborhood of one-half of the equivalent consumptions of reciprocating engine units.

Internal-Combustion-Engine Prime Movers are Effectively used at the present state of the art only in plants of small and medium capacity unless the cost of coal or of an hydro-electric development is unusually large. In small plants, say those up to 300 kw. in capacity, the internal-combustion-engine prime movers may, unless the

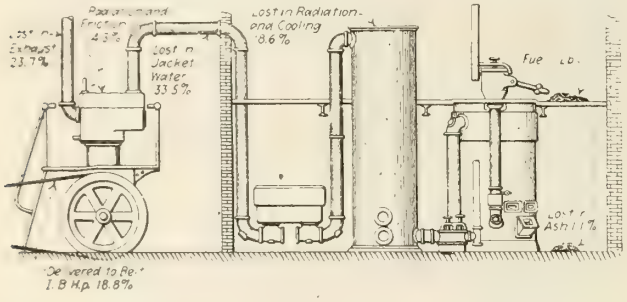
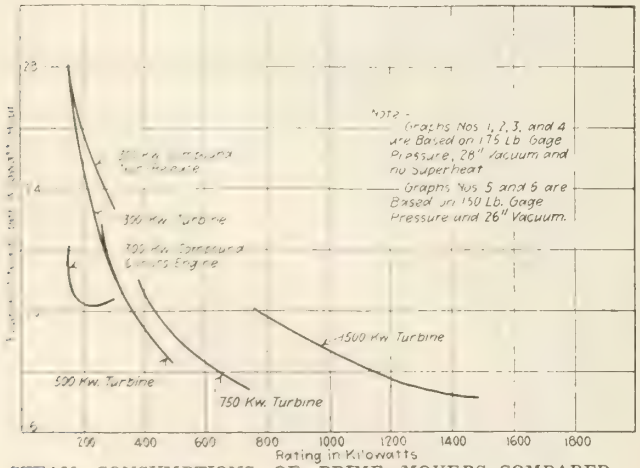


FIG. 22—LOSS IN A SUCTION GAS PRODUCER PLANT. (Practical Engineer, Dec. 15, 1914, p. 1200)

cost of coal is very low, be more economical than steam engine plants. This is particularly true of small plants which operate only a portion of the twenty-four hours. For a small central station plant which operates only at night or for a small industrial plant which operates only during the day, an oil or gas engine usually would generate power at minimum cost because such an engine does not involve the stand-by losses which obtain with the steam prime movers. As suggested in the above note, where a large power output is required, the internal combustion engine has been put entirely out of the running by the condensing steam turbine. If the cost of development is not excessive, it may be possible to generate power with a water-wheel—hydraulic turbine—cheaper than with an internal combustion engine. The producer gas plants, which are much more economical than ordinary non-condensing, medium-capacity steam-engine plant, (Fig 21 and 22) cannot usually compete with the condensing turbo-



STEAM CONSUMPTIONS OF PRIME MOVERS COMPARED.

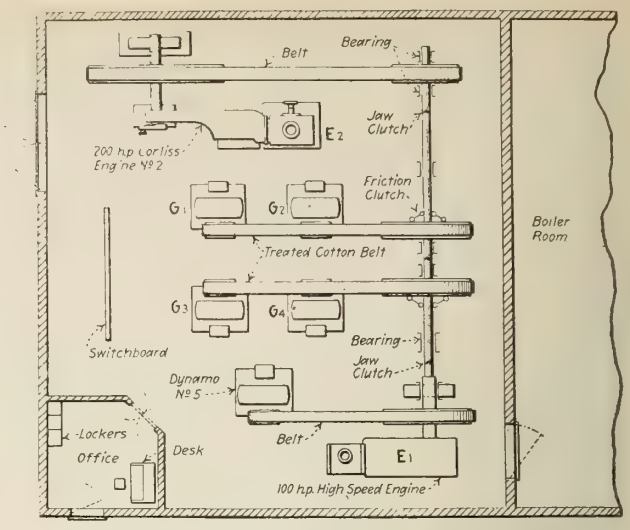


FIG. 24—LAYOUT FOR A SMALL BELTED PLANT DRIVEN BY A CORLISS AND HIGH SPEED ENGINE.

generator outfit unless the cost of fuel which may be used in the producer is very low.

Hydraulic Prime Movers are Most Economical where the cost of developing the hydro-electric plant is not excessive. It appears to be the common impression that merely because the water, which drives the turbines or water-wheel in a hydro-electric plant, costs nothing, that the cost of the power developed should be correspondingly low. This is far from the truth, because in determining the total cost of the power developed, it is necessary to include the fixed charges (interest, depreciation, insurance, taxes and the like) on the investment required to develop the hydro-electric property. If it is necessary to pay these fixed charges on an expensive dam and on a large real-estate investment required for the storage-water area, and then in addition pay the fixed charges on a long, expensive transmission line, such fixed charges may more than overbalance the cost of the coal and attendance that would be required by a modern steam station. The fixed charges on the transmission line should, usually, properly be in-

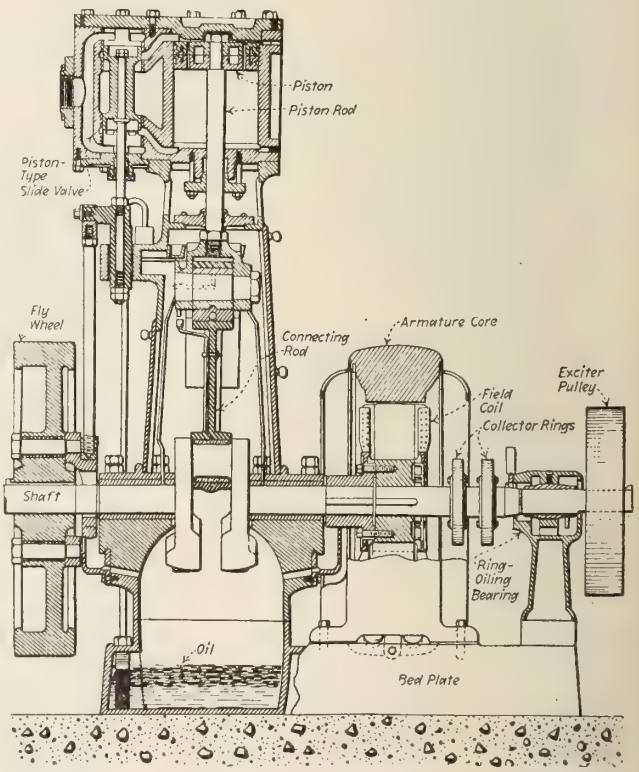


FIG. 25—DIRECT CONNECTED GENERATING UNIT. A HIGH-SPEED PISTON-VALVE ENGINE DRIVING A SMALL ALTERNATOR

cluded with those on the hydro-electric plant and development. Without the transmission line the plant would be useless.

The Development of Low-Head Hydro-Electric Plants is likely to involve excessive cost. On the other hand, if,

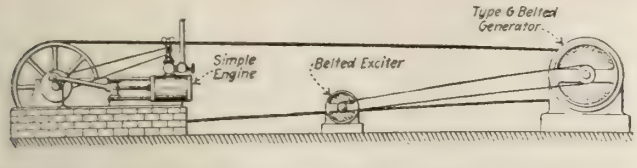


FIG. 26—A HIGH-SPEED SIMPLE ENGINE BELTED TO A SMALL THREE PHASE GENERATOR.

due to local conditions, it is possible to install a hydro-electric plant without incurring a large investment in dams, storage reservoirs and transmission lines, hydro-electric power may be developed very cheaply. Some of the high-head plants used in the West involve a relatively low first cost per kw. of capacity and, hence, can produce power very cheaply. Some hydro-electric plants for towns

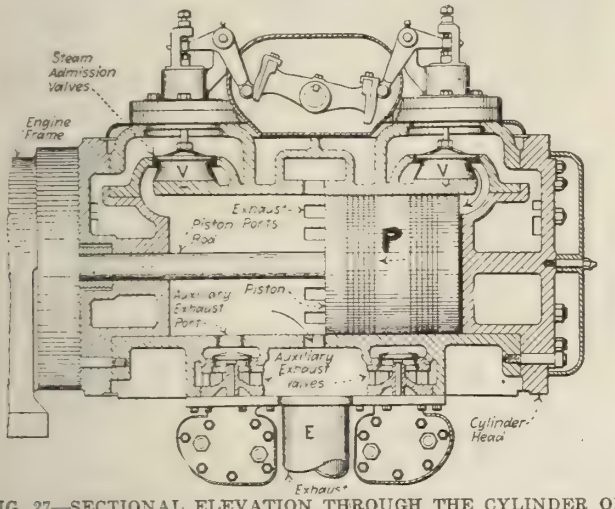


FIG. 27—SECTIONAL ELEVATION THROUGH THE CYLINDER OF A SKINNER-POPPET-VALVE UNIFLOW ENGINE. (FULL OPENING EXHAUST THROUGH CENTRAL PORTS.)

and factories are often economical where the plant can be located close to the load—so that a transmission line investment is not required—particularly if an expensive dam and storage reservoir is not necessary.

STEAM PRIME MOVER STATIONS.

Steam Plants May be Conveniently Divided Into Four Classes.* While there can be no definite dividing line, it is convenient to consider steam plants under four headings:— (1) *Small Plants,* to include all of those under 300 kw. capacity, (2) *Medium Plants,* to include those between 3,000 and 5,000 kw. capacity, (3) *Large Plants,* those between 5,000 and 50,000 kw. capacity, and (4) *Extra Large Plants,* which include those above 50,000 kw. capacity.

In Small Steam Plants it is usually considered good practice to install only one or two units. Often only one unit of suffcient capacity to carry the entire load is used. The graph of Fig. 23 indicates the water rates of some relatively-small steam prime movers. It will be noted that the efficiency at full load decreases rapidly as the size of

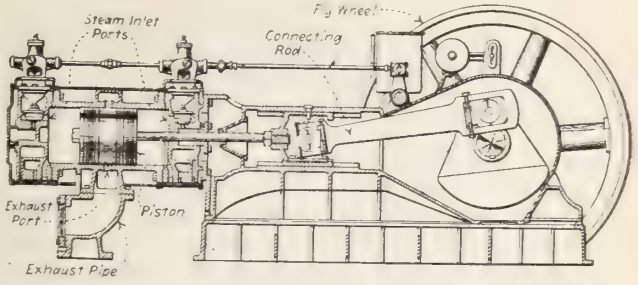


FIG. 29—SECTIONAL ELEVATION SHOWING CONSTRUCTION OF THE AMES-STUMPH UNIFLOW ENGINE.

the turbine decreases. It should also be noted that with all of the units, the efficiency decreases rapidly as the load on the unit decreases. Hence, it is desirable to use the largest units possible and to always operate them at as nearly full load as is feasible. Frequently it is desirable, in these small plants, to operate non-condensing because the fixed and operating charges on the condensing equipment may be such that its first cost is not justified. In such installations where simplicity and reliability of service are the most important factors, a high-speed engine of the slide valve or non-releasing Corliss-valve type may be used. Or instead, Corliss engines may be installed.

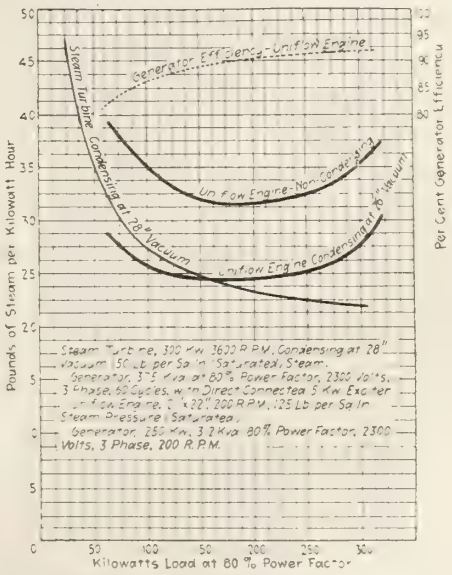

Generator Efficiency-Uniflow Engine
Steam Turbine Condensing at 28" Vacuum
Uniflow Engine-Non-Condensing
Uniflow Engine Condensing at 26" Vacuum
Pounds of Steam per Kilowatt Hour
Per Cent Generator Efficiency
Kilowatts Load at 80 % Power Factor

FIG. 30—CHARACTERISTIC PERFORMANCE GRAPHS OF THE UNIFLOW ENGINE. (From Characteristics of Uniflow-Generating Units, Electrical World, Feb. 10, 1917, p. 260.)

Non-condensing reciprocating steam engines are more economical than non-condensing turbines.

In Considering Belted vs. Direct-Connected Steam Engine Units for Small Plants, it should be recognized that the cost of the belted outfit is always lower than that of the direct-connected, because where the generator is belted it may operate at high speed—which involves low generator cost. If the generator is direct-connected to the engine, its speed must be the same as that of the engine, which is relatively low. Fig. 24 shows a typical belted in-

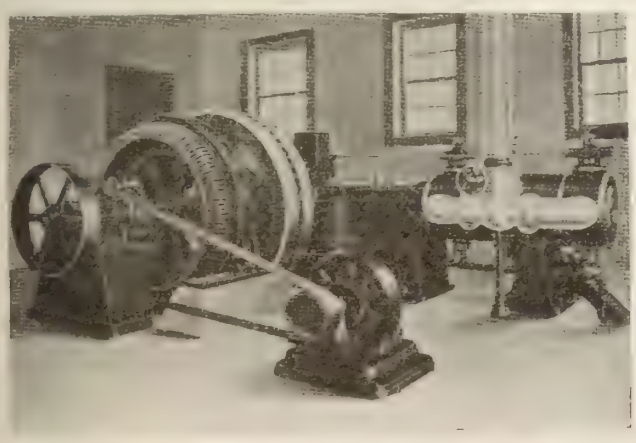


Fig. 28—An 18 in. x 24 in., 200 R.P.M. Ames-Stumph Uniflow Engine operating condensing at 141-lb. pressure, superheat approx. 100 deg., driving an Allis-Chalmers 2500-kv.-a 220 volt, 3 phase, 60 cycle generator, served by a 125 volt exciter. Installed in plant of the Winsor, Vt., Electric Light Company.

*J. W. SHUSTER, *"Tendencies in Central Station Practice," Electrical Review,* March 3, 1917.

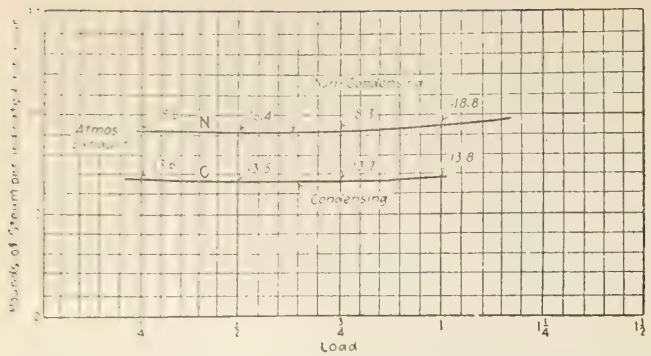


Fig. 31—Graphs showing water rates of a Skinner 21 in. by 22 in. Uniflow engine running non-condensing and condensing, saturated steam at 140 lbs. This and the next illustration are from data on engines which were direct-connected to generator of 200 true kw. capacity and would be considered 320 h.p. engines at normal full load. However, the engines are good for 400 indicated horsepower for maximum continuous operation.

stallation*. A high speed engine, *E*1, is direct-connected to the jack shaft from which the generators are belted. A Corliss engine is also belted to the jack shaft. Both of the engines are used to pull the station at time of peak load. At other times either the Corliss engine, *E*2, or the high-speed engine, *E*1, were used to pull the load, depending upon which could operate most economically. Small stations of this general character may give satisfactory service in towns where the cost of coal is low and

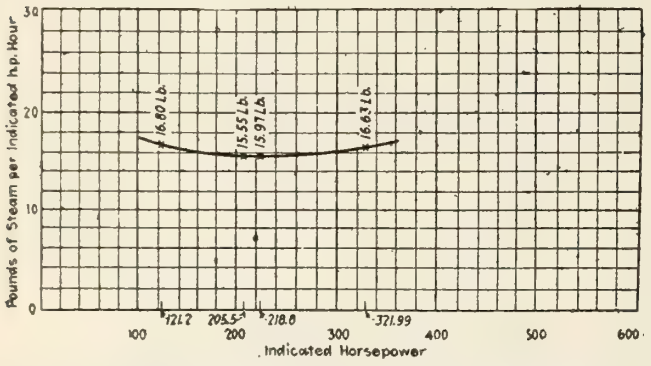


FIG. 32—GRAPH SHOWING WATER RATE OF A 21 IN. BY 22 IN. SKINNER UNIFLOW ENGINE OPERATING AT A PRESSURE OF 149.1 IBS. AND WITH A SUPERHEAT OF 102.5 DEG. FAH.

where reliability and ease of operation are of more importance than high economy.

A Small Direct-Connected Generating Unit, similar to that of Fig. 25, may be used where economy of space is an important factor. A unit of this type which is equipped with a small slide valve engine will not be as economical as one having an engine with an automatic cut-off valve gear.

A Small Alternating-Current Generator Belted to a High-Speed Slide Calve Engine is shown in Fig. 26. Units

*F. W. Salmon, "Practical Engineer," June 15, 1915

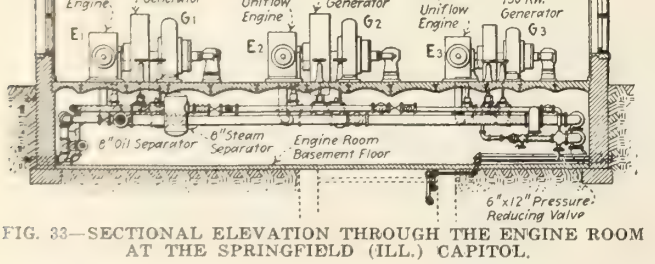


FIG. 33—SECTIONAL ELEVATION THROUGH THE ENGINE ROOM AT THE SPRINGFIELD (ILL.) CAPITOL.

of this character may be used in small stations where the cost of fuel is low and where an easily-handled outfit of very low first cost is imperative.

Uniflow Engines, which have been used in Europe for a considerable period, but which have only recently been thoroughly developed in the United States, afford economical prime movers for small units. A uniflow engine is one in which the steam (Fig. 27) leaves the cylinder at its middle point, *E*. The steam enters the cylinder through valves, V, at either end and is discharged through ports in the middle which are opened and closed by the cylinder piston, *P*, which acts as an exhaust valve. The economical performance of the uniflow engine is due to the fact that cylinder heads are always maintained at the same temperature so that there is little condensation in the cylinder. The steam alawys flows in one direction. With the simple

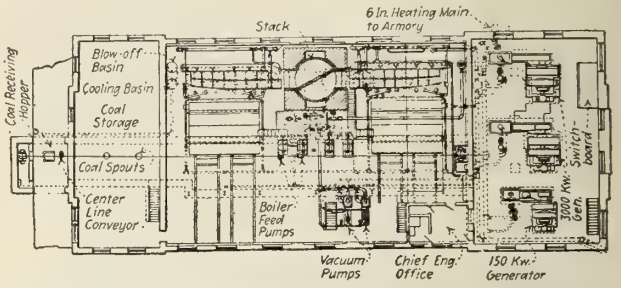


FIG. 34—PLAN OF THE UNIFLOW ENGINE PLANT AND THE BOILER PLANT IN THE SPRINGFIELD (ILL.) CAPITOL.

engine, each cylinder head alternately is heated and cooled as the steam is permitted to enter and exhaust from the cylinder. Uniflow engines can be used with superheated steam, which results in further economics. It appears that modern uniflow engines in capacities up to about 500 horsepower are as economical as any of the other types of steam prime movers. They can be obtained for both condensing or non-condensing service, or for combined condensing and non-condensing operation. Fig. 28 shows a uniflow engine direct-connected to an alternating-current generator which is served by a belted exciter. Fig. 29 shows the construction of an engine of the type reproduced in Fig. 28. Tests of uniflow engines operating non-condensing at 140 lb. boiler pressure have shown an economy of 30 lb. of steam per kwh. when operating at full load. Fig. 30 gives typical economy graphs for a uniflow unit as compared with a turbo-generator. It will be noted

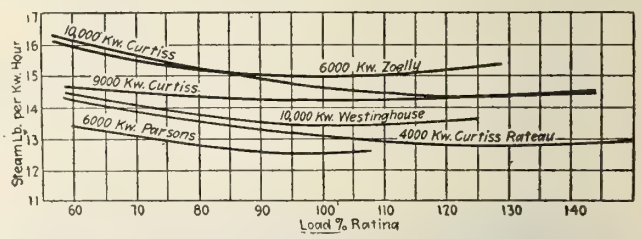


FIG. 35—WATER RATE GRAPHS OF SOME MEDIUM-CAPACITY CONDENSING TURBINES. (Standard Handbook.)

that the performance graph of the uniflow engine near the no-load point is almost horizontal. That is its efficiency does not change greatly with change in load, around the full-load point. This feature is shown in the performance graphs of Figs. 31 and 32.

A Uniflow Engine Installation is shown in Figs. 33 and 34. These illustrate the equipment used for supplying electrical energy to the State buildings at Springfield, Illinois. Three direct-connected engine-driven units are installed. Each unit comprises a Chuse-Poppet valve engine direct-connected to a Westinghouse direct-current generator. One 18 x 21 in. engine drives a 200-r.p.m., 150 kw., 125-volt generator Each of the other units is driven by a 22 x 28 in. engine, the generators being rated at 300 kw., and operated at 150 r.p.m. The 150-kw. unit is operated when the load is light—on Sundays and at

night. The present day-load is handled by one of the 300-kw. units.

Steam Turbine Stations have recently attained a position of great importance. This is particularly true of the stations wherein units of 20,000 kva. and greater capacities may be utilized. As suggested above, a modern, large, steam-turbine generates power, under ordinary conditions, more economically than can a prime mover of any of the other types. Steam turbines are now widely used even in capacities of under 500 kw. They are also because of their simplicity and reliability, used for driving the auxiliary apparatus in a station, such as condenser pumps and feed pumps. High steam pressures are desirable, hence pressures ranging from 150 to 250 lb. are encountered. Since superheating also increases the economy, the steam is usually superheated from 125 to 150 deg. High vacuums ranging from 28 to 29 in. are employed.

*Example** —A 500-kw. turbo unit, when operating on steam pressure of 150lbs. and 125 deg. of superheat and a 28-in. vacuum, has a steam consumption of approximately 17½ lb. per kwh. A 15,000-kw. unit operating at a steam pressure of 250 lb. with 125 deg. of superheat and a 29-in. vacuum, has a steam consumption of only 11½ lb. per kwh.

Why the Large Steam Turbine is so Economical may be explained thus: *First*, since no lubrication is necessary in the parts of the turbine with which the steam comes in contact, a higher degree of superheat is possible with it than with the reciprocating engine, for which cylinder lubrication is necessary. *Second*, when the turbine is used condensing, as it must be for maximum economy, the turbine utilizes the expansive power of the steam down to the highest vacuum which can be developed. The reciprocating engine can utilize the expansive power of the steam only down to possibly a 25 or 26-in. vacuum. If an endeavor is made with a reciprocating engine to expand the pressure of a high vacuum, the low-pressure cylinders and the reciprocating parts associated therewith would be so large that their cost and frictional losses would more than offset the theoretical economics resulting therefrom. It is evident, therefore, from the foregoing, that a much greater part of the total energy is the system can be realized with the turbine than with the reciprocating engine. Another factor which renders the turbine so economical, is its low first cost per unit of power output. This is because the turbine is inherently a high speed prime mover.

The Efficiency Graph of the Turbine is almost flat, Fig. 35. It follows that a turbine operates at good economy over a wide range of loads.

The Growth in the Capacities of Turbo-Generator Units has been almost phenomenal. As suggested in the graph of Fig. 36, single units have been manufactured having outputs of 60,000 kw. The manufacturers assert that there is no reason why units of greater capacities than 60,000 kw. cannot be built provided there is a demand for them. Fig. 36 indicates the gradual increase in the capacities of the generating units in the stations of one central station company.

A Comparison of the Steam Turbine and the Steam Engine as regards their applications is summarized in the following data* which relates particularly to units of less than 500 horsepower.

*NOTE**—*Applicability of Turbines.* (1) direct-connected units, operating condensing. 60-cycle generators in all sizes, also 25-cycle generators above 1,000 kw. capacity. Direct-current generators in sizes up to 1,000 kw. capacity. Direct-current generators in sizes up to 1,000 kw. capacity including exciter units of all sizes. Centrifugal pumping machinery operating under substantially-constant-head-and-quantity conditions and moderately high head, say from 100 feet up, depending upon the size of the unit.

Fans and blowers for delivering air at pressures from 1½ in. water column to 30 lb. per square in.

(2) Direct-connected units, operating non-condensing for all the above purposes, in those cases wherein steam economy is not the prime factor or where the exhaust steam can be completely utilized, and, in the latter case, particularly where oil-free exhaust steam is desirable or essential.

(3) Geared units, operating straight condensing or non-condensing for all the above mentioned applications, and in addition many others which would otherwise fall in the category of the steam engine, on account of the relatively-slow speed of the apparatus to be driven.

*J. S. Barstow, "Turbines vs. Engines in Units of Small Capacities," a paper read before the A.S.M.E.

Slag Wool For Covering Steam Pipes

The results of some tests on the efficiency of slag wool as a covering for steam pipes, carried out at the National Physical Laboratory, are forwarded by Messrs. Frederick Jones and Co., of Kentish Town. The test pipe used was a piece of 4-in. steel steam pipe, 13-ft. 8¼-in. long between flanges, and experiments were made with two thicknesses of covering (nominally 1-in. and 2-in), at three different steam pressures. With the thinner covering the saving of heat, as compared with the loss from a similar bare pipe, was 84.9 per cent., with a steam pressure (gauge) of 53.9-lb. per sq. in., 84.9 per cent. with a pressure of 109.2-lb., and 85.5 per cent. with a pressure of 256.3-lb. The results for the thicker covering was 91.8 per cent. with a pressure of 54.1-lb., per sq. in., 91.6 per cent. with 107.8-lb. and 92.5 per cent. with 258.9-lb. The principle on which the tests were based was that of measuring the weight of steam condensed in the pipes during one hour, two such one-hour runs constituting a test. There was no flow of steam through the pipes, except a very small amount due to the condensation; hence, in practice, where there is flow, the quantity of heat lost for the same difference of temperature between steam and air would not be the same as in the test pipe, but the efficiency figure will not be materially affected thereby, since it is the ratio of two tests under nearly identical conditions.

Storm Warning For Electric Plant

An article in the Scientific American Monthly—the new form in which the Scientific American Supplement is being published—gives an interesting description of the arrangements used in the Waterside power house, New York, to warn the staff of impending thunderstorms, which may have the effect of greatly increasing the load on the alpnt. Atennæ are mounted on the roof of the station and connected to an alarm. At a time varying from two to seven hours, depending upon whether the path of the storm is direct or roundabout, the bell may begin to ring, at intervals of from five to fifteen minutes, giving a warning of some distant atmospheric disturbance, indicating a storm possibly 100 miles away. This is regarded merely as a preliminary warning, for as the storm approaches the bell will ring more frequently. When about two hours away, the bell will ring about once every half-minute or minute; and when this occurs the reserve boilers are ordered into service and the auxiliaries of extra generating units are started and the generating units themselves may be run at low speed. The bell rings continuously about one-half or one hour before the storm reaches the city, and even at this time the sky may be unclouded to the eye, even of an experienced storm observer.

Erecting Boiler and Engine Foundations

One of a Series of Articles Descriptive of the Proper Methods of Design and Construction for Foundations of Various Types of Power Plant Apparatus

BY T. H. FENNER

ONE of the most important things for an erecting engineer, as mentioned at the conclusion of the last article, is to visualize the progress of events. To handle heavy and awkward masses, with the minimum of effort, and the maximum of safety, requires confidence in one's own ability, the capacity to exact instant obedience from the men on the job, and a cool head. Furthermore, never for the sake of saving a few minutes, take a chance on doubtful material. A rope or chain that you are not sure of, a plank that is on the light side, a piece of blocking improperly placed, can all bring disaster. Every man who has had experience in this kind of work can give you instances where taking a chance has delayed the job and injured men. Don't do it. Be sure everything is right, and then go ahead in confidence.

Let us suppose that the boiler is standing on a flat car, on a siding some little distance from the boiler room. It will very likely be on skids, and some of the mountings, such as safety and stop valves, may be in place. If there are no mountings on it, there will at least be the suspension brackets, which usually preclude any idea of rolling, which would be the simplest method. In handling a boiler of the H. R. T. type, do not forget that it is very easy, by carelessness, to flatten in a plate. A boiler dropped a short distance even, and landing on a narrow block, stands a good chance of having a plate dinged in. This applies more particularly to the boilers having plates of ⅜ in. and under. Therefore don't get the idea because the boiler is made of steel that it can be knocked round any old way. To get the boiler off the car, first make sure that the brackets are on good and fast, and the wheels well blocked. Build an inclined plane of timbers from the deck of the car to the ground, and make it long enough to ease the boiler down in handy fashion. The supports for this runaway at the car itself can be well made by a couple of good strong barrels, and at a short distance back start the blocking as additional support Now what size timbers will be needed to carry the weight of the boiler? Say the boiler and skids as they stand on the car weigh 20,000 lbs. If the timbers we are to run the boiler down are supported every ten feet, what size will they have to be to support the boiler?

Now in this matter of selecting timbers and blocking the average man is ruled by instinct, usually erring well on the side of excessive strength. This of course is good, but it sometimes happens the error is made the other way. Again useless labor is involved in lugging heavy beams around when smaller ones would do. The factors governing the size of the timbers are the breaking strength of the material, and the distance between supports. Now to handle a proposition like a boiler, you require a good broad surface for the skids to travel on at least as wide as the skids themselves. That is the factor governing the width. The depth will be the same, as square timber is usually the handiest. However, do not forget that the strength of a beam varies with the square of the depth. That is a beam 10×10 will have a breaking strength of $\frac{S \times 10^3}{6}$, while one of 10×12, with the long side vertical will have a strength of $\frac{S \times 10 \times 12^2}{6}$. In the first case the result is $\frac{1{,}000\ S}{6}$, while in the second it will be $\frac{1{,}440\ S}{6}$, a very respectable difference.

Suppose there are some 8-inch square timbers handy. The safe strength of timbers under a deflecting stress may be taken as 1,000 lbs. per square inch, giving a factor of safety as 9. Therefore an 8-inch square beam will have a safe strength of

$$\frac{1{,}000 \times 8^3}{6} = 85{,}333, \text{ say } 85{,}000 \text{ lbs.}$$

The weight of the boiler is 20,000 lbs., and this will be divided between two beams, 10,000 lbs. on each. What distance should the supporting blocks be spaced, or can they be spaced? Consider the load as a uniformly distributed load on a beam supported at each end. Then the bending moment, or the force tending to produce a deflection of the beams at the centre will be $\frac{W\ l}{8}$, that is W = weight, l = length in inches between supports.

When $\frac{W\ l}{8} = 85{,}333$ or $\frac{10{,}000 \times l}{8} = 85{,}333$, therefore $l = \frac{85{,}333 \times 8}{10{,}000} = 68.2664$, say 68 inches.

However the length of the skids is 20 feet so that the actual weight coming on the beams between supports at this distance would be much less than 10,000. We can safely place the supports 10 feet apart, because even then the weight would always be divided between at least three sections of the beam. The crushing strength of wood is about 8,000 lbs. per square inch, and allowing a factor of safety of 4 would be 2,000 lbs. Therefore any good square blocking, solidly placed, and wide enough to give a good landing for the beams will be suitable.

If the ground is soft, get some good wide planks and lay them down at the end of the runway to prevent the skids sinking into the earth. With hard ground this is unnecessary. Get several lengths of 2-inch iron pipe long enough to extend over the width of the runway and get two good pairs of chain blocks to check the boiler back as it goes down the beams. These must be secured to the body of the car, and the slings hooked up to the brackets on each side of the boiler. In this way they can be used for straightening up if the boiler tends to slide off to one side or the other. The strength of a rope ¾ inch diameter is roughly 2 tons. A good rough rule for the breaking strength of rope is circumference $^2 \times 720$. This applied to a ½ in. diam. rope would give $(.5 \times 3.1416)^2 \times 720 = 1{,}800$ roughly. This of course is the breaking strength and a factor of safety of 4 or 5 should be used, according to the condition of the rope. In fact, a higher factor than that can do no harm. In using blocks and tackle, be sure they are good enough for the job, and see every sling is made fast properly yourself. If there is a man on the job who knows more of handling tackle than you do yourself, let him run it and observe his methods. A faulty sling, a knot that slips, may mean valuable machinery damaged and loss of life or limb. Be sure.

Having rigged your runway, and got the checking tackle, or preventer guys, whichever you like to call them, made fast, the next step is to get the skid pried up at one end high enough to get a roller under. This may be done with bars, but on a heavy piece like a boiler, it will probably be necessary to use a jack. Lift the end of the skid nearest the runway high enough to run your pipe roller back to the centre of the boiler, and then stick another one in near the front end. Have a third ready to put in as the boiler moves along. You will need half a dozen at least. Once you have got the weight of the boiler on the rollers, it will be easy for three or four men with bars to move it forward. There is another point to watch. As the end of the boiler comes clear of the car floor, it will overhang the runway, but owing to the greater part of the weight being on the car will not land. It will have to come off the car far enough for the forward end to overbalance before it will tilt downwards on to the running beams. It is

at this point that you need to be careful. Take two pieces of iron pipe that will enter the tubes and put them in the two outside tubes (right and left) of the bottom row. Take two pairs of blocks, easy running rope blocks if you like, and make them fast to the car near the front end, making the other ends fast to a sling round each of the pieces of pipe. Heave short on these, and you can effectually prevent any sudden tendency to twist on the part of the boiler, and ease the descent of the overhanging end. Once you have got the skids on the runway with the rollers under them, it is only a question of easing away on your blocks till the boiler rests on terra firma. From there into the boiler house is a question of rollers and pinch bars, assisted by block and tackle wherever a purchase can be secured.

The boiler having been manoeuvred into position, and the steel work for suspending it being already erected, the lifting may be done by chain blocks or jacks. If chain blocks are available, they form the handiest method. A block is slung at each corner of the suspension girders, corresponding with the brackets. The blocks should be of 3 tons capacity each, and as the boiler is hoisted, it should be blocked up from underneath, so that the failure of any part of the lifting apparatus would not be attended by any harm. If jacks are used, four should be employed. The preliminary lifting may be done by blocking up under the brackets, and raising one end at a time till head room for the jacks can be secured underneath the skids. A jack at each corner makes the lifting easily controlled. When the boiler is high enough, insert the suspension bolts, and the job is complete. The brickwork can then be put in. In the next article something will be said about settings.

HAND FIRING SOFT COAL

IN ORDER to secure efficient combustion in any boiler furnace, the furnace must be correctly designed and properly operated. A furnace designed according to correct principles is ineffective without proper operation, and no fireman can secure the best results with a furnace unsuited to the kind and quantity of fuel burned.

In this bulletin, which is intended for the use of those in charge of hand-fired plants; mention only is made of some of the requirements of furnaces for burning soft coal, it being the purpose to explain those firing methods which practical experience has shown to be the most sucessful under average conditions in this state. While the particular methods of firing explained will not make it possible to obtain equal success in the operation of all furnaces or in the burning of all kinds of fuel, their adoption will give satisfactory results in most cases.

Cleaning Fires

On account of the fact that clinker and coarse ash will not pass through the grates, it is necessary to clean the fires from time to time.

In the side method of cleaning fires, one side of the fire is cleaned at a time. The good coal is moved to one side of the grate, with the hoe or slice bar and the exposed clinker and ash removed. After one side of the grate has been cleaned, the good coal is all moved to that side and the rest of the grate cleaned. The burning fuel is then spread over the entire grate.

In the front to rear method of cleaning the burning coal is pushed back to the bridge wall and the coarse ash and clinker removed, after which the coal is spread over the grate.

In many plants, especially small ones, the fireman has other duties, in addition to firing, so that large charges must be fired at rather long intervals. When such is the case, the coking method of firing should be used.

In the coking method, the fresh coal is fired at the front of the grate, after most of the live coal has been pushed back. A considerable area of live coal is left uncovered at the back of the furnace, so that the volatile matter from the fresh charge is burned in passing over this hot coal. The fire door should be cracked to admit the air required for combustion of the volatile matter. When the coal is coked it should be spread evenly over the entire fuel bed, and the fire door and fire door damper closed. Care should be used in spreading, not to stir up the fire.

Smoke Prevention

Smoke is caused by the presence of very fine particles of unburned carbon in the gases which pass out of the fire box. These particles are so fine that they are carried along by the slightest current and are able to float in the air for some time, finally being deposited as soot.

Practically all smoke is produced during the time that distillation is taking place, that is after firing fresh fuel. The products of perfect combustion being invisible gases, smoke appears only when combustion is incomplete, due to lack of air, imperfect mixing of air and gases, or cooling of the mixture before combustion takes place. Under these conditions, some of the carbon in the volatile matter is unconsumed and passes out as smoke.

It is often stated that black smoke issuing from a chimney for any considerable length of time is an indication that the full heating value of the fuel is not being utilized on account of furnaces improperly designed for the kind and quality of fuel being burned, or improper methods of firing or both. While this statement is absolutely true, the fact that a chimney is not smoking must not be taken as an indication of high furnace efficiency. As a matter of fact, this smokeless condition may be due to the dilution of the smoke by the admission of large quantities of excess air to the furnace. Every pound of air admitted to the furnace in excess of the amount actually required for combustion, simply decreases the efficiency of the furnace by absorbing heat and carrying it up the stack. Smoke prevention or rather dilution by this means is expensive.

The matter of furnace design is very important in burning coal having a large percentage of volatile matter. The combustion chamber must be designed to provide for the thorough mixing of air with the gases before they pass out of the chamber. In order to maintain a high temperature, the gases must not be allowed to come into contact with the comparatively cool boiler shell or tubes until combustion is complete, otherwise they may be cooled below the ignition temperature and pass out unburned.

These requirements are usually taken care of by having a combustion chamber of considerable length provided with a suitable fire brick arch or by covering part of the cooling surfaces (tubes and shell) with fire clay blocks. Many of the arches used serve two purposes—in helping to mix the gases and keeping them from being cooled.

The most common fault in the design of hand fired furnaces using Iowa coal is that the combustion chamber is too small. This is probably due in large measure to the installation of equipment designed for burning eastern coals, many of which are low in volatile matter, while Iowa coals often contain above 40 per cent. volatile matter.

MUST WEAR PANTS

'El Universal', the leading newspaper of the City of Mexico, has this remarkable dispatch:

Morelia, Mex., April 21.—The Mayor, Senor Idalecio Contreras, has just issued a public order by which he makes obligatory the wearing of pants by the male residents and visitors when passing through the streets of the town. The order directs that all persons who do not possess these articles of wearing apparel must provide themselves with these not later than May 5. Failure to comply with the order is punishable, and the offender must secure pants before released from custody. The Mayor specifies that the use of underwear will not be regarded as complying with the order.

AUTOGENOUS WELDING

Continued from page 136

From the above examples and the rules set forth by the Steam Boiler and Fly Wheel Service Bureau, the limits of usefulness of the autogenous welding process are clearly defined. It is evident that for building up corroded portions of plates, or ensuring a water tight joint, this method can well be used. In places where the full stress on the metal is liable to come upon the weld, without other support, it should not be employed. Even in such work as piecing tubes together it is not allowed, whereas one would have thought this was a legitimate field for the process.

It must be remembered that these rules have been drawn up from the experience of engineers, all of whom have had a wide field of observation. Power plant engineers and owners should read these rules carefully and keep them for reference.

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 39 Tenth Avenue West.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII TORONTO, March 20, 1920 No. 6

PRINCIPAL CONTENTS

Re the Ontario Graded Certificate 125
The Crossley Cold-Starting Oil Engine 128
The Khang; a Comparison Between the Old and New 132
Autogenous Welding as Applied to Boilers 134
Electrical Energy Generating Stations 138
Foundations 142
Editorial 144
New Equipment 146
Operators' Point of View 148

The St. Lawrence River

THE deepening of the St. Lawrence and its improvements for navigational purposes together with the vast amount of potential power waiting for development, render the work of investigation now being undertaken by the Joint International Commission of very great interest to both Canada and the United States.

It is evident that powerful interests are opposed to any development of this character, but it is evident that their opposition arises from selfish motives. The railroads, as might be expected, are putting forth strong efforts to have the project defeated, and it is interesting to note that some of the Eastern States, and cities along the Atlantic seaboard of the United States, have joined with them in opposition. It is true that were ocean-going ships able to reach the head of the Great Lakes, the immense grain trade from the West would be diverted, and thus lost to the railroads. This, after all, should cause them little worry since at the present time they are unable to handle it in anything like a satisfactory manner.

In shipping by an all-water route to Europe the saving on each bushel of grain would be no small item. And similar economies would be apparent in other ways.

When the power possibilities are investigated the magnitude of the river flow and its characteristics render a tremendous amount of power available. The mean annual flow at the head of the river is in the neighborhood of 241,000 second-feet, and owing to the effect of the Great Lakes which act as storage reservoirs, the flow is remarkably low. The maximum and minimum flows differ by only about 25 per cent.

Alexander T. V. Vogelsang, the First Assistant Secretary of the Interior, Washington, is the authority for the statement that the amount of theoretical power per foot of fall in the St. Lawrence River, as shown by the mean annual flow is 27,360 horse power, and as a total fall of 92 feet is available in the international section of the river, the theoretical power in that section is about 2,520,000 horse power. Assuming that only 70 per cent. of this energy can be made available on account of losses in head and influences of water wheels and generating equipment, this stretch of the river owned equally by the United States and Canada would furnish 1,764,000 horse power, or 882,000 horse power to each.

"About 95,000 horsepower of the portion belonging to the United States has already been developed by the St. Lawrence River Power Company by means of a canal which diverts a maximum of 30,000 second-feet from the river near the head of the Long Sault Rapids through the power house into Grass River which joins the St. Lawrence below the Long Sault Rapids. Here a head of about 40 feet is developed. After the power utilized at this development is deducted from the power of the portion belonging to the United States the power not yet developed in that portion of the river amounts to about 790,000 horsepower.

"As a horsepower is practically three-fourths of a kilowatt, 790,000 horsepower is equivalent to about 590,000 kilowatts. This amount of power is about one-third the total installed generating capacity of all the plants engaged in producing electricity for public use in the State of New York.

"If the development were so made that a certain amount of regulation of stream flow by storage in Lake Ontario were possible and if load conditions were adapted to the full utilization of all the power produced, it would appear that the share of the United States of the St. Lawrence River would be about 425,000,000 kilowatt-hours per month.

"The power possibilities of the St. Lawrence have therefore very large economic importance, and any plans for developing the river for navigation should make provision for the energy that it will afford. This provision can be made only by working out a comprehensive plan in which both Canada and the United States seek the best engineering and economic solution of the problem. No doubt private capital is available to make all this improvement in consideration of a grant of the power privilege, but," according to Mr. Vogelsang, "there is equally no doubt that this will not be done. Canada as well as the United States would not permit it."

Ask Yourself—

Am I hitched up right, or am I a round peg in a square hole?

Do I feel every drop of blood and every fibre in me tugging away at my ambition, saying "Amen" to my work?

Am I backing up my chance in life in every possible way, or am I sliding along the lines of least resistance?

Am I keeping myself fit to do the biggest thing possible to me every day of my life?

Am I working along the line of my talent, or am I getting my living by my weakness instead of my strength?

Am I strengthening my weak points, making my strong points stronger, and eliminating the things which are keeping me back, the enemies of my success?

Do I decide things quickly, finally, or am I forever on the fence, fearing to make definite decisions which I cannot reconsider?

Have I the initiative which begins things without being told to; which does things without waiting for others' instructions?

Do I dare to attempt the thing I instinctively feel capable of doing, and I know that I ought to do?

Have I the courage which dares to branch out in an original way, dares to make mistakes that may humiliate me if I should not happen to succeed?

Do I try to develop that bigger man back of the smaller man I am, by obeying the God-urge that ever bids me up and on to greater endeavor?

If you can answer the above questions in the right way, you will bring out a hundred per cent. of your ability instead of the fifty per cent. that the majority of young men are content to develop; you will attain your ambition and be what you long to be.—"Success."

Some Cane in Queensland

Queensland is an important producer of sugar cane, and in view of the world-wide search of natural vegetable sources for alcohol, the discovery of the utility of sugar cane in that direction is an important one for producers in Queensland. The official Journal of the Commonwealth Institute of Science and Industry says:—"The sugar content of cane varies very much, equally in the stems as in the tops. The amount will also depend on where the tops are cut off, whether they are to be left on the field to be ploughed in or taken to feed stock. If the threshing has been done some time before cutting, the green cane under the leaves ripens, and the cut is made just above the base of the last leaf. The percentage of hydrolisable sugars might be taken as 2.6 per cent. If a little more of the stalk is taken when cutting off the top, *i.e.*, below the last leaf, the percentage might rise to 4.6 per cent., or 5.9 per cent. as a maximum. The moisture would be about 70 per cent. One ton of cane tops should produce from 3.63 to 8.24 gallons of absolute alcohol, but varying up to, say, 7 gallons, depending on place of cutting off tops, ripeness of top, and variety of cane, etc. It is not very safe to generalize too much for calculation, and it is better to be on the conservative side and calculate on a rate of 4 to 5 gallons."

Conserve Your Boiler Tubes

THE power plant operator has little call to follow market conditions closely, and it comes as a shock to him occasionally that certain lines of supplies and repair part are almost unprocurable. Particularly is this true of boiler tubes and like products of the steel industry. This is no new thing, tubes have been scarce for some time, but a fairly good indication of the market at present for such material as seamless tubing, is furnished by the fact that several of the warehouses in Toronto are not able to correct the price list that is published elsewhere. It may be gauged from the other list that goes with it, viz., lap-welded. One firm volunteered the information that a 2-inch tube was worth 32 cents per foot at the present time. There is need for tubes, many of the cases calling for them being bona fide repair jobs that are badly needed.

Power From Peat

The high cost of fuel again raised the question of utilizing to a greater extent the large deposits of peat in Ireland, and it will be recalled that a report was issued some twelve months ago by the special committee appointed to inquire into the peat resources of that country. Meanwhile, successful results have been obtained by utilizing peat in gas producer plants, and at one works in Ireland it was stated that the quantity of peat consumed was equivalent to 2.78-lb. per i.h.p. hour, or, assuming 88 per cent. mechanical efficiency, 3.16-lb. per b.h.p. hour. Allowing 3-cwt. for banking, the all-round consumption was estimated as 3.5-lb. per b.h.p. hour, as an outside figure.

The peat used contained on the average about 25 per cent. of moisture, and it was calculated that by handling large quantities, and employing every practical labor-saving device, the peat could be won from the bog, dried, and be delivered for a radius of five miles into a generating station at a price which would not exceed 0.56 cents per unit of electricity generated. As against this it was stated that a modern steam turbine plant, operating at 160-lb. to 180-lb. pressure, 100 deg. F. superheat, and 28-in. vacuum would, under similar conditions of load, cost 0.84 cents per unit, with coal at $8.75 per ton, and that an anthracite gas plant would cost 0.72 cents per unit with anthracite at $11.25 per ton.— Engineering Supplement London Times, Jan. 20.

Still the World Goes On!

Progress in New Equipment

NEW RADIAL TYPE LOADER FOR RAPID AND ECONOMICAL LOADING OF LOOSE MATERIALS

In recent years the increasing use of sand, gravel, crushed stone, ashes, slag, etc., for road building, concrete work, and other purposes, as well as the increased storage of coal and coke, has caused the handling and re-handling of immense quantities of loose materials.

During the time that help was plentiful and cheap, the prevailing method was to use a gang of laborers to shovel materials from ground storage to wagons or trucks. However, the constantly increasing cost and acute shortage of labor demanded the substitution of mechanical handling machinery to replace the old expensive and laborious "hand shovel" method.

To meet this demand the Jeffrey Self-Propelling Loader was brought out about ten years ago, after extensive experiments and tests and careful study of the then existing conditions, being the first machine of its kind to be placed on the market, and has proved a remarkable labor saver and quick handler of materials.

It has been used with great success by hundreds of leading concerns, but in order to meet developments in the various industries and the constantly changing conditions, the Jeffrey Company has developed an improved design known as the Radial Loader, which overcomes all the objections of the old type of machine, and is the last word in design and construction.

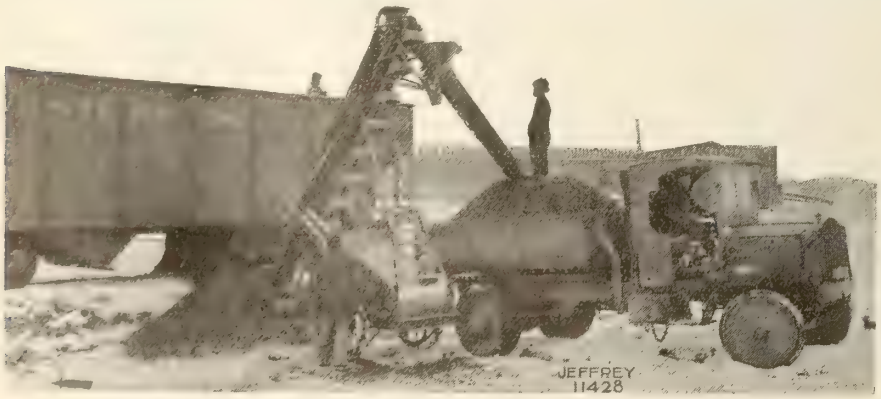
There is a great advantage in having the loader feed itself into the pile over other methods of hand shoveling or using a special mechanical device to pull the materials in front of the buckets. The greatest objection to the old 4-wheel type of Self-Propelling Loader was its inability to feed into the pile.

SHOWING THE EXTREMELY SHORT TURNING RADIUS.

The three-wheel construction of the Jeffrey Radial Loader enables it to move backward and forward along straight lines into a pile of material, or to cut wide swaths across the face of a pile by swinging alternately upon its driving wheels as pivots, which action is obtained through the use in its driving unit of a set of differential gears, the same as in an automobile, whereby the driving wheels act in conjunction with or independently of each other.

As noted in Fig. 1, Neg. 11291, by turning the steering wheel at quite an acute angle to the driving wheels, the discharge chute will remain practically stationary at the centre of the circle while the pick-up end of the extending elevator boom will travel in a circular path or by alternately reversing the propelling drive, the loader will oscillate back and forth in an arc. If the steering wheel is gradually turned through a few degrees either way from the above circular path, the whole machine, while cutting from right to left in an arc will gradually move forward into the pile, allowing full range of the machine. This illustration also shows the small radius in which the Jeffrey Radial Loader will operate.

The Radial Loader is designed to handle heavy materials such as crushed stone, sand, gravel, coal, etc. The large wheels enable it to pass over soft, rough or uneven ground, and it will rigidly maintain its equilibrium under all condi-



LOADING FROM CAR TO TRUCK.

FIG. 3—LOADING CAR FROM STORAGE PILE.

tions of ordinary rough storage ground or floor. The quickly adjustable loading boom makes the loader an ideal clean-up machine on both smooth and rough ground.

Buckets are designed for heavy service. 14-in. x 10-in. heay malleable iron buckets with renewable digger steel teeth riveted on front lips and ends protect it from wear.

The Radial Loader has a fast speed of 60 feet per minute for travelling from pile to pile, and a slow speed of 4 feet per minute for feeding into the material. Experiments have shown that a two-speed machine is absolutely essential to obtain the greatest result with the least labor.

The capacity of the Radial Loader is 1 cubic yard per minute. Will load crushed stone maximum size pieces through 2½-inch ring—maximum size coal 6-inch lumps.

The Radial Loader is equipped with either electric motor or gasoline engine. skilled labor is not required for its operation, and all controlling levers are in plain sight and in easy reach of the operator.

Fig. 2, Neg. 11400,Radial Loader handling material from storage pile to railroad car. The perfect swiveling chute makes it convenient to distribute material over a large area of car without moving the loader.

Fig. 3, Neg. 11428, leading direct from hopper bottom car into motor truck. An extra man has been placed in car to feed material through the hopper doors.

NEW PUBLICATION

In a pamphlet entitled "High Efficiency Centrifugal Pumps," the De Laval Steam Turbine Co., of Trenton, N. J., has described official tests made by the City of Minneapolis upon a 20-inch De Laval centrifugal pump driven by an induction motor, and similar tests made by the city of St. Paul upon two 12-inch De Laval centrifugal pumps driven by synchronous motors. The Minneapolis pump, which discharges 30,000,000 gal. per day against a head of 251.56 feet, showed a combined efficiency of motor and pump of approximately 82½ per cent., and a pump efficiency of 86 per cent. The smaller St. Paul units, pumping against heads up to 185 feet, showed over all efficiencies including pump and motor, of 78 and 78.4 per cent. respectively and pump efficiencies of 81.8 and 82.2 per cent. These performances, together with favorable contracts for electric power, have resulted in remarkably low costs for pumping water in each instance. This publication should be of interest to all who are concerned with the handling of water by electric power.

THE SOCIETY FOR ELECTRICAL DEVELOPMENT ENLARGE ACTIVITIES

During the war, the Society for Electrical Development was obliged to restrict its activities, although it continued throughout to do all its curtailed budget permitted, and carried on sufficiently to justify the subscriptions of those members who supported it. During the past three months so many of the big companies have resumed their membership, The General Electric Company, Westinghouse Electric & Mfg Co., Commonwealth Edison Co., Edison Electric Illuminating Co., of Boston, Consolidated Gas, Electric Light & Power Co., of Baltimore, Middle West Utilities Co., etc., that the funds available for the Society's work are over fifty per cent. greater than at the time of the November meeting of the Board of Directors.

Greater activities will be undertaken as justified by the increased revenue, and it is now desired to line up the entire industry in support of the very important work being carried on and contemplated. This work has for its main feature the education of the public to an appreciation of the uses of electricity for domestic and power purposes. No other organization is equipped to render this important service, the value of the continuation of which is far greater than the cost to the industry.

The Link-Belt Company, Chicago, have issued a leaflet descriptive of the Pratt Ballast Cleaner, which saves the work of four men in mechanically cleaning the ballast of railway tracks. The ballast is automatically excavated, screened and returned to the roadbed.

ANNOUNCEMENT

MR. F. A. COMBE, known to many readers in his former capacity of chief engineer for Canada to Babcock and Wilcox, Ltd., has severed his connection with this company, and is practising as consulting combustion and steam plant engineer with offices in the Southam Building, Montreal.

Mr. Combe's special study of problems relating to the boiler-room and his realization of the need for co-operation with operating engineers and management have determined his decision to devote his whole time to this work.

Mr. Combe was born in 1882 at Gorlestone, England, was educated at Framlingham, College; Bedford and Manchester Technical Schools, and served five years apprenticeship in the shops and drawing office of W. H. Allen, Son and Co., Ltd., Bedford. Following this training, he spent two years with the British Westinghouse Electric and Manufacturing Company on

MR. F. A. COMBE.

gas engine, erection test and outside trouble work in England, Spain and France, later returning to Messrs. Allen as chief assistant in the testing department.

Coming to Canada in 1907, he was associated for three years with various consulting engineers, having charge of the operation and remodelling of the Central Heat, Light and Power Company's plant, Montreal; Vancouver General Hospital, etc., with Messrs. Ross and Holgate; and of design and construction of the McGill University Power House, distribution systems, heating and ventilating of the McGill University Medical Building with Prof. R. J. Durley.

Since 1910, Mr. Combe has been with Messrs. Babcock and Wilcox, Ltd., during which time he has been closely connected with the majority of the large plants in Canada. Mr. Combe is a member of the Engineering Institute of Canada and also of the American Society of Mechanical Engineers.

The Operators' Point of View

NEW STYLE AND TRAP

This trap is somewhat out of the usual run of home-made affairs. I have been told that it works and gives excellent satisfaction. It is used for returning condensation from low pressure mains to a hot well, or elsewhere, by gravity.

A new point to me is the float with an open bottom. The body of the trap is made from a piece of large diameter pipe flanged top and bottom as shown, holes being drilled and threaded in the solid flanges where required.

On the end of the outlet pipe is the bottom part of an upright check valve, to disc piece of which check valve is attached a long rod a quarter of an inch in diameter. This rod should be of brass. Rests are attached to this rod at the top and at the bottom for the float to rest on.

The float is made from light sheet copper, with a copper tube soldered into the centre. The bottom of the tube is held central by four wires soldered to the tube and to the side of the float. The rod passes through this tube. The idea given me of its operation is that, as the water rises in the chamber it will gradually compress the air in the float, ultimately raising the top stop and opens the valve.

A large amount of the entrapped water will run out before the float starts to descend, thus allowing the valve to close.

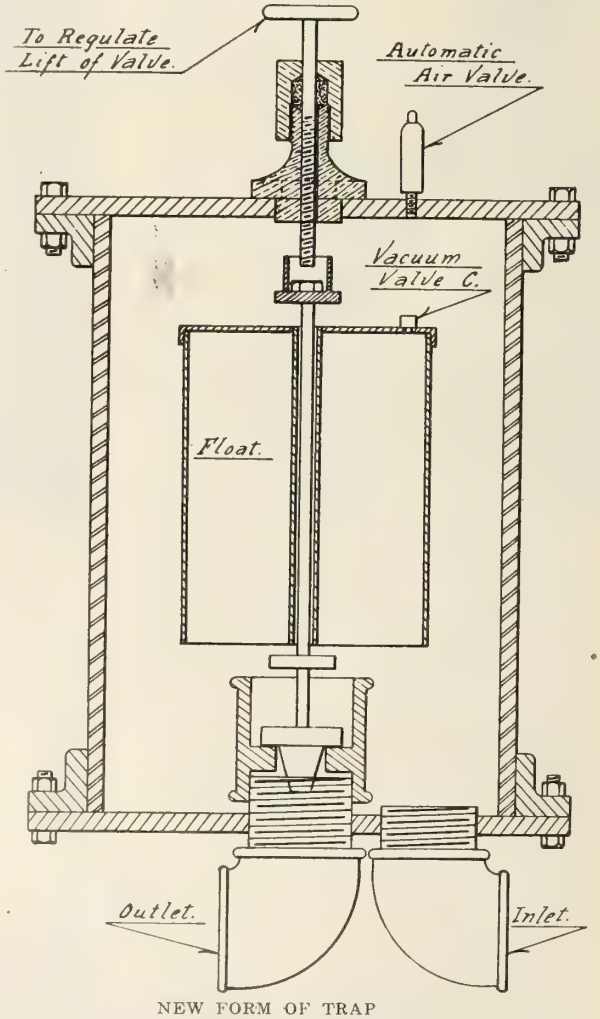
The idea is not patented and about the only thing liable to cause trouble is the small vacuum valve at C, which allows air to enter the float as the water leaves it, and closes as soon as the air reaches atmospheric pressure. However it is only a few minutes' work to remove the top flange and examine the interior of the trap at any time.

James E. Noble.

Technical Vs. Practical Skill

TECHNICAL VS. PRACTICAL SKILL

THERE have been a great many letters commenting upon the benefit and otherwise of technical and theoretical knowledge. "Get this": there is not anything to surpass it in usefulness if it is taken in proper quantities and combined with practical experience. Alone or nearly alone there is nothing more dangerous. I will tell you a true story to illustrate this fact. Mr. Blank has a university education, he also has some shop and power plant experience, not a lot. It does a fellow good to listen to him get off a fine "spiel," describing up to date power plant engineering practice. Passing for first class papers would be, and perhaps will be, pie to him, in fact, he could easily pass a superfirst examination.



NEW FORM OF TRAP

Many of your readers know gentlemen like Mr. Blank. Nice fellow and all that, just one of the boys.

One day he was standing in the engine room of a plant, the chief was also there but more distant from the engine than was Mr. Blank. Just then something went wrong with the governor and the engine started to race; the chief reached the throttle in a few half second jumps and closed it; he had to pass Mr. Blank to reach it. This gentleman only came to life after the valve was closed. Understand this, he knew perfectly well what had to be done, but not having the many years real operating experience the chief had, he could not act automatically as the chief did; he had to think before he could act; to stop to think, if only for a few seconds would have allowed time for a fly-wheel wreck.

At another time a corporation appointed a technical graduate as boiler and machinery inspector for their factories. He was a relative of the superintendent, hence the appointment. He was standing near one of the boilers telling the engineer how to do and how not to do many things. Among others he warned him to always remain cool in times of danger. This was one of the first things an engineer must learn. A man who can not remain master of himself is never to be trusted. Unless he had this control, he was not capable of teaching and controlling the rest of the engineering staff. Just at this point in the lecture, one of the high-pressure boiler safety valves let go with a bang. Mr. Inspector nearly broke his neck trying to get up the boiler room stairs without using them. Just for a few seconds he made an ass of himself. He knew perfectly well what had happened but he acted automatically up to what he was used to doing, dodging danger, not preventing it. He had not the engineer's years of personal power plant contact, so he had to think before he could realize what had happened.

The high-class technical expert is an office man; it is in the office that he can show a return in dollars and cents for the knowledge he possesses. A man must concentrate greatly to become an engineering technical expert in everything the name implies. If he does this he is bound to effect his practical experience, which enables him to do the right thing, at the right time, practically without knowingly thinking, really acting automatically.

Constant concentrated study will ad-

versely affect the practical efficiency of a mechanic. A certain amount of technical knowledge is desirable, in fact, so far as operating engineers are concerned it is indispensable.

To study up thoroughly on engine, boiler, machine, refrigerating and other machine design, requires a thorough knowledge of a dozen cults, any one or which will take a man many months to master even in a minor degree. There are exceptions but the older a person gets in manhood the more difficult it becomes to act the book student successfully.

When the average man is trying to absorb a hide full of book knowledge his mind is apt to be working independently of his body, trying to solve some problem that had bothered him the night before when he was studying up instead of sleeping. This is sure to be the very time when some dinged machine will take a notion to act contrary, and, on account of the wondering condition of his mind, the damage may be done before he can get it into its usual channel.

No operating engineer who has actual charge of a watch should concentrate overmuch on study. Take it easy, a little at a time and it will act as a tonic, not as an enervater, as much of it will surely do. This is different advice from that usually given; believe me it is the right stuff nevertheless. Of course the big fellows with a large staff of men to look after the actual operating, can study "till the cows come home," their principal work is clerical and overseeing.

Even at that, anyone who has visited many large plants will not have failed to notice the preoccupied and nervous movements of some of these big chiefs; there is too much on their minds. If they have been technical men all their business lives, having secured their practical engineering experience mainly in the office working out the financial and other power plant charts, their nervousness will be nil. Such men can not and do not understand, the love, the hate, the lure and the real dangers of the power plant. If they are men who have worked up by constant hard study and hard work they are apt to be a mass of "nerves."

I have written this article from notes taken by personal observation. Perhap I am not qualified and have formed wrong conclusions. I wonder if any other engineers have noticed things as written here.

John Ellehon.

ANNOUNCEMENT

The Mono Corporation of America, 48 Coal & Iron Exchange, Buffalo, N.Y., announce that they have purchased the entire stock of Mono apparatus and accessories from the F. D. Harger Co., Buffalo, N.Y. This includes all rights for the manufacture and sale of their various types of Mono apparatus for the automatic analysis of C02, C0, O2, H2, S02, N2, C1, etc. Mr. F. D. Harger, M.E., has not severed his connection, but will serve as general manager of the new corporation. A service and inspection department, connected with the laboratory, is now in operation and a competent chemical engineer in charge. Capable erectors will be placed at the disposal of customers in connection with the erection of new work and regular inspection trips will be arranged to visit existing installations with a view to bringing about closer co-operation between the customer and the corporation.

The Armstrong Cork Company, Pittsburg and Toronto, have issued a publication on "Small Cold Storage Rooms," which deals with the use of Nonpareil Corkboard Insulation for cold rooms in dairies, creameries, fruit and produce warehouses, retail and wholesale markets. The publication takes up engineering problems of design and pays particular attention to details of construction.

The McAlear Mfg. Co., 1901 S. Western Ave., Chicago, have issued Catalogue No. 25 and a booklet descriptive of the McAlear system of steam heating. Both of these publications deal with the apparatus and system installed by this firm and list all the equipment handled.

S. W. Craig, late of C. Cole, Ltd., has joined the Canadian Farnsworth Co. engineering staff. The Canadian Farnsworth Co. are handling the Farnsworth trap with the improved valve arrangement as developed by Mr. Rose, and are general condensation experts. Mr. Craig is well known among the engineering fraternity, who will wish him success in his new venture.

The American Steam Conveyor Corporation, Chicago, have issued a folder entitled: "A Man is Known by the Company He Keeps—A Product by Its Users." The folder shows some 50 or 60 trade marks or trade names of nationally-advertised and nationally-known concerns using the American steam jet ash conveyor

The American Steam Conveyor Carporation announce that arrangements have been made with the Wellman Bibby Company, Ltd., 36 Kingsway, London, W.C. 2, England, to act as their representative in Great Britain and Ireland for the sale of the American Steam Ash Conveyor. It is the intention of the Wellman Bibby Company to manufacture the American Steam Ash Conveyor in England.

The Jeffrey Manufacturing Company, Columbus, Ohio, is opening a branch office in Los Angeles, Cal., to look after their business in California, Arizona, Nevada, and the State of Sonora, Mexico. The office will be in charge of Mr. F. R. Field, who has been manager of the firm's Denver office, and his knowledge of this territory and of its requirements especially fit him to render assistance to clients in solving their elevating, conveying, crushing, and mining machinery problems.

STEAM TABLES—1920 EDITION

The Wheeler Condenser & Engineering Co., Carteret, N.J., announce the publication of the 1920 edition of their popular "Steam Tables for Condenser Work." This is the fifth edition. Every engineer who deals with the condensation or evaporation of steam should have one of these handy tables. The pressures below atmosphere have been especially calculated for this book by Prof. Marks.

The book gives the properties of saturated steam from 29.8 in. vacuum to atmospheric pressure in increments of tenths of an inch. The vacuum in inches of mercury is referred to a 30 in. barometer. This method is of course superior to the old method of giving absolute pressures in pounds per square inch, since it is customary to read vacuum in inches of mercury.

A complete table is also given of the properties of saturated steam above atmospheric pressure.

The book tells how to make measurements by means of the mercury column and barometer. It gives constants and tables for making corrections. It gives the correction to be made for relative expansion of mercury and brass scale, etc. It is a very handy book and of a size that can be carried in the pocket.

Officers Elected.—At a recent meeting of the stockholders of the Buffalo Forge Company, new officers were appointed, as follows: Henry W. Wendt, president; Edgar F. Wendt, vice-president and treasurer; Henry W. Wendt, Jr., vice-president and secretary; C. A. Booth, vice-president and sales manager. The new directors include the above-named officers, and, in addition, Mr. H. S. Whiting.

New Tractor Plant.—The Chase Tractors Corporation has been formed to carry on the manufacture of the Chase tractor for the Canadian market. The company will have a capital stock of $1,000,000 7 per cent. preference stock, of which $750,000 will be issued at present and $1,000,000 common stock, all of which is now issued. The company has secured a large plant adjoining the Canadian National Exhibition grounds, which will give it facilities on the main line of the Grand Trunk and C. P. R.

We are continually receiving from readers of POWER HOUSE letters telling us how much our subscribers admire the paper. We are very glad to get these letters, not so much for the purpose of reading their good words, but because they show that POWER HOUSE is meeting a real need and service in Canada. A letter of recent date says: "POWER HOUSE is very helpful to me and I would not be without it." We believe this the opinion of all our readers. The same writer says that he secures considerable valuable instruction through reading the advertising pages. The value of this is apparent to advertisers—getting the merits of their line before the engineers in an educational manner.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
⅛	$ 6 00	$ 8 00	$.....	$.....
¼	4 83	6 96	5 31	7 44
⅜	4 83	6 96	5 31	7 44
½	6 42	7 99	7 10	8 67
¾	8 11	10 24	9 03	11 16
1	11 99	15 13	13 35	16 49
1¼	16 22	20 47	18 06	22 31
1½	19 39	24 48	21 59	26 68
2	26 09	32 93	29 95	35 89
2½	41 24	52 07	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 50
Linseed oil, raw, single bbls.	2 90
Linseed oil, boiled, single bbls.	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

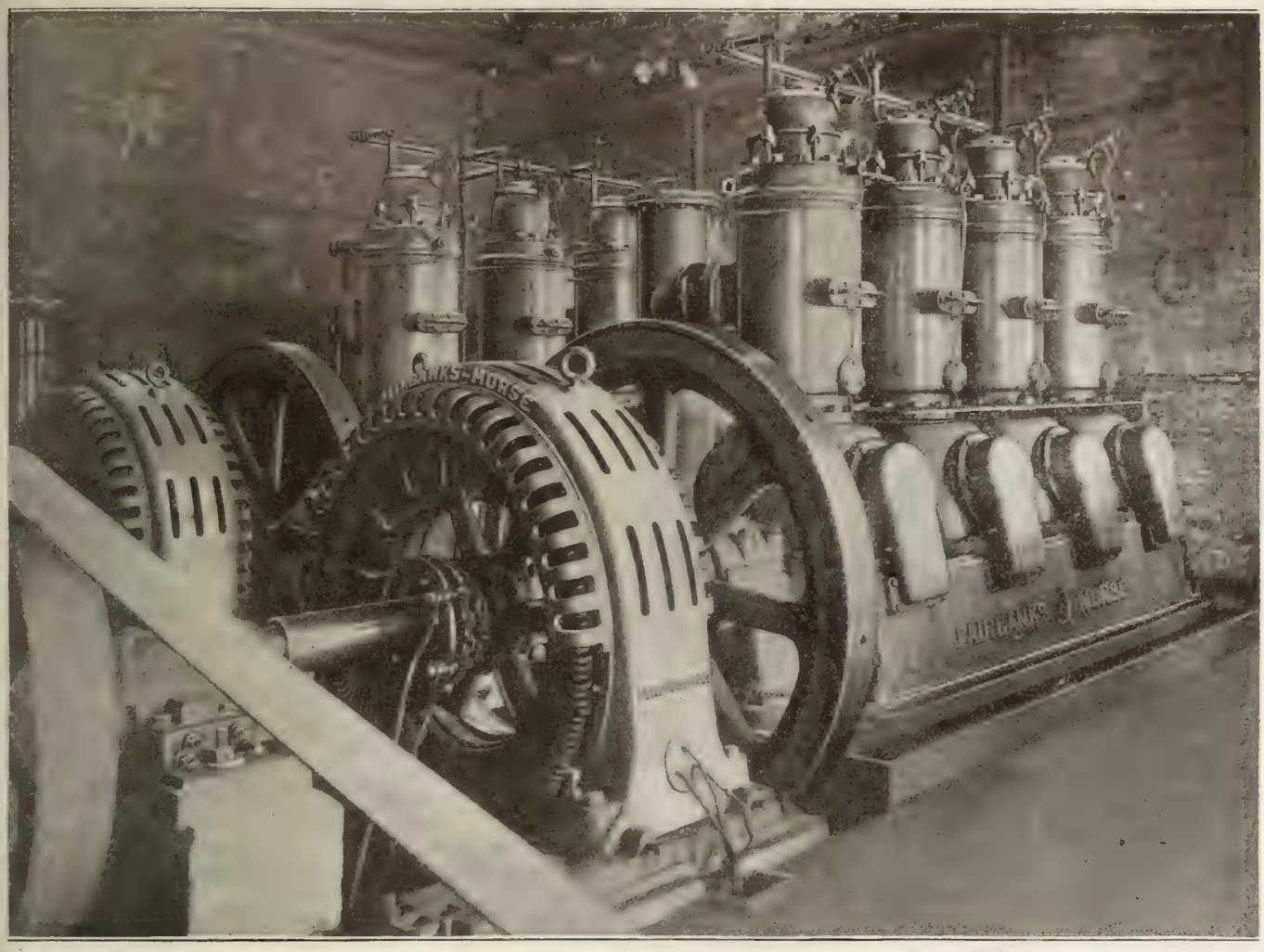
	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



FAIRBANKS-MORSE
ELECTRIC POWER MACHINERY

Each of the units shown above consists of a 200 H.P. Semi-Diesel Oil Engine and a 170 K.V.A. Generator.

Our smallest plant is a 1½ H.P. 9 K.W. Automatic Suburban Lighting Outfit.

Fairbanks-Morse Electrical Machinery covers the entire range between the above sizes.

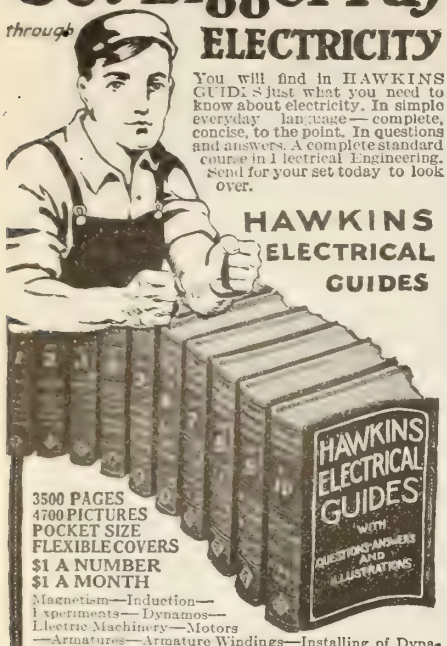
Our experience is at your service.

The Canadian Fairbanks-Morse Co. Limited

"CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS"

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON
WINDSOR WINNIPEG SASKATOON CALGARY
VANCOUVER VICTORIA

Get Bigger Pay through ELECTRICITY



You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language — complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors — Transformers — Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied.

Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination **Hawkins Electrical Guides** (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____

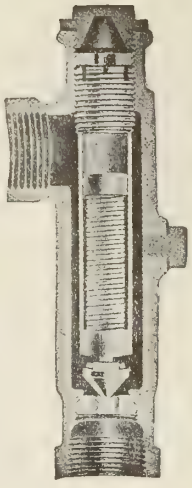
Occupation_____

Employed by_____

Residence_____

Reference_____

What Do You *Pay For* When You Buy a Steam Trap?



When you buy a steam trap of the cumbersome float or bucket type you **get** a lot of levers, gauges, packing, stuffing boxes and other complicated attachments. These attachments **cost money** — and you may be sure that **you** pay the bill.

It is these mechanical nuisances — that cost you **time** (for adjustment) as well as money — that make the float or bucket trap cost three times as much as

Steam Trap SARCO

The Sarco is a simple, **compact** Trap that eliminates all these mechanical extravagances. It has only one moving part and is so small that it can be placed at any point on the line in the most limited space, and at any angle. It requires no storage space, no floor space, no supports, no building up. It releases condensate almost as rapidly as it collects and sends it to the hot well while still hot — not **cold** from lying around as in the bucket traps. The lines are kept drained of **all** condensate **all** the time. Yet so promptly and accurately does the Sarco operate that no live steam is allowed to escape.

Made in sizes from ⅜" to 3" for any given pressure up to 200 lbs.

Let us ship you a Sarco for a 30 days' free trial to conclusively prove that it does everything that the three-times-more-expensive bucket trap ever did — and does it more effectively. Booklet J-7 is yours for the asking.

SARCO CO., Inc.
239 Broadway, New York City

Buffalo Detroit Chicago Philadelphia Cleveland. Peacock Bros., Montreal

The Annual Refrigeration Number of Power House

will be issued on April 20th. This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the REFRIGERATION NUMBER

WANTED—5 TO 7½ H.P. A.C. 25-CYCLE 110-volt Induction Motor in good condition. Box W.F.S., Power House, Toronto.

STATIONARY ENGINEERS

Those who wish some practical tuition for their Graded Certificates from a practical power house engineer holding highest certificates are invited to communicate with T.H.F., Box 208, Power House.

POWER HOUSE advertisements will give you last minute up-to-date information of educational value. Are you using this opportunity?

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED
TORONTO

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

And all for Two Dollars

There Is Only One
Plastic Fire Brick

COMES IN
THE YELLOW-TOP
BARREL

Anyone

can see that the weakest parts of a boiler lining are the joints.

The logical remedy is to have no joints—to cover all the brick work with a one-piece, monolithic furnace lining.

But the ordinary fire brick is not elastic. If you used it for this work it would crack and crumble away to dust.

The successful furnace lining is

BETSON'S
REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

It is the pioneer and a tried boiler refractory material. It has twenty years' practical experience behind it. It is elastic—won't crack and crumble.

There is nothing about a Betson lining to loosen or fall down. Use it in the furnace, on door arches, on rear arches, on baffles, bridge walls, etc.

Practical booklet on furnace linings sent free.

Canadian Distributor:

International Chemical Co.
44 Lombard Street
TORONTO, ONT., CANADA

Made in Canada

JONES

Used the World Over

UNDERFEED STOKER

Increased boiler capacity—even with low grade fuel

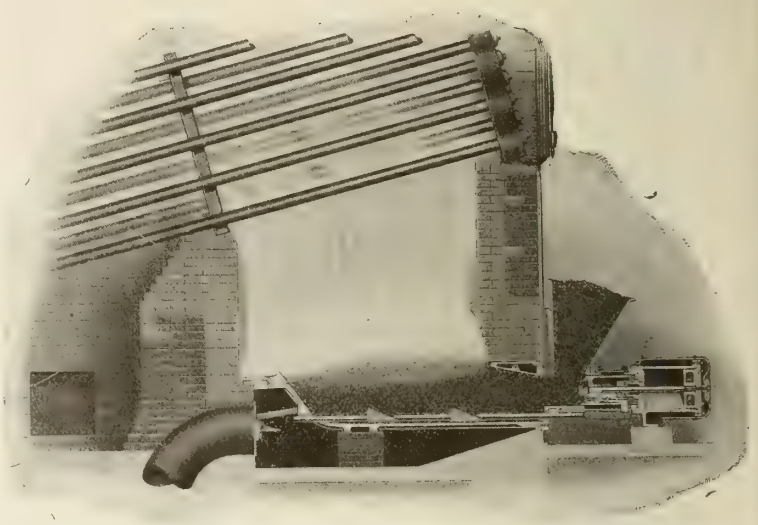
Are you up against the difficulty of keeping up steam with poor coal?

Or has the demand for steam exceeded the boiler capacity?

Wherever there are such conditions there is need for a Jones Underfeed Stoker.

A Jones Stoker equipment will increase the steaming capacity of your boiler and do it automatically without the close attention of the fireman and immediately show you a saving of 15 to 20 per cent. over your regular hand-fired conditions. Think of it—as much as one ton of coal saved in every five and with the price of coal where it is to-day your Jones Stoker equipment quickly pays its initial cost and then—large dividends on the investment and all the while your chimney is smokeless.

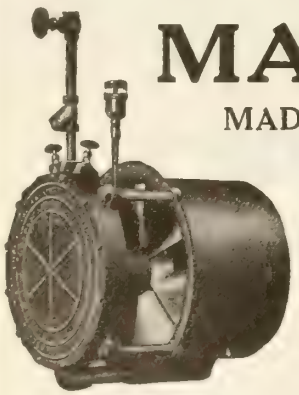
Write us for full facts.



Jones Underfeed Stoker Company, Limited
37-41 Britain Street - - TORONTO

MASON'S

MADE-IN-CANADA



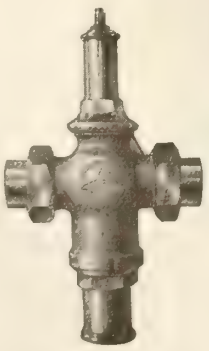
Coppus Turbine Driven Blower

Quality Specialties

We carry a complete line of Power House specialties Made-in-Canada by Canadian workmen — that is why we are able to make prompt deliveries on all orders.

We have only Quality equipment to sell. Our engineering department is always ready to give sound advice on the efficient and economical application of Mason products.

Write us to-day for bulletins and full information.



Mason Reducing Valve

Mason Regulator & Engineering Co., Limited

153 Dagenais St. Montreal — 1002 Kent Bldg. Toronto

Works at Montreal

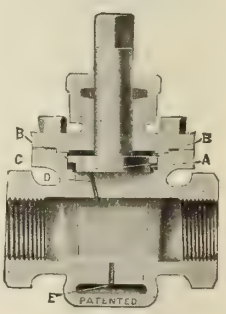
Homestead Valves

Simple and Convenient

One quarter-turn opens a HOMESTEAD QUARTER-TURN valve from absolute tightness to a straight unobstructed flow, while it takes anywhere from 6 to 10 turns of the wheel to open or close the ordinary globe or gate valve. Think of the time saved—think of the convenience—just one-quarter of a turn with a HOMESTEAD.

That's why HOMESTEADS have replaced globes and gates in hundreds of plants.

They are used for air, steam, water, oil, or acids and will keep your pipe lines absolutely tight.



HOMESTEAD VALVES are made in Straightway, Threeway and Fourway patterns.

Order your requirements to-day. Send for Catalogue.

Homestead Valve Mfg. Company

Pittsburgh, Pa. : : Works: Homestead

GOODYEAR
MADE IN CANADA

INDUSTRIAL HOSE

Tires Lowered the Cost of Hose

The policy which built the Goodyear tire business—and made Goodyears the largest selling tires in the world—has made possible lower costs for hose in industrial plants.

Hose built to fit the *needs* of many different industries.

Fabrics specially selected for hose. Rubber compounds brought to an exact, scientific standard. Construction governed only by the work the hose is to do.

Is it any wonder that Goodyear Industrial Hose is giving longer service; reducing hose costs; preventing delays due to repairing and replacing hose?

In foundry, paper mill, mine, railway, steel plant, and every other industry, Goodyear is setting new standards for hose.

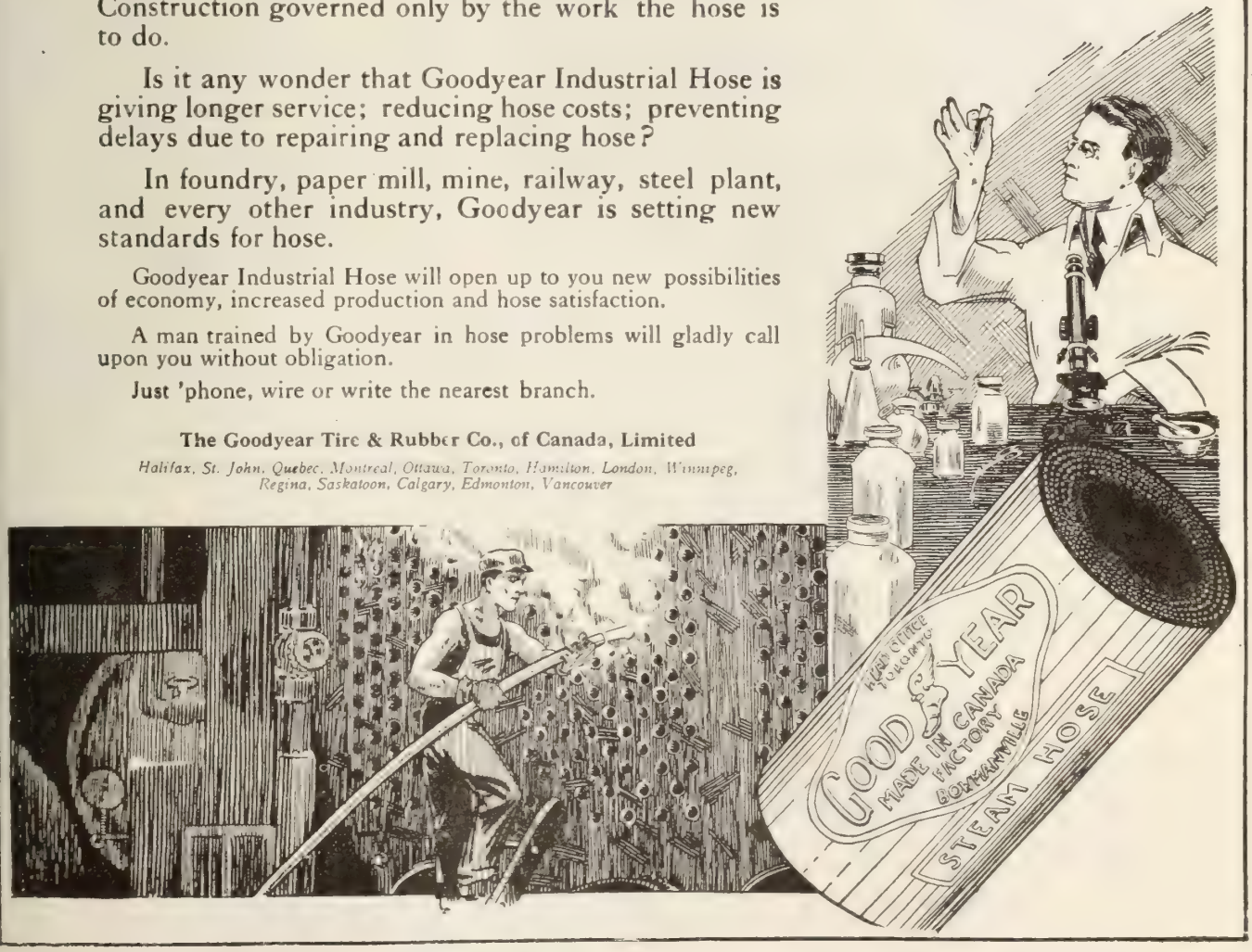
Goodyear Industrial Hose will open up to you new possibilities of economy, increased production and hose satisfaction.

A man trained by Goodyear in hose problems will gladly call upon you without obligation.

Just 'phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co., of Canada, Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver



Western Canada—Centre of Drug Smuggling

IS Western Canada the centre of the illicit drug traffic of the continent? Does the underground system, by which the body and soul-destroying narcotics are distributed to the addicts of America begin on Canadian soil?

Official U.S. investigators say so, and, in discussing the drug traffic in the March 15th issue of MACLEAN'S, Mrs. Murphy (Janey Canuck) acknowledges that there may be some truth in the statement.

In this article, the second in a series that she is writing after thorough investigation, Mrs. Murphy traces the ramifications of the underground system—how the drugs are smuggled in and purveyed to the hopeless thousands, the whole sordid story of the filching of souls and the degrading methods by which it is done.

Mrs. Murphy's articles are beginning to stir things up in Canada on the drug question. Ottawa is showing an interest, the police of many cities are displaying unusual zeal, the newspapers are awakening to the menace. Mrs. Murphy will continue her series until she has laid bare the whole truth about this danger that is gripping Canada.

Eight Months Adrift in the Arctic
By STORKER STORKERSEN

The remarkable story of how a small party of Canadian explorers, headed by the author, spent eight months adrift on ice floes in the Arctic Ocean and came back safe and sound and with a wealth of scientific data. This story has been written for and appears exclusively in MACLEAN'S.

All We Like Sheep
By NELLIE L. McCLUNG

A humorous article on a Canadian author's venture into the sheep business and what befell her.

Commerce in the Clouds
By J. VERNON McKENZIE

An interesting article on the uses of aircraft for commercial purposes in Canada.

Letting Herb Do It
By J. L. RUTLEDGE

A sketch of the remarkable business career of a young Canadian, Herbert J. Daly.

Get Your Copy Early

Another Issue will be on the Newstands April 1st

In addition many other articles, stories and serials by well-known authors.

"Review of Reviews" Section

Some of the reprinted articles found in this department are:

German Government Will Be Overthrown
Changing the Shape of England
Eleven Millions Are Starving
Whither is the Earth Travelling?
Farming in an Inferno
A German Plan That Failed
One Hundred Million Women Have Vote
The Inside Story of the Bullitt Mission
Locating the Reasons for Unrest
The Land of Model Husbands
"Bully" Hayes, a Modern Pirate

You pay no added exchange when you buy Canada's National Magazine

Over 80,000 Canadian Families Read

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

MARCH 15th ISSUE *Now on Sale at All News Dealers* *20c*

Pop! —never fails

THE reliability of Lunkenheimer Pop Safety Valves has been demonstrated through many years of satisfactory service, on all types of boilers.

Rigid tests under live steam and their careful adjustment to meet the individual service conditions, is assurance that they will efficiently perform the functions for which they are intended.

Their remarkable durability, due to correct design and high "quality" materials, is a source of economy in many boiler plants.

Users KNOW. A trial CONVINCES.

Write for booklet No. 502-DC

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI Boston
New York Chicago
4-13-43 London

This is a real test.

CLINTON CEMENT

The conditions that exist in a brass furnace like this are a real test of the refractory lining. The expansion and contraction, the tremendous temperatures that occur, soon wreck the ordinary lining. The fireclay binder burns out and leaves the edges of the bricks exposed, the bricks rapidly disintegrate under the blast of flame and the lining becomes useless.

The success of Clinton Cement under these conditions is due to its unusual properties. It sets to a flexible, glass hard surface that is not affected by temperatures up to 3000° F. It is the ideal furnace lining for refractory work of any kind — but particularly the kind that gives trouble.

Five-pound tin sent free for trial.

Standard Machinery & Supplies, Ltd.

261 Notre Dame St., W.

MONTREAL

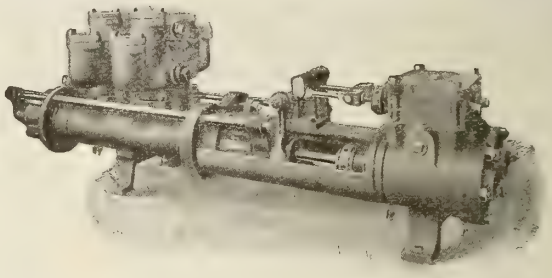
HINTS TO BUYERS

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

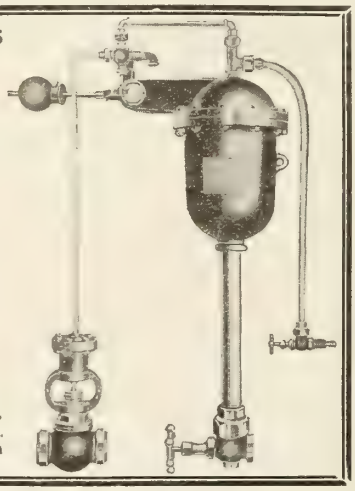
The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300



PUMPS that give
Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

PROTECT YOUR BOILERS
VIGILANT
Water-Feed Regulators
will absolutely safeguard your boilers. The VIGILANT is the pioneer automatic feed water regulator in this country, and it has remained at the zenith ever since their invention. They ensure dry steam for your engines—prevent accidents to the boilers from low water — prevent flooding of engines—lessen repairs to boilers from leaky tubes — save fuel — insure more uniform operation of feed pumps, heaters, etc.
Write for our latest instructive catalog to-day.



The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.
Also Manufacturers of the Fulton Pump Governor.

CRANE MALLEABLE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

LANCO BALATA BELTING
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO
SCANDINAVIA BELTING

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO
Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.
MAKERS OF THE "LITTLE GIANT" TURBINE
Put Your Water Wheel Proposition Up To Us

DEPARTMENT OF LABOUR

Ontario Government

Minister: Hon. W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

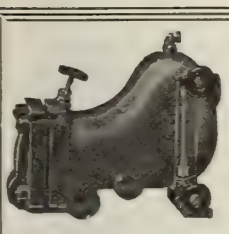
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



McDANIEL IMPROVED **STEAM TRAP**

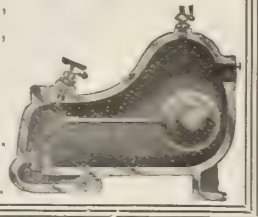
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

A HELPING HAND

Engineers, firemen and other power plant operators are earnestly requested to take up any matters upon which they desire information with the Editors of POWER HOUSE. This applies particularly, at the present time, to the grading of certificates in Ontario. Any new development of this kind naturally gives rise to a period of uncertainty and information is often desired by those who are most intimately concerned. We are in a very advantageous position for extending a helping hand to those in doubt as to what to do under the new regulations. Questions regarding the Act, its regulations and their interpretation, requirements for the different grades, studies to be undertaken, etc., will be cheerfully answered.

DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

ECONOMIC **Carling** BLOWERS SUPERIOR

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

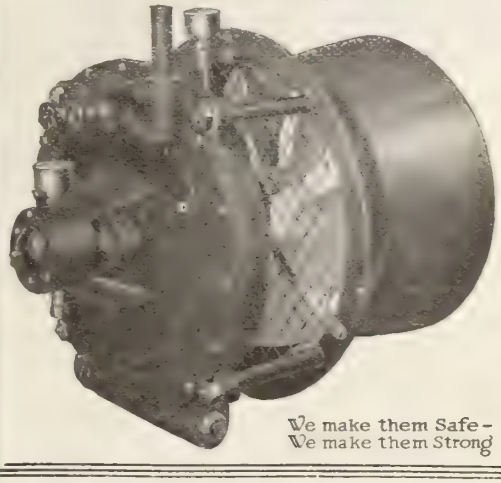
Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY

Engineers and Manufacturers WORCESTER, MASS

Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

P LEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.

D.K.McLAREN, LIMITED · MONTREAL · TRADE MARK

THE hides used in making D. K. McLaren's Belting are cut from the *backs* of the choicest steers. The back is the strongest part—and there are equal strength and elastic qualities throughout.

D. K. McLAREN'S

Genuine British Oak Tanned

Leather Belting

THE exclusive use of selected flawless *backs* together with the world-famous British Oak method of tanning gives

D. K. McLaren Leather Belting

mighty toughness that makes for exceptionally long service.
D. K. McLaren's Belting needs but little taking-up in service because the stretch is practically all removed before shipment.

Years of strenuous service in many of Canada's largest power plants have proved D. K. McLaren's leather belting to be literally *the Belt of Greatest Reliability and Economy.*
Look for the Oak leaf. It is satisfaction insurance for you.

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

HEAD OFFICE AND FACTORY
351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

VANCOUVER, B.C.
334 Cordova St. West

TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 German St.

Robb Power Plants.

The Robb line includes engines and boilers of all kinds, designed in accordance with the most modern approved practice, and constructed with the accurate workmanship that results in long life and reliability.

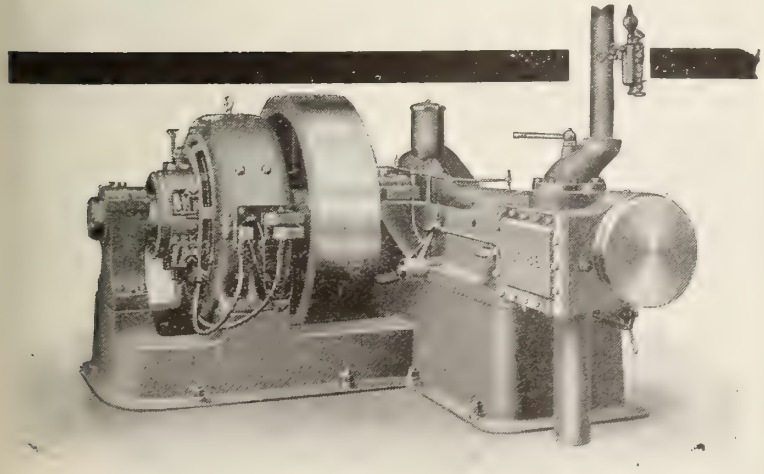
Robb equipment will develop the maximum of efficiency in your plant.

We are experts in power plant engineering. Obtain our advice on any problem.

Robb Engineering Works, Ltd.

Amherst, N. S.

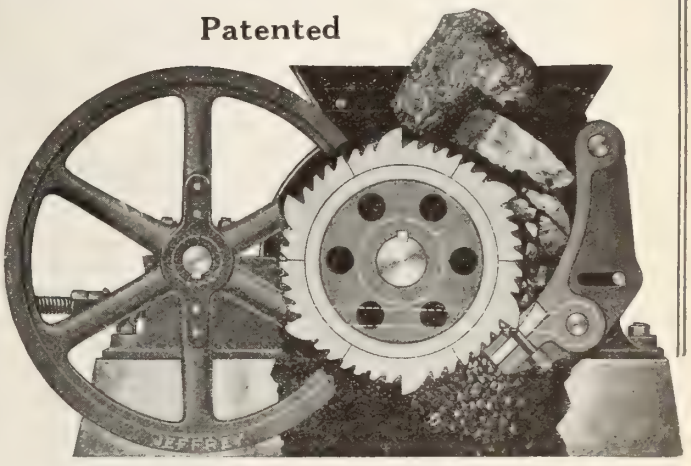
Montreal **Toronto**



The Jeffrey

Single Roll Coal Crusher and Power Plant Efficiency

Patented



Insure the coal supply of your plant by installing the

JEFFREY SINGLE ROLL COAL CRUSHER

Make your plant independent of mine and traffic conditions by crushing your own stoker coal—right in your own plant. The JEFFREY Crusher will reduce Run-of-Mine or Lump Coal in one operation to the proper sizes for maximum heat efficiency in stokers.

Bulletin No. 141-A gives complete information. Write today for your copy

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken. but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto,
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont,
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Dominion Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd. Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co. Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati O.

BOILER FITTINGS
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co. Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

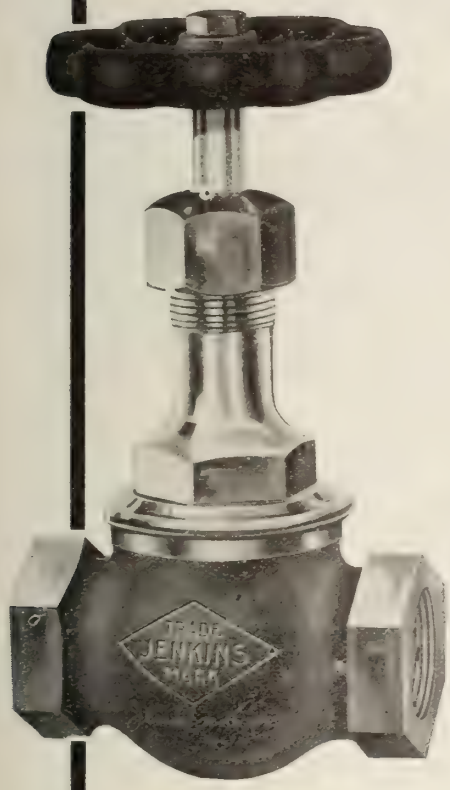
CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Beveridge Paper Co., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

TRADE JENKINS MARK



Jenkins Bros.
Brass Globe Valve, standard pattern, Fig. 106

Dependability

— the most important feature in a valve.

The ability to withstand heavy pressures without breaking — to seat with perfect tightness under all

The certainty that there is a clear passage when the valve is open — that there is absolutely no flow when it is shut — that is dependability.

A reputation for absolute dependability has sold thousands of Jenkins Valves.

If you are a user of Brass Globe Valves and know what troubles arise from the use of ordinary makes, specify Jenkins Brass Globe Valves on your next order (see cut) and you will get the result you desire.

Catalogue 8 free on request

Jenkins Bros. LIMITED

Head Office and Works :
103 St. Remi St.
Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch
6 Great Queen St., Kingsway
London, W.C. 2, England

TRADE JENKINS MARK
Jenkins Bros

TRADE JENKINS MARK
Jenkins Bros

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Montreal General Tool Co., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton. Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto., Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto., Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal,
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS

MacLean Publishing Co., Toronto.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk, Con.

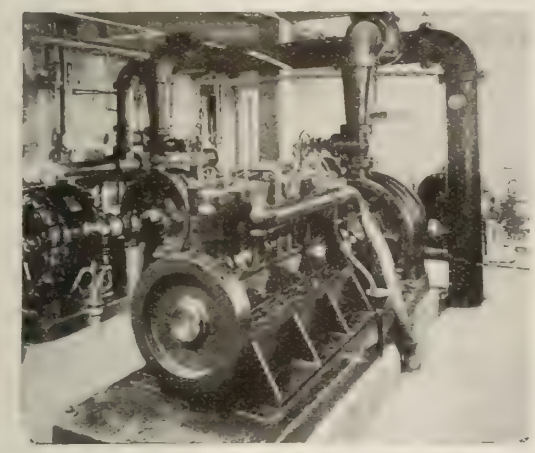
Sterling

THE ENGINE of REFINEMENT
For the finest boats that float

HIGH SPEED EMERGENCY POWER PLANTS

12 to 300 H. P., 400 to 1400 R. P. M.
For centrifugal pumps and electric generator drives.

UNUSUAL EFFICIENCY



Sterling 85 H.P. engine direct connected to Worthington 3-stage fire pump at Cartierville, Quebec. Capacity 1,250,000 Imperial gallons in 24 hours. This engine has been in operation over 4 years, and has never given trouble in any way. It has a record run of 7 days and 7 nights, 24 hours per day continuous running at top speed and full load without stopping.

STERLING ENGINE COMPANY
Dept. C-4 BUFFALO, N.Y., U.S.A.

Structural Steel and Steel Plate Work

of every Description

Penstocks
Thimbles
Draft Tubes
Wheel Cases
Steel Gates
Racks
Gate Steelwork
Power House

MacKinnon Steel Co. Limited

Write for prices.
PROMPT DELIVERIES

Sherbrooke, Que.

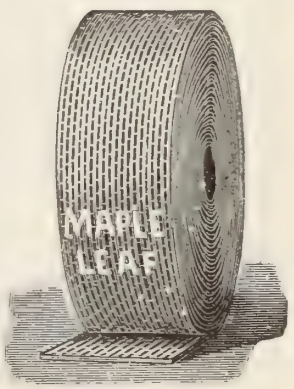
Montreal Office:
404 New Birks Building

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM. DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

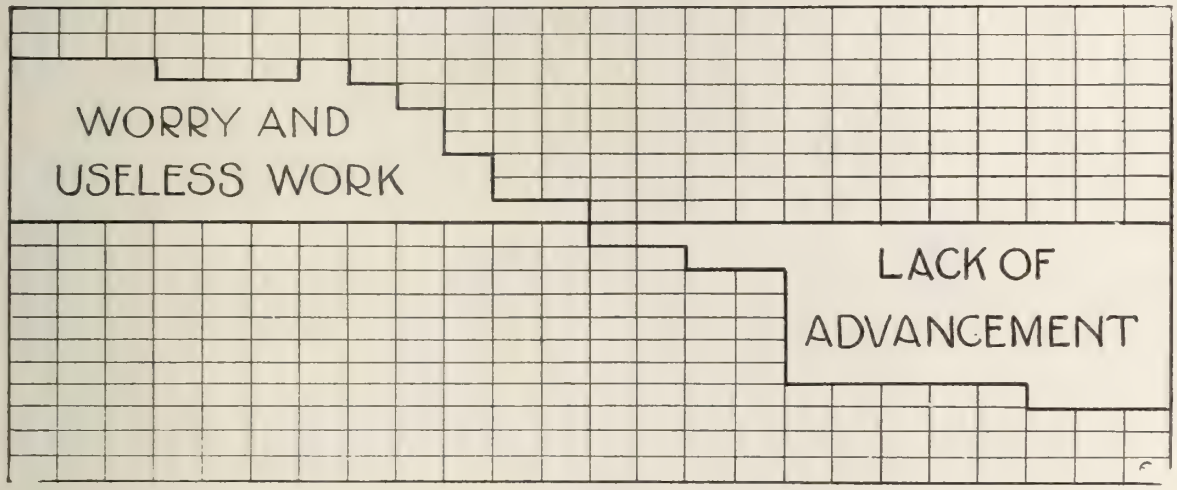
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

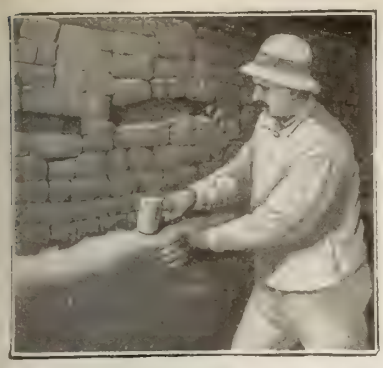
Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.
Beveridge Paper Co., Ltd., Montreal.
MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, AIR
E. J. Philip & Sons, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.
METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
METERS, GAS
E. J. Philip & Sons, Toronto, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.
METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
MIXING VALVES
Crane's Limited, Montreal.
MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.
OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.
ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.
PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.
PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.
PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.
PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.
PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek



Showing ease with which Plibrico is laid in place.

PLIBRICO SAVES COAL

by making your furnace air and gas-proof.

Plibrico can be installed by inexperienced labor. Plibrico also makes an excellent material for baffle construction and repairs.

A High Grade Refractory

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate shipment.

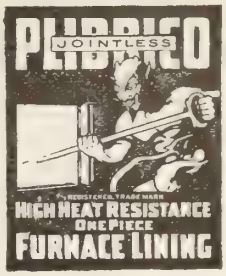
Write for book on furnace building

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office

LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

GEORGE T. LADD COMPANY

Farmers Bank Building

PITTSBURGH - - PENN., U.S.A.

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for

LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. **Glass Tubes and Rod**

S. & C. BISHOP & CO., St. Helens, Lancashire.

Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1919 catalog showing the Curtis line of Engineering Supplies.

JULIAN D'ESTE COMPANY

26 Canal Street **BOSTON, MASS.**

Agencies:
83 Barclay St., New York City.
174 North Market Street, Chicago, Ill.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
Defender Automatic Reg. Co., St. Louis.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York. N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

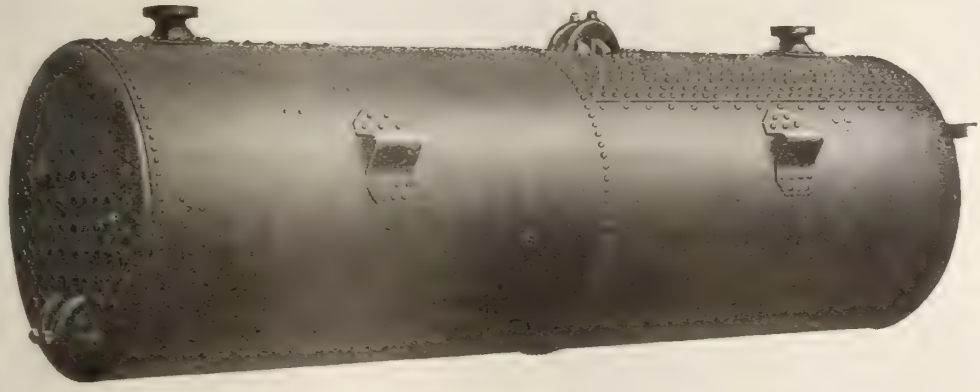
UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUBULAR BOILERS

If you value A 1 Service as well as A 1 Workmanship you'll be very glad you placed your order with us.



Horizontal Tubular
Vertical Tubular
Locomotive Type

Write for Prices, etc.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Claton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville.

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

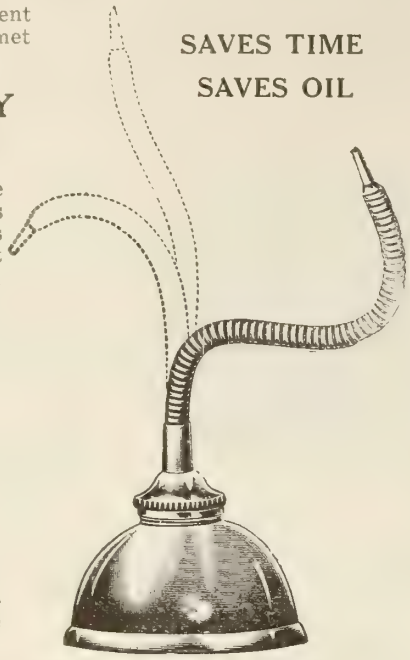
"SAFETY FIRST"

Bend the Spout
to suit position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL



Note the flexible spout. It enables you to oil all places — many places that previously could only be reached with force pump cans with specially bent spouts.

Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET, WEST - TORONTO, ONTARIO

Tycos TEMPERATURE INSTRUMENTS
·INDICATING · RECORDING · CONTROLLING·

MANY progressive manufacturers are specifying ***Tycos*** instruments. Industrial demands are met efficiently by them because they are designed and applied by men who know the up-to-the-minute needs of industry thoroughly.

Request more detailed information.

Taylor Instrument Companies
Rochester, N.Y.
110-112 Church Street,
Toronto, Canada

THERE'S A *Tycos* OR *Taylor* THERMOMETER FOR EVERY PURPOSE

WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

INDEX TO ADVERTISERS

All-Way Oiler Manufacturing Co... 64
Audel Co., Theo. 44
Badger & Sons Co., E. B. 7
Betson Plastic Fire Brick Co. 45
Bishop & Co., S. & C. 61
Busch-Sulzer Bros.— Diesel Engine Works 11
Can. Assoc. Stationary Engineers... 59
Can. Fairbanks-Morse Co. 43
Can. Farnsworth Company..... Inside back cover
Can. Mead-Morrison Co. 4
Carling Turbine Blower Co. 51
Chaplin-Fulton Manufacturing Co... 50
Crane, Limited 50
Cole, Limited, Geo. W. 12
Coppus Eng. and Equipment Co.... 9
Darling Bros. 50
Dart Union Co. 13
Department of Labor 51
D'Este Co., Julian 61
Dominion Belting Co. 57
Durabla Manufacturing Co. 5
Electric Welding Co., The..... 50
Engineering and Mach. Works of Canada, Limited 63
Federal Engineering Co. 50
Gates Refractories, Limited..... 2
Gilman, Frank 61
Goldie & McCulloch Co. 16
Green's Economizer, Limited 45
Goodyear Tire and Rubber Co..... 47
The Garth Co. 51
Hays School of Combustion..... 8
Hints to Buyers 50
Homestead Valve Manufacturing Co. 46
Hoyt Metal Co. 2
Imperial Oil Co. 3
Jeffrey Manufacturing Co. 53
Jenkins Bros. 55
Jointless Fire Brick Co. 61
Jones Underfeed Stoker Co. 46
Ladd Co., The George T. 61
Laurie & Lamb 51
Leonard & Sons, E. 6
Lunkenheimer Co. 49
MacKinnon Steel Co. 57
Mason Regulator and Engr. Co..... 46
MacLean's Magazine 48
Morrison Brass Mfg. Co., Jas..... Outside back cover
McLaren, D. K. 52
Murphy Iron Works 13
Norwalk Iron Works 5
Northern Electric Co. 1
Pilley Packing and Flue Brush Mfg. Co. 51
Penberthy Injector Co., Limited..... Front cover
Philip & Sons, E. J. 7
Refrigeration Dept. 10
Royles, Limited 12
Robb Engineering Works..... 53
Sandford-Riley Stoker Co. 13
Sarco Co., Inc. 44
Scaife, Wm. B., & Sons Co. 64
Sexton Boiler Setting Co. 6
Shell-Bar Boico Supply, Ltd. 11
Smart-Turner Mach. Co. 50
Standard Mach. and Supplies, Ltd... 49
Starrett Co., L. S. 14
Sterling Engine Co. 57
Steel Mill Packing Co. 11
Sturtevant Co., B. F. ..... Inside front cover
Taylor Instrument Co. 64
Tagliabue Co., C. J. 4
Victoria Foundry Co. 50
Watson & McDaniel Co. 51
Wilson Manufacturing Co., J. C..... 50
Williams Co., J. H. 7
Worthington Pump and Machinery Corporation 15
York Manufacturing Co. 10

Put a Farnsworth System to Work in Your Steam Plant

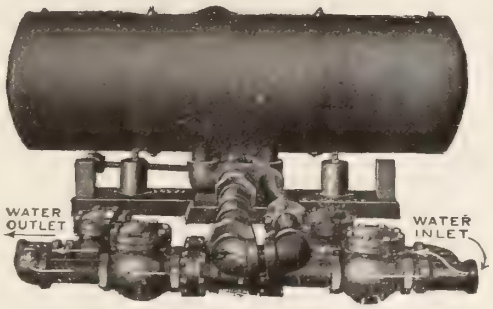
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no triunions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE
Canadian Farnsworth Company
1-24 Hillingdon Avenue, TORONTO, Canada
W. H. ROSE, Gen. Mgr.
BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

The

Guarantee TRADE MARK J.M.T. REGISTERED *of Quality*

MORRISON'S

TRADE MARK J.M.T. REGISTERED
A GUARANTEE OF QUALITY

Morrison Injector

Morrison steam goods have earned a reputation for quality and dependability that is unexcelled. There are Morrison fittings for every requirement of the engine and boiler room, and every article is tested and guaranteed by us. Design and construction are approved by the Provincial Inspection Departments. Write for the Morrison catalogue.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 7. Publication Office, Toronto—April 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE

JENKINS

MARK

Type "K"

Jenkins Bros

Brass Gate Valves

Jenkins Type "K" Brass Gate Valves are designed on novel and graceful lines and are the most popular line of gate valves in use in the power houses of Canada today. The simplicity of the closing mechanism, ease of operation and reliability are some of the reasons why engineers prefer them.

The bodies of Jenkins Type "K" Brass Gates Valves are globe-shaped, which, with the even distribution of the metal, insures great rigidity and strength—preventing distortion due to strain and shock. All parts are carefully machined to gauge and the metal is of the highest quality.

There's a Jenkins Valve for every purpose.

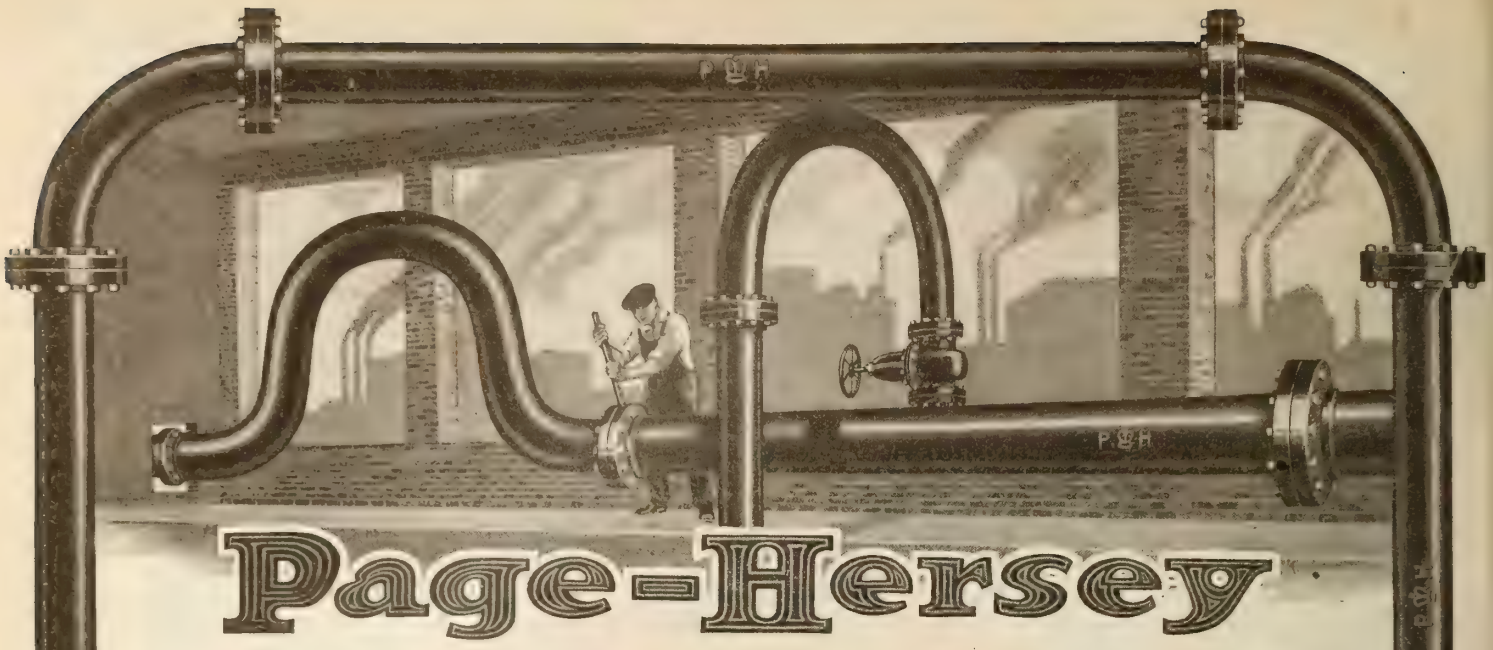
Jenkins Bros. LIMITED

The Diamond Trade Mark is cast on every genuine Jenkins Valve — demand it. Stocks at all dealers.

Head Office and Works: 103 St. Remi Street, Montreal, Canada.

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England.



Wrought Pipe Bends

ALL KINDS AND SIZES

UP TO 10 INCH PIPE

Flanged Pipe Joints

ALL TYPES

We maintain a Service Department comprised of Specialists on Pipe, who are ready at all times to consult with You.

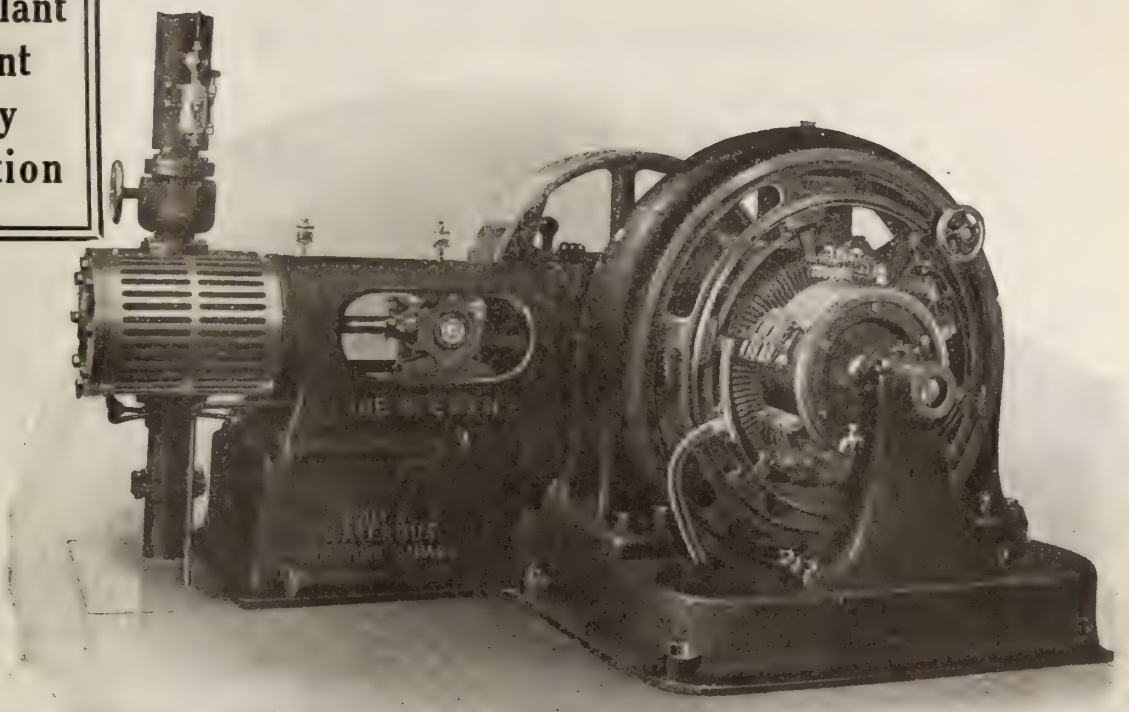
MADE IN CANADA BY

Page-Hersey Iron, Tube & Lead Co.

LIMITED

100 CHURCH ST. :: TORONTO, ONT.

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

Your careful investigation of their actual service performance record in all parts of the country specially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

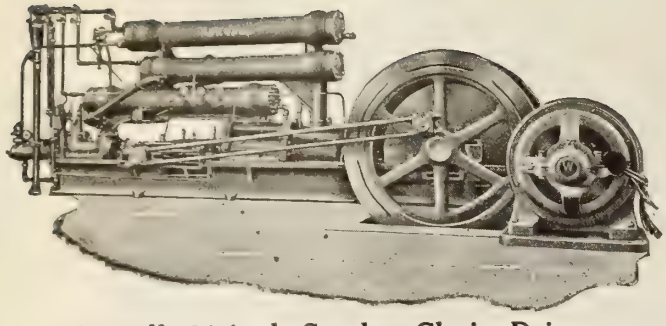
Waterous

BRANTFORD, ONTARIO, CANADA

POWER HOUSE, April 5, 1920, Vol. XIII., No. 7. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

NORWALK
AIR & GAS · COMPRESSORS

When in Doubt



Norwalk 24-inch Stroke, Chain-Driven,
Four-Stage Air Compressor

as to just how your compressing requirements can best be filled, do not waste time in speculation. Place the necessary data before our engineers and profit by their forty years of experience in meeting unusual conditions.

This service is part of our system of making sure that each Norwalk Compressor is perfectly adapted to the work in hand before it is sold. And it costs you nothing.

How can we co-operate with you?

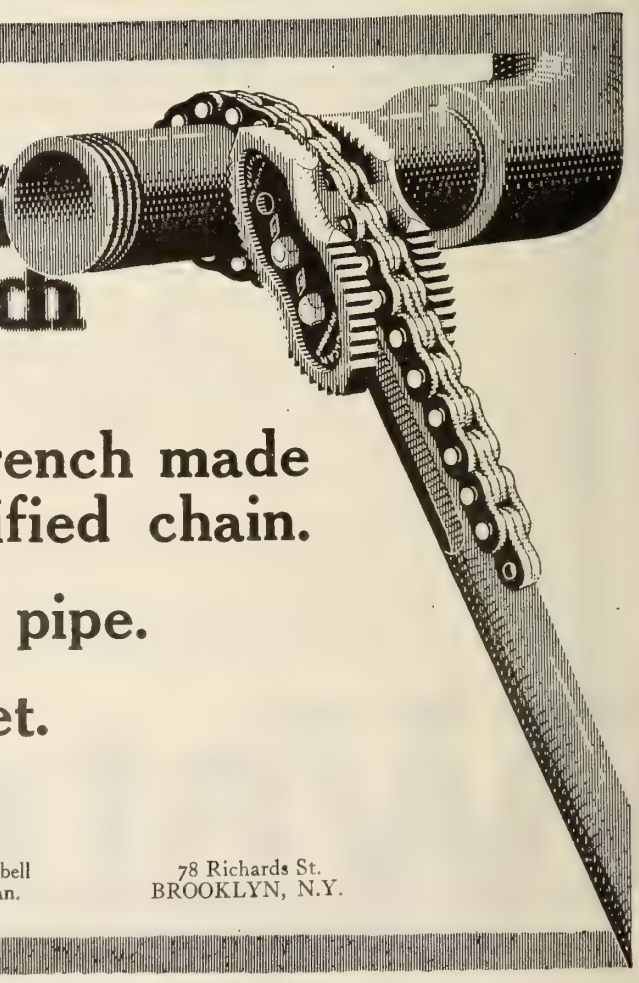
The NORWALK IRON WORKS CO.

Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

Williams' Improved "Vulcan" Chain Pipe Wrench



The *only* chain pipe wrench made with proof-tested, certified chain.

8 sizes for 1/8 to 18 inch pipe.

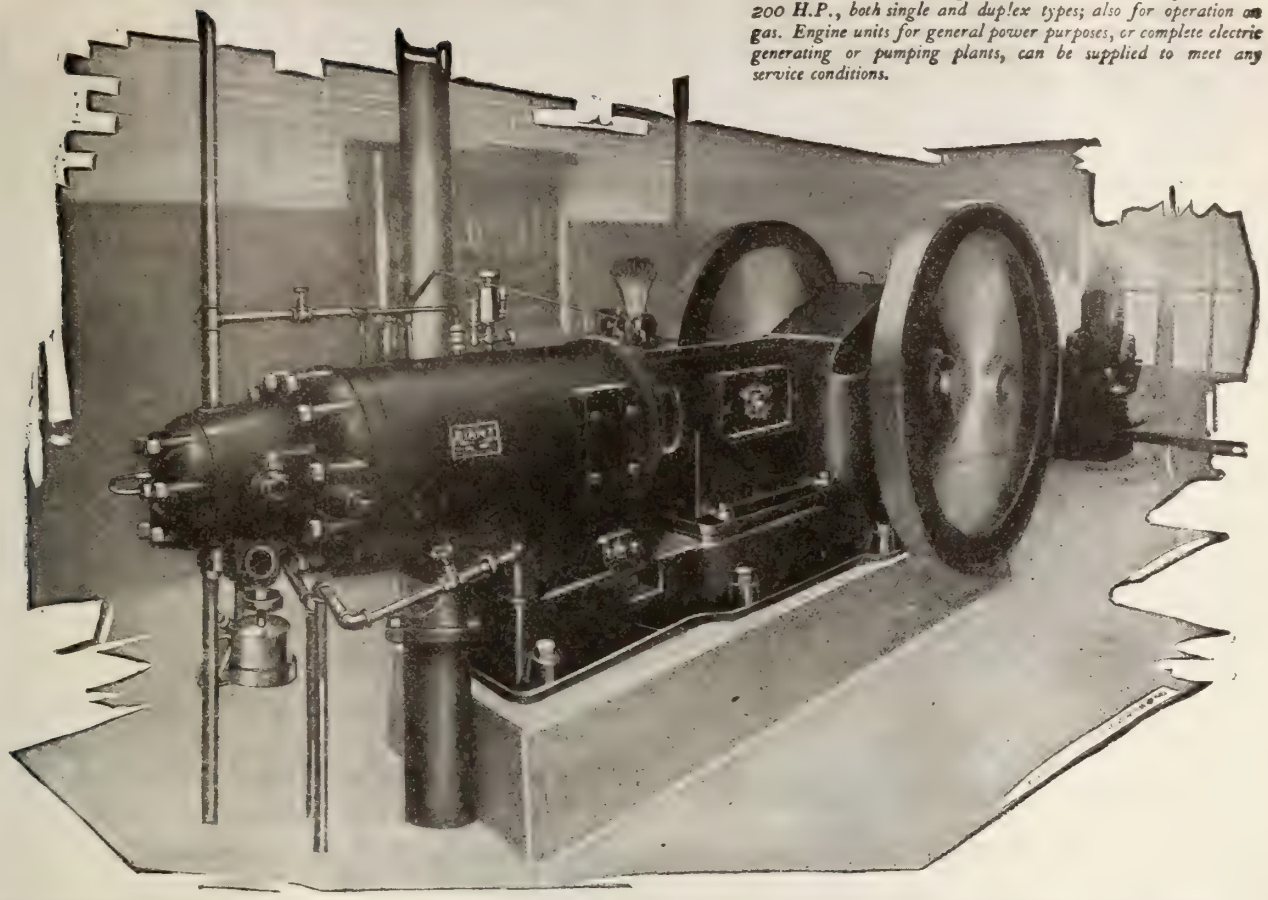
Ask for our new booklet.

J. H. WILLIAMS & CO.
"The Wrench People"

78 So. Clinton St.
CHICAGO, ILL.

Western Canadian Agent: W. Bruce Campbell
78 Confederation Life Bldg., Winnipeg, Can.

78 Richards St.
BROOKLYN, N.Y.



Giant Semi-Diesel Oil Engines are built in capacities from 12 to 200 H.P., both single and duplex types; also for operation on gas. Engine units for general power purposes, or complete electric generating or pumping plants, can be supplied to meet any service conditions.

Highest efficiency *automatically*

THE fullest advantages of fuel oil as a source of economical, dependable power are obtained through complete combustion, properly timed and regulated, in accordance with load conditions. The simple ignition and regulation system in Giant Semi-Diesel Oil Engines injects oil into the cylinder late in the stroke. The fly-ball type governor automatically releases the exact amount of oil for the amount of power required. The hot-tube ignition system quickly gasifies and ignites it. Complete combustion is the result. And *fuel input* is kept constantly proportionate to *power output* independent of human attendance. Giant Oil Engines are ideal prime movers for most power purposes. Ask for Bulletin.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Fender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN.31 H

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

New Truths and Old Fallacies

Fusibility of Alloys

Of the many correlative sides of equal importance to a babbitt metal discussion, it is difficult to fix upon any choice in the order of precedence, but we shall first discuss the fusibility of Alloys.

When the tin supply became scarce, because of the war, the Bureau of Investigation and Research of the War Industries Board, of the United States Government, made inquiries as to the best babbitt formulas containing reduced percentages of tin which could be used as substitutes for Genuine Babbitt, and they specifically asked our opinion concerning a mixture containing 50 per cent. tin.

In response we expressed the opinion that only two babbitt compositions were seriously worth considering—one a strictly tin base (Genuine) babbitt; the other a strictly lead base babbitt containing a comparatively small quantity of tin.

We gave as our reason for this seemingly revolutionary advice the extreme low fusibility of all intermediate grades of babbitts, whatever their composition, which makes them highly susceptible to the influence of frictional or initial heat and limits their usefulness to the nature of conditions under which they are used.

We recommended that tin could best be conserved by confining the use of Genuine Babbitt to thin shell bearings, which, by reason of the loose play and pounding made malleability of prime importance. For all other bearings where the lining was secured by recesses or soldered, or well seated, we recommended a well balanced, properly made lead base metal, maintaining that it would wear longer, run cooler and give the most economical service.

Continued next month.

For copy of complete article:

"New Truths and Old Fallacies"

Address our Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

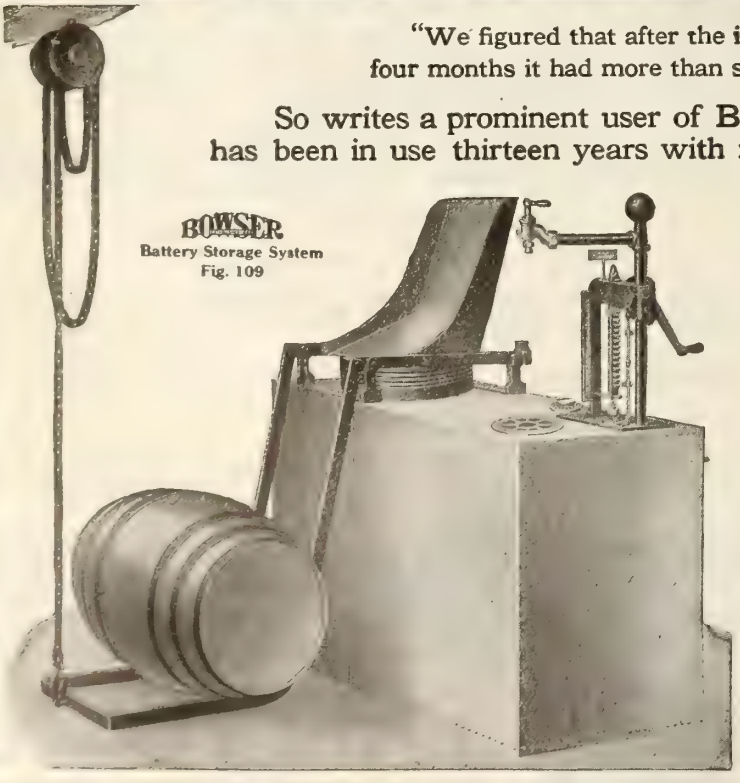
Office and Factory:

Montreal: 225 St. Ambrose St.

Why Don't You Save Too!

"We figured that after the installation had been in three or four months it had more than saved its entire cost."

So writes a prominent user of Bowser Oil Storage. Their equipment has been in use thirteen years with no operating troubles or upkeep cost.



If you are not using Bowser Storage Systems for your oils you are losing money every day.

BOWSER ESTABLISHED 1885

Systems Do Save

You can save the Bowser Way. Our literature shows how. Write for it at once.

BOWSER COMPANY, LIMITED

68-68 Fraser Avenue

TCRONTO, ONT.

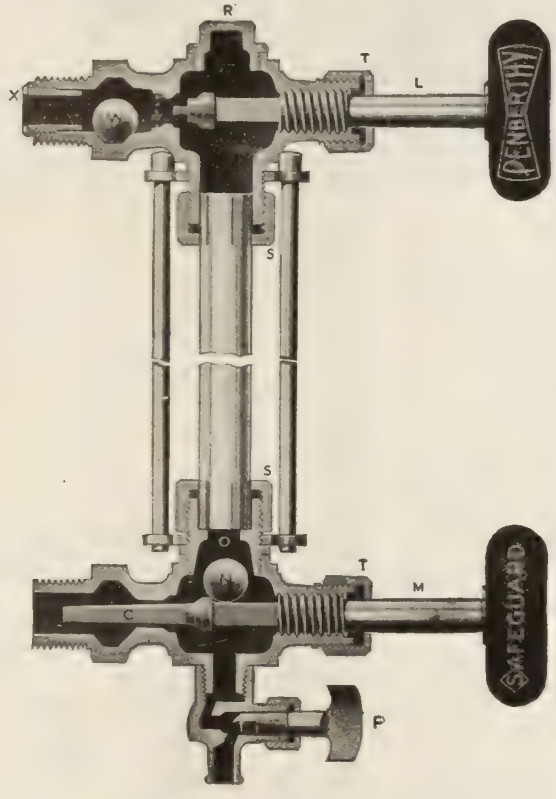
LONDON
32 Victoria St. S.W. 1

HAVANA
Lonja del Comercio 427

PARIS
5 Rue Denis-Poissor.

SYDNEY
6 Castlereagh Street

TRADE
PENBERTHY
MARK.



"SAFEGUARD"
AUTOMATIC WATER GAGE

POSITIVE PROTECTION

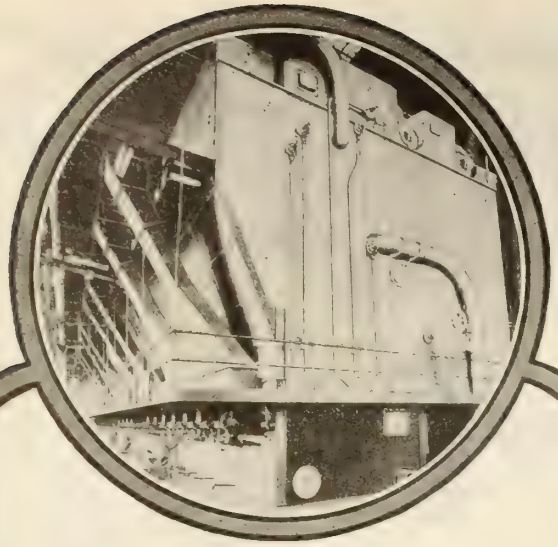
¶ When a "Safeguard" gage glass is broken, your boiler room attendants will not be exposed to the dangers of shutting off the gage valves in the midst of escaping steam and scalding water. The quick, positive action of the "Safeguard" will automatically protect them and also prevent the burning of your boiler plates, as might happen when a boiler is nearly drained through a broken gage glass.

PERFECT OPERATION

¶ The automobile ball-valves of the "Safeguard" close only when glass is broken and positively drop away from their seats as soon as the new glass is inserted. This feature makes the gage operate perfectly at all times and wholly prevents the showing of a false water level and the dangers which might result. We feel confident that the "Safeguard" is the utmost in automatic water gage construction.

"LET THE SAFEGUARD GUARD YOUR SAFETY"

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA



Keeping the World's Largest Boilers Operating at High Efficiency

When engineers design boilers of 2,350 H.P. and over, they find it necessary to construct enormous, many-galleried boiler rooms, equipped with elaborate coal and ash-handling systems, and fitted with many delicate measuring instruments. The initial cost of such plants may run into hundreds of thousands of dollars.

To justify this investment — to protect it — to earn dividends upon it — it is absolutely essential that the boilers continuously produce more steam per pound of coal than would normally be obtained with the operation of smaller units. High operating efficiencies being not merely desirable, but **imperative** if the plant is not to prove a white elephant, how are they to be obtained?

Through Clean Heating Surfaces!

Nearly, if not fully, **90** per cent. of the world's boilers of 2,350 H.P. and over, are equipped with Diamond Soot Blowers.

(Names of plants and details upon request.)

This fact is of tremendous importance to every boiler operator. If Diamond Soot Blowers are essential to the economical operation of the world's largest boilers because of their ability to save fuel and labor, and to increase boiler efficiency, they are just as necessary on smaller boilers, and just as desirable from an investment standpoint.

Diamonds usually pay for themselves twice over in a year. You owe it to your plant to obtain full information. Ask for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ontario

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Ladder: An article used in many ways but now obsolete in the power plant for controlling overhead valves from the floor. (Babbitt.)

Yes, Babbitt removed the ladder from the power plant, and cut down the number of accidents by putting in his adjustable sprocket rim and chain guides which make every valve easily accessible **from the floor.**

Are you still using a ladder?

93-45

Write for descriptive booklet.

Babbitt Steam Specialty Co.
NEW BEDFORD, MASS., U.S.A.

Western Distributors.,
Jenkins Bros., 300 W. Lake St., Chicago, Ill.

Canadian Agents:
Engineering Specialties Co., Ltd., Toronto, Ont., Can.

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston,) Mass.

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office

Fireman's CO_2 Guide on Boiler Front

Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet

"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 EMPIRE BLDG., NEW YORK

Make it Easier—

ALL-WAY

Flexible Spout Grease and Oil Guns

Make it easy to refill the most out-of-the-way gear cases or transmission as the flexible spout can be bent to any desired angle. The Cleaning Device at the end of the **"ALL-WAY"** spout reduces cleaning time and oil wastage to a minimum.

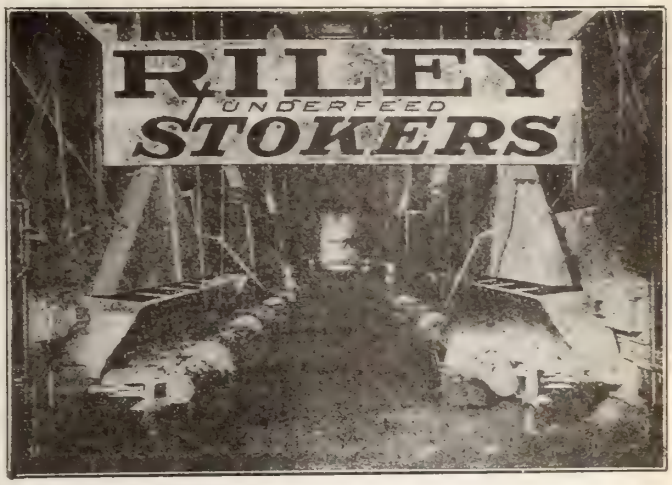
The **"ALL-WAY"** gun is especially useful and handy in filling lineshaft hanger reservoirs.

If your dealer cannot supply you, write us.

We also manufacture the well-known "ALL-WAY" Oil Can. Saves you 50% of your oil bill.

The All-Way Oiler Mfg. Co.

196 KING STREET WEST
TORONTO, ONT.



LET RILEY STOKERS REDUCE YOUR COSTS

Riley Stokers are always on the job—you can rely on them to be at work every day. They are tireless—working all hours of the day and night without complaint.

Industrial plants can cut their operating costs to a minimum by using Riley Underfeed Stokers. Consider the following facts:

EFFICIENCY—Boiler tests on Riley Stokers have shown over-all efficiencies of 80% and higher.

LABOR SAVING—One or two men can replace ten or twelve required for hand firing. Continuous, automatic discharge of ashes means elimination of drudgery in fire cleaning. Labor for ash handling in a well laid out plant is negligible.

COMPLETE COMBUSTION—The underfeed method and moving grates intimately mix the proper amount of air and coal, giving perfect combustion.

CATALOG HR-4 SENT ON REQUEST

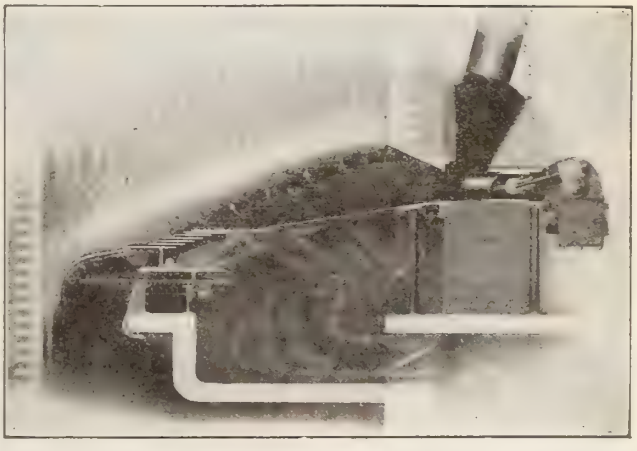
For information on the Murphy Automatic Furnace for small plants see last month's advertisement, or send for Murphy catalog HM-4

Sanford Riley Stoker Co.

WORCESTER, MASS.

British Licensee: Erith's Engineering Co., Ltd., London

French Licensee: Erith, Leroy & Cie., Paris, France



THE STOWE STOKER

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

In addition, the Stowe Stoker abounds in many new applications of other well-recognized principles. One such application is (see illustration across page):

The scientific distribution of the air supply

The *conveying elements* (A) alternate with rows of short, stationary *tuyeres* (B). These tuyeres are interchangeable and are made in several widely-varying percentages of air-space.

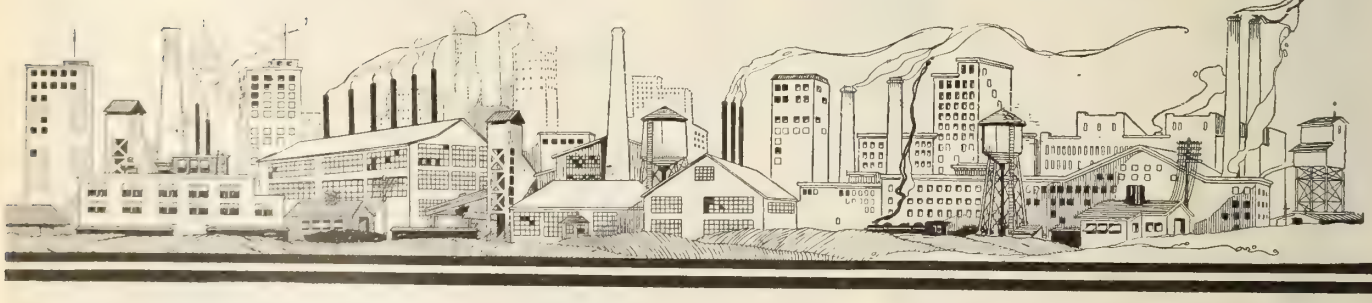
Forced-draft is employed.

Each stage of combustion is provided with the proper tuyere for its particular air requirements.

The fuel-retarding mechanism (C) brings about a heavy fuel-bed at the ash-discharge end of the stoker. This thicker fuel-bed, together with tuyeres of minimum air-opening, reduces the air supply where the fuel is nearly spent; but the intensity of draft is just as effective here as at the forward end, where two to three times as much air is provided to take care of the destructive distillation of bituminous coals.

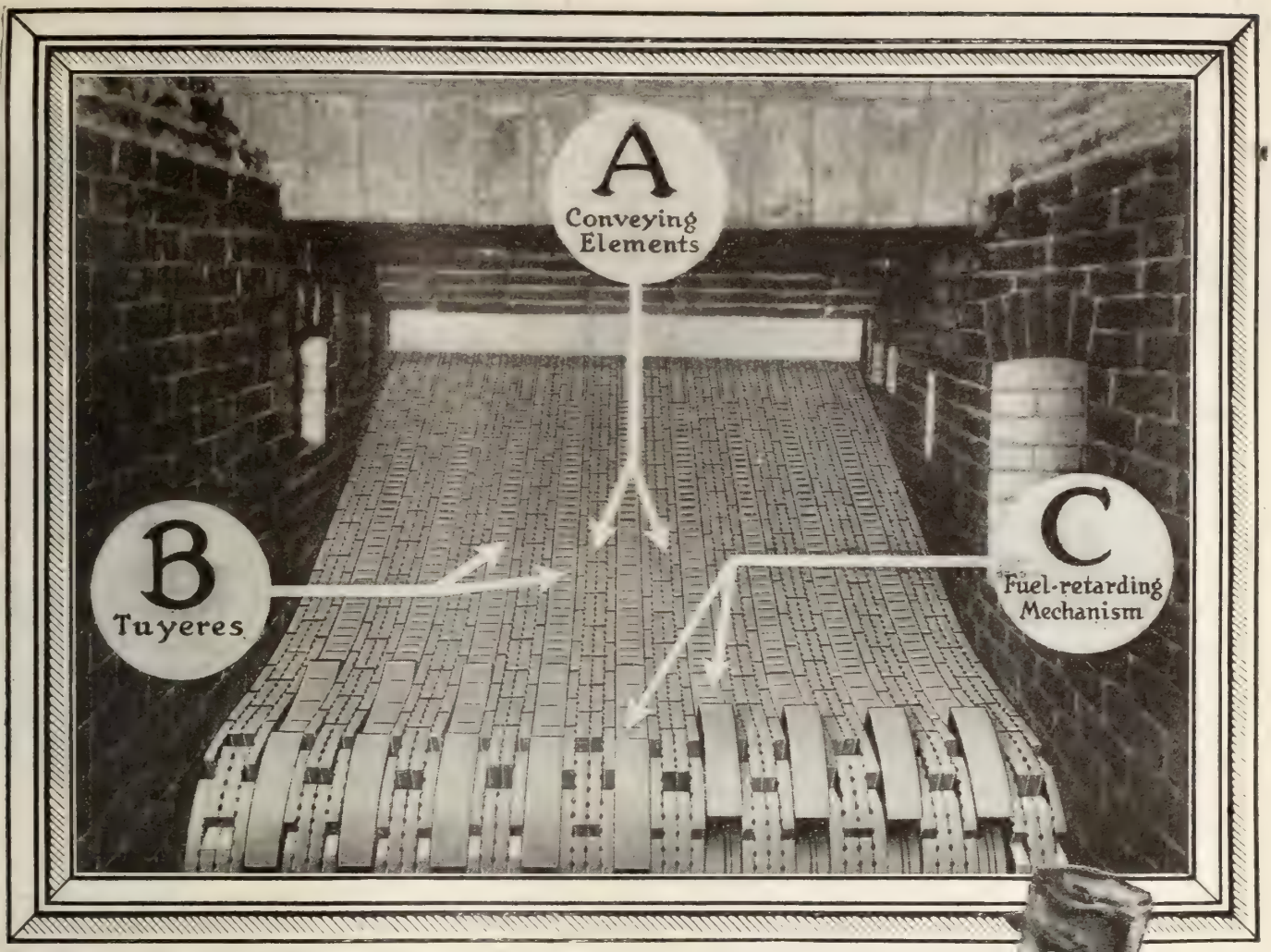
These interchangeable tuyeres, plus the high draft pressure *throughout* assures *correct air distribution* —one vital requisite for high fuel economy.

We also manufacture the L-C Chain Grate Stoker—the Dominant Natural-Draft Type for Higher Volatile Coals



LACLEDE

A BUSINESS INSTITUTION



BRANCH OFFICES:

Chicago 1366 Peoples Gas Bldg.
Pittsburgh, 901 Oliver Bldg.
New York, 504, Fifty E. 42nd St.

DISTRIBUTORS:

A. C. Warner Co.
Bulletin Bldg., Philadelphia, Pa.

Thermal Efficiency Co.
1210 Scarritt Bldg., Kansas City, Mo.

J. R. Purser,
406 Commercial Bank Bldg., Charlotte, N. C

Schwarz Engineering Co.
310 Mack Bldg., Denver, Colo.

Wm. A. Goold
701 Merchants Bank Bldg., Winnepeg, Canada

John C. Russell
109 Place D'Youville, Montreal, Canada

CHRISTY

FOUNDED 1844 ST. LOUIS

Looking Ahead

ONE reason why so many owners of refrigerating plants insist on insulating their cold rooms with Nonpareil Corkboard is because of its established reputation for durability. These men know that under average conditions Nonpareil Corkboard will last practically as long as the building itself.

The main reason for the remarkable durability of Nonpareil Corkboard is the ability of its sole ingredient—clean, ground cork—to resist moisture. Cork, being cellular in structure, possesses no capillary attraction. Therefore, it does not take up moisture from the atmosphere and in a short time become watersoaked, moldy and unfit for use.

The results of insulating refrigerated rooms with Nonpareil Corkboard are low operating costs, long service and practical freedom from repairs.

Sharp freezer in the plant of the Hazelwood Dairy Company, Spokane, Wash. Insulated with Nonpareil Corkboard.

After you have read the interesting book, "Nonpareil Corkboard Insulation," you will realize more clearly why it is that Nonpareil Corkboard is the preference of so many owners of refrigerating plants who appreciate real merit. Send for a copy today.

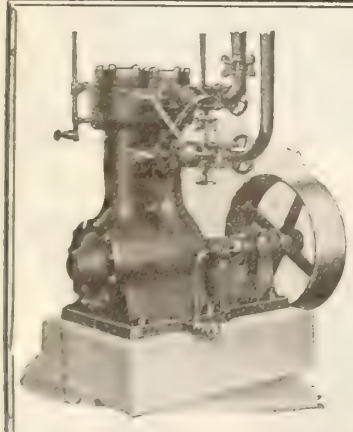
Armstrong Cork & Insulation Company

504 McGill Building, Montreal, Que., Can.

Also manufacturers of Nonpareil Cork Covering for cold pipes; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings, etc.; Nonpareil Cork Machinery Isolation for deadening the noise of machines; Circle A Cork Brick for cold storage room floors; and Linotile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants Equipped With

FRICK Refrigerating Equipment

are much more sanitary than the use of harvested ice—and more convenient.

Get in touch with our Canadian representative and secure from him such information as you desire.

Frick Refrigerating Plants are made to suit every practical condition.

Write for Catalogs

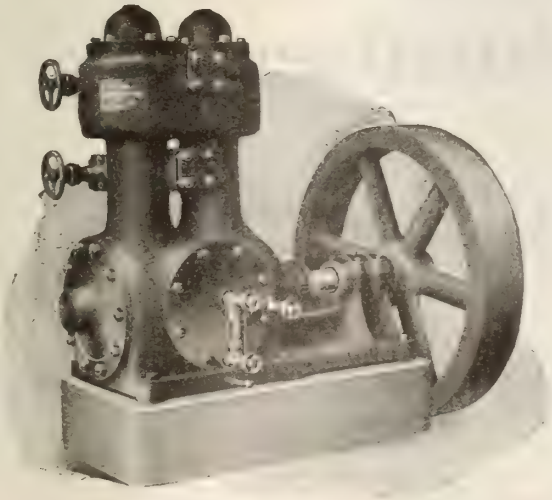
Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION should make it a valuable adjunct to **your** business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of even a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant**, as we find **them substantially made** and the **insulation perfect.** We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are **equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"**The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

The Annual Refrigeration Number of

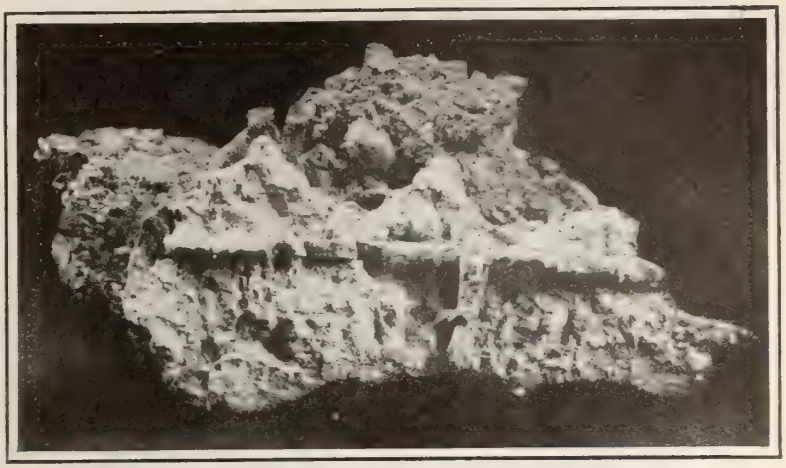
POWER HOUSE

Will Be Issued April 20

This issue presents a splendid opportunity for advertisers of ice and refrigeration equipment to bring their name and lines favorably before the Canadian trade.

Arrange Now for Special Advertising in the REFRIGERATION NUMBER

Why do clinkers stick to fire-box walls?



An example of slice-bar clinker surgery, which would have been unnecessary if the brick had been protected.

THIS picture of a piece of clinker which in being sliced away has taken with it part of the faces of two bricks and the mortar between the bricks is a typical example of the way clinkers destroy fire-boxes.

You know clinkers penetrate the surface of unprotected fire brick and cling to them, and if there is not a perfect joint, the clinkers eat in there as well.

The way to prevent clinkers from penetrating into fire-box walls is to use Johns-Manville Heat Treatment.

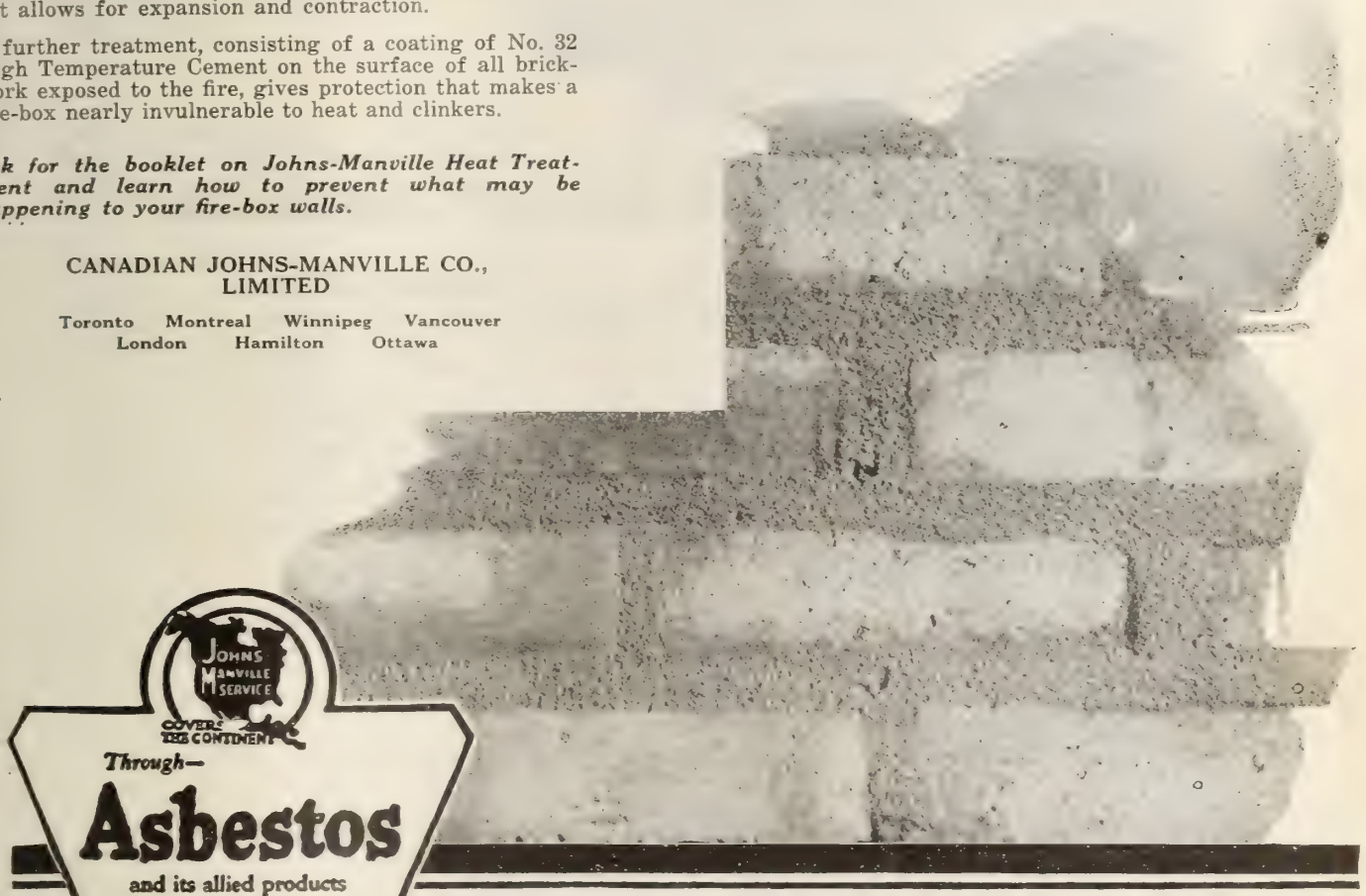
The joints of Johns-Manville No. 26 and 31 High Temperature Cement are extremely elastic and of high tensile strength — they do not fall out from between the bricks. This prevents spalling, which is so common when ordinary, easily loosened fire-clay is used — yet allows for expansion and contraction.

A further treatment, consisting of a coating of No. 32 High Temperature Cement on the surface of all brickwork exposed to the fire, gives protection that makes a fire-box nearly invulnerable to heat and clinkers.

Ask for the booklet on Johns-Manville Heat Treatment and learn how to prevent what may be happening to your fire-box walls.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa



JOHNS MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

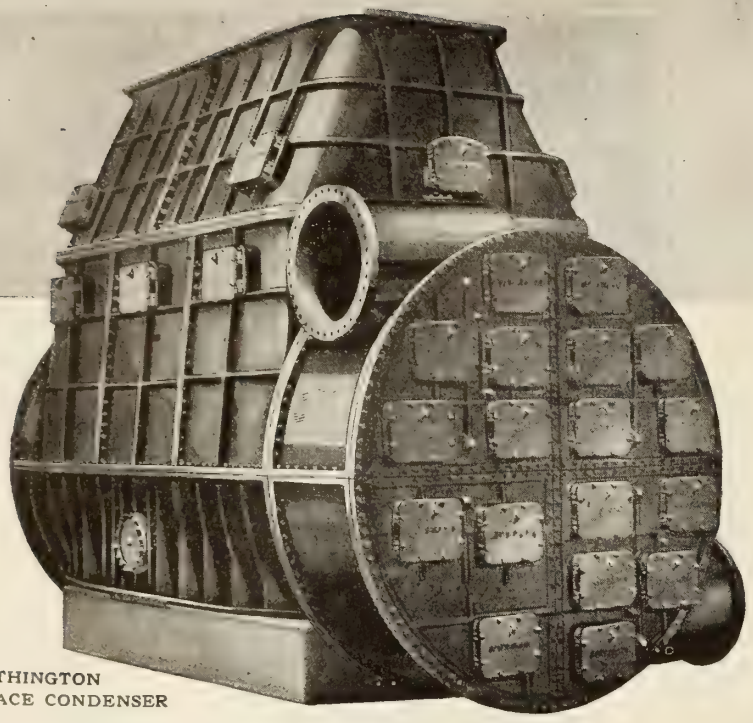
Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE

POWER PLANT MATERIALS

WORTHINGTON POWER PLANT APPARATUS

Oil Engines	Condensers
Compressors	Meters
Pumps	Heaters



WORTHINGTON
SURFACE CONDENSER

Worthington Condensing Apparatus

Worthington plays no favorites in condensing apparatus. All installations are made according to service requirements and type of apparatus is dictated by plant needs.

Since 1840, Worthington has been standard for pumps and pumping machinery; and 80 years in world's service for power plant equipment has resulted in a full, round organization and a range of service and equipment that is unparalleled.

There is no problem in power plant equipment that Worthington engineering service cannot successfully and economically solve with Worthington apparatus.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.

Epping-Carpenter, *Pittsburgh, Pa.*

Laidlaw Works, *Cincinnati, Ohio.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.

Continuous service and low maintenance cost due to the self-cleansing seat

LUNKENHEIMER "DURO"

BLOW-OFF VALVES

Remain tight under the most severe operating conditions because the self-cleansing seat feature eliminates the cause of most of the wear to which Blow-off Valves are subjected.

This self-cleansing seat feature,—exclusive in Lunkenhiemer "Duro" Blow-off Valves, functions automatically when the valves close by cutting off the inlet and allowing only a fine spray of water to pass, thereby removing foreign substances which may have lodged on the seat during the blow-off period.

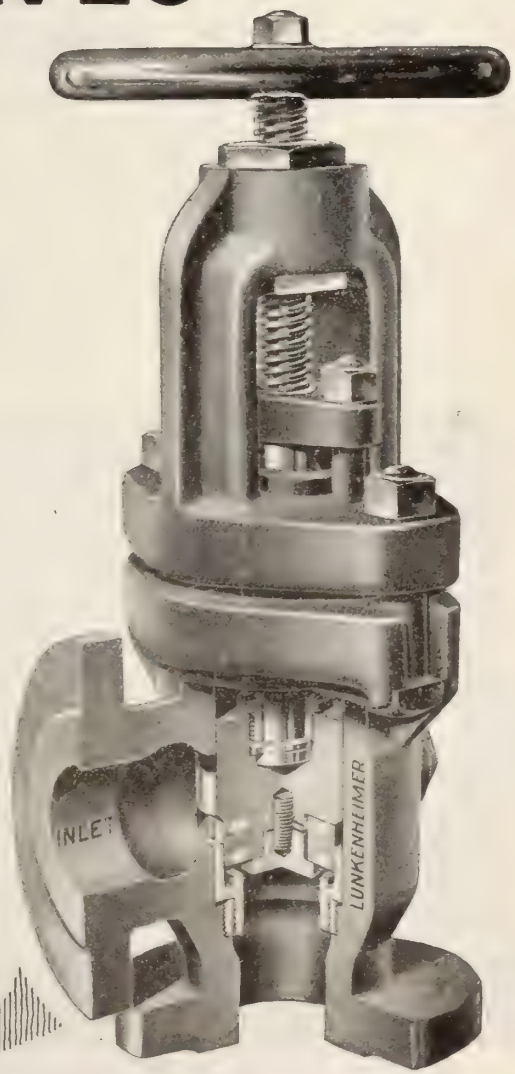
In addition to the self-cleansing seat feature, the disc is reversible and has seat faces made of a durable alloy which readily accomodates itself to any irregularity in the seatring insuring tight though easily operated valves.

To further enhance their durability as a whole, all the parts are renewable.

Lunkenheimer "Duro" Blow-off Valves have proved their merit in service and are specified where boiler mountings of the better grade are desired.

All standard sizes, in material combinations to suit a wide range of pressure and temperature conditions.

Your local dealer can furnish them; if not, write us.
Write for descriptive booklet No. 515-DC



THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

16-19-43

AMERICA'S BEST
LUNKENHEIMER
QUALITY
SINCE 1862

REES RoTURBo

Single and Multi-Stage

Centrifugal Pumps

Self-Regulating

REES RoTURBo Pumps give high and permanent efficiency over a wide range of duties and being **self-regulating** insure the prime mover against overloading.

The low water velocity through all passages results in almost complete freedom from wear, even when pumping gritty water.

These valuable advantages are due to the REES RoTURBo Patent Pressure Chamber Impeller. It has other exceptional features worth knowing about—this appears on opposite page.

Send for Complete Descriptive Catalog

The Goldie & McCulloch Co., Limited

Head Office and Works, GALT, Ontario, Canada

Toronto Office:
Suite 1101-2, Bank of Hamilton Bldg.

Quebec Agents:
Ross & Greig, 400 St. James St., Montreal, Que.

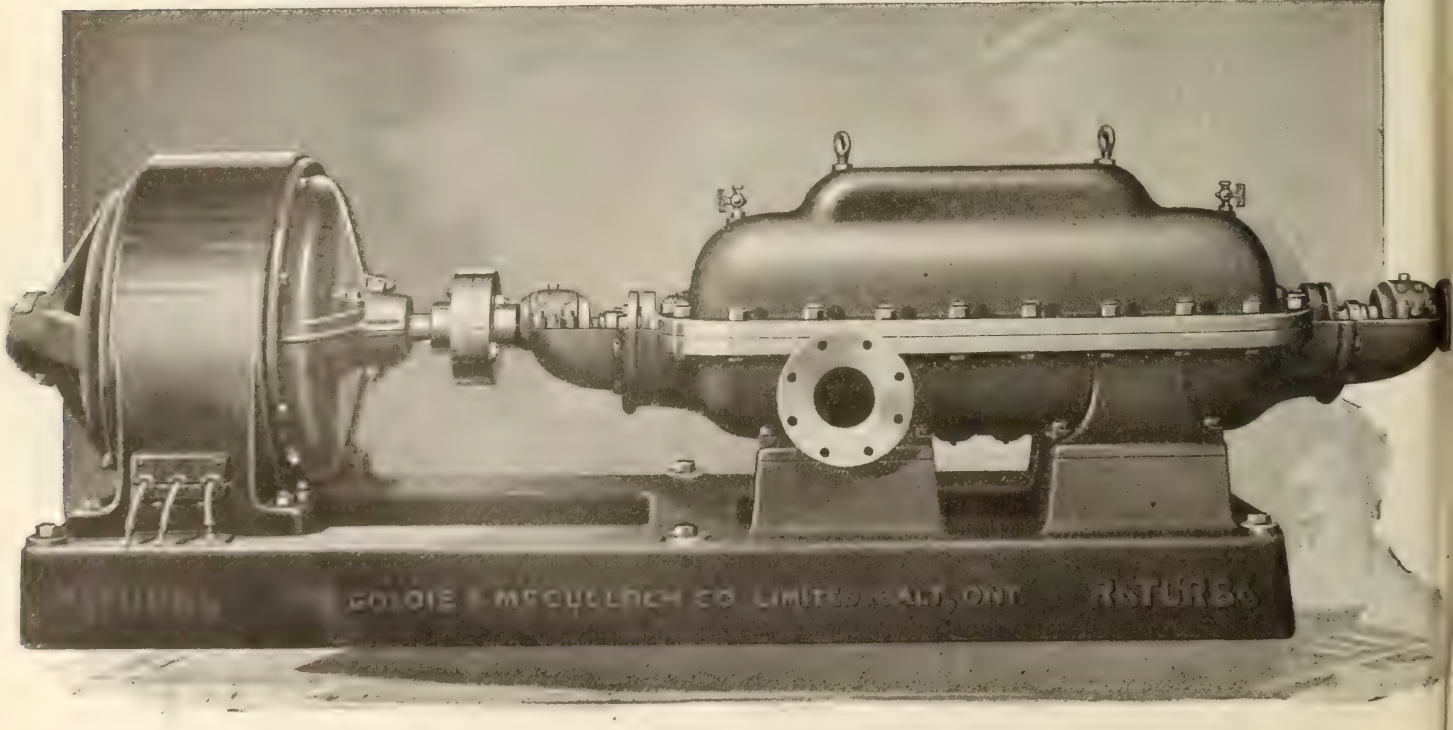
Western Branch:
248 McDermott Ave., Winnipeg, Man.

British Columbia Agents:
Robt. Hamilton & Co., Vancouver, B.C.

Dependable Power Plant Equipment

Made in Canada

We have the sole manufacturing rights in Canada for REES RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Jet Vacuum Pumps.



POWER HOUSE

Established 1907 | Canada, $2.00 per year; U.S. $2.50 per year. | Published Semi-monthly

Power Plant Features of the *Quaker Oats Mills* at Peterborough, Ont.

By W. F. Sutherland

THE Quaker of by-gone days, with his, to our eyes, curious dress and his well-known simplicity of life, would seem to have little in common with present day industry; yet he is one of the characters made most familiar to all of us through present day advertising. When the word "Quaker" comes before our eyes in the course of our reading, we naturally and instinctively associate him with a particular cereal, so dear to the heart of the Scotchman. It is not surprising then, that an extensive industry has grown up around this trade character and it is only to be expected that the power plant would be an important feature in the milling of the rolled oats, wheat flour and other products manufactured by the Quaker Oats Company. This is the case and the present article is devoted to a description of the power plant equipment which supplies energy to their mill at Peterborough, Ont.

While water powers such as Niagara Falls and others of comparative size are spectacular in their picturesqueness and valuable for the amount of power they are capable of developing, many smaller ones exist throughout this country, and these, while of limited size, are of much value in the industrial development of their immediate neighborhood. The River Otonabee flows through Peterborough, and a surprising amount of power is there developed both by the Hydro-Electric Power Commission and by the Quaker Oats Company, which owns its own power plant, and operates it by means of a subsidiary organization known as the Hydraulic Power Company.

Originally built in 1902, the plant now consists of the usual dam and tail race, generating station, a short transmission line and a substation at the mill of the Quaker Oats Company.

River Characteristics

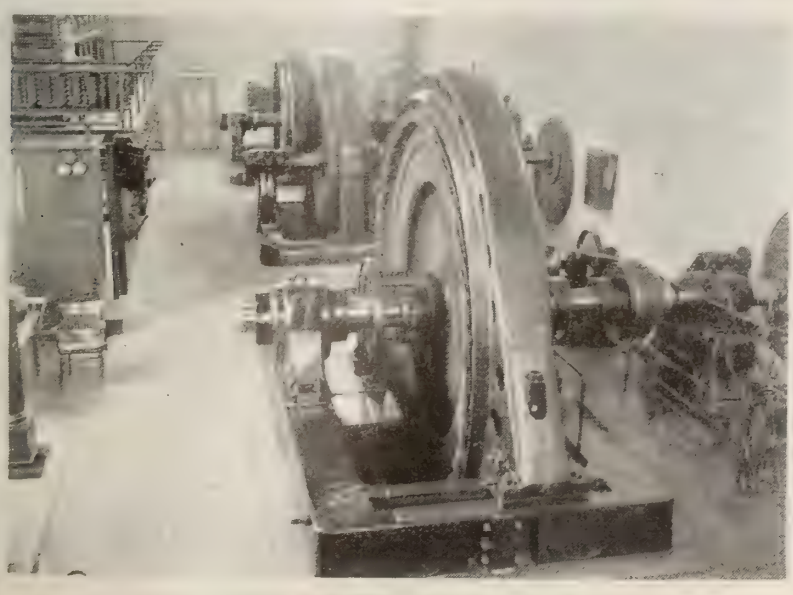
A pondage of about 7,000,000 square feet is created by the dam and a normal head of twenty-eight feet results. The flow is sufficient under the worst summer conditions to generate under the above head 3,000 kw. on 24-hour service. Incidentally the plant is operated continuously 24 hours per day and 365 days a year.

Anchor ice is usually prevalent between the first of December and the end of March but its effects on plant operation are never very serious. It usually settles on the racks and can usually be removed. In the last five years only one shut down has occurred from this source. This is true insofar as the main generating units are concerned, but considerable trouble has been experienced with anchor ice trouble in the exciter wheels, these being smaller and more liable to trouble from this source.

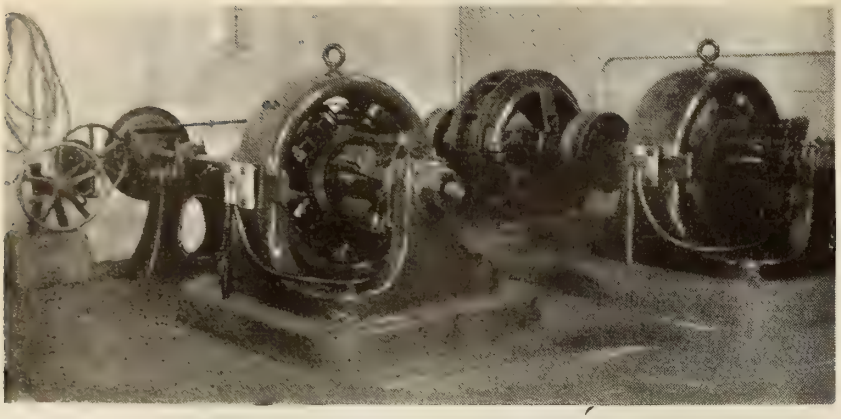
The fore-bay is well designed to eliminate float ice which is carried over the dam and down the river. It is estimated that about 50 per cent. of the winter stream flow is run off for this purpose.

Generators and Wheels

Three direct connected units are installed in the power house with a total



VIEW IN POWER HOUSE SHOWING GENERATORS.



EXCITER SETS IN POWER HOUSE.

capacity of 4,375 K.V.-A. Three-phase power is generated at sixty cycles and 2,300 volts. The first unit, installed in 1902, is rated at 1,500 kv-a and is direct connected to a Samson turbine, made by the Wm. Hamilton Manufacturing Company, Peterborough. The generator is of Canadian Westinghouse make and the unit is controlled by Lombard oil pressure governor. The speed is 150 revolutions per minute.

Unit No. 2 is a Canadian General Electric generator rated at 1,875 kv-a and driven at 180 revs. per minute by a Leffel runner, made by James Leffel and Company, Springfield, Ohio. This runner is in a Wm. Hamilton casing. This unit was installed in 1919 and is the most modern of the three.

Governing is accomplished by a 12.5 in. by 14.7 in. Woodward governor, made by theWoodward Governor Company, Rockford, Ill. It is extremely sensitive, and controls the speed to within very close limits. The oil pressure carried in 200 lbs. per square inch, and means for adjustment is provided so that the amount of gate opening can be controlled at various loads. Safety devices are also fitted and remote control is installed so that the unit can be shut down from the switchboard.

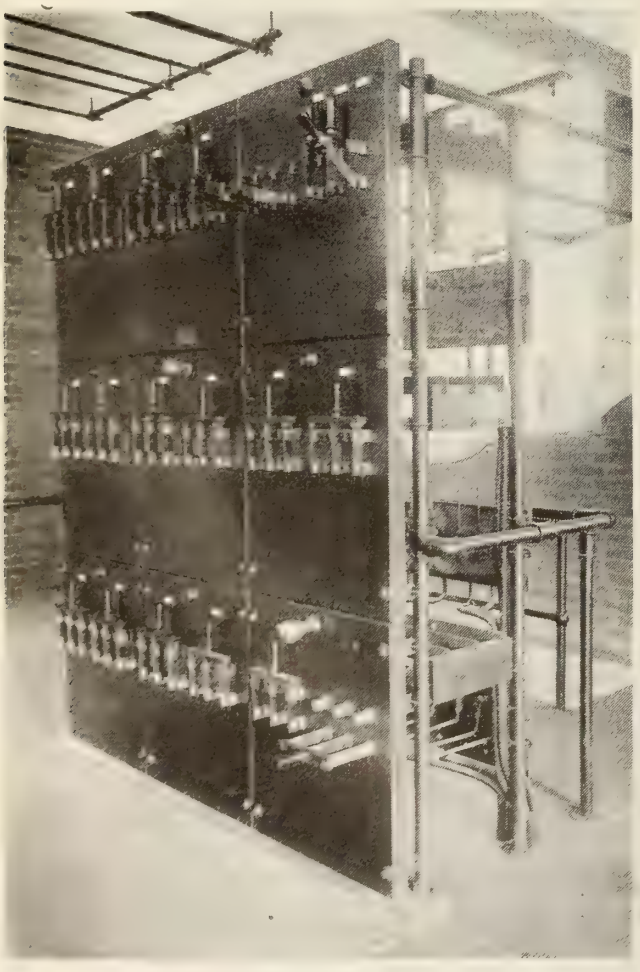
The third generator, installed in 1908, is also of Canadian General Electric manufacture, and is rated at 1,000 kv-a. It is driven at 180 revs. per minute, by a Leffel type wheel and is controlled by a Lombard governor similar to the first one installed.

Exciters

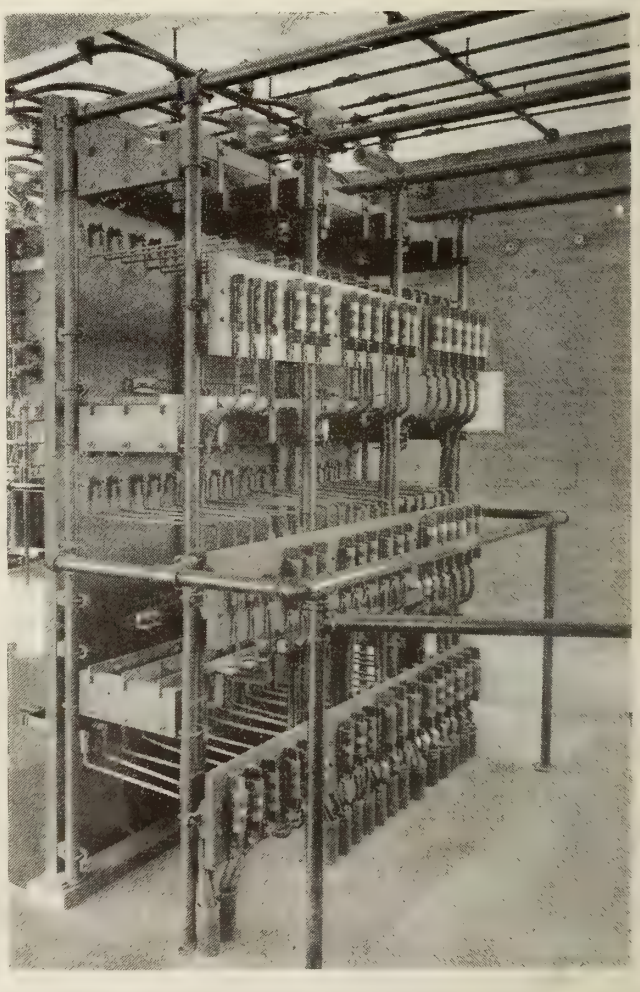
Two exciter units are provided, driven by individual wheels. The first is 75 kw. capacity, and generates current at 125 volts. The speed of the wheel and generator is 454 revs. per minute. The second unit is of similar construction and size, except for the fact that the generator has been moved forward and an induction motor, direct connected between the wheel and the generator. This induction motor is of 100 h. p. capacity and takes energy from the station busbars at 2,200 volts. Anchor ice trouble is overcome by its aid, for so soon as the exciter slows down the motor picks up the load and carries on till free running conditions are restored again.

Operating Characteristics

Mention has been made of the fact that anchor ice causes little trouble. Little has b en experienced from other causes and since the capacity of the plant is more than ample, one generator is usually held in reserve, each generator being cut out in turn. Every fall the wheels are thoroughly overhauled as well as the generators and the latter are painted.



FRONT VIEW OF LIGHTING BOARD IN SUBSTATION.



REAR VIEW OF LIGHTING BOARD, SHOWING BUSSES

Switchboard

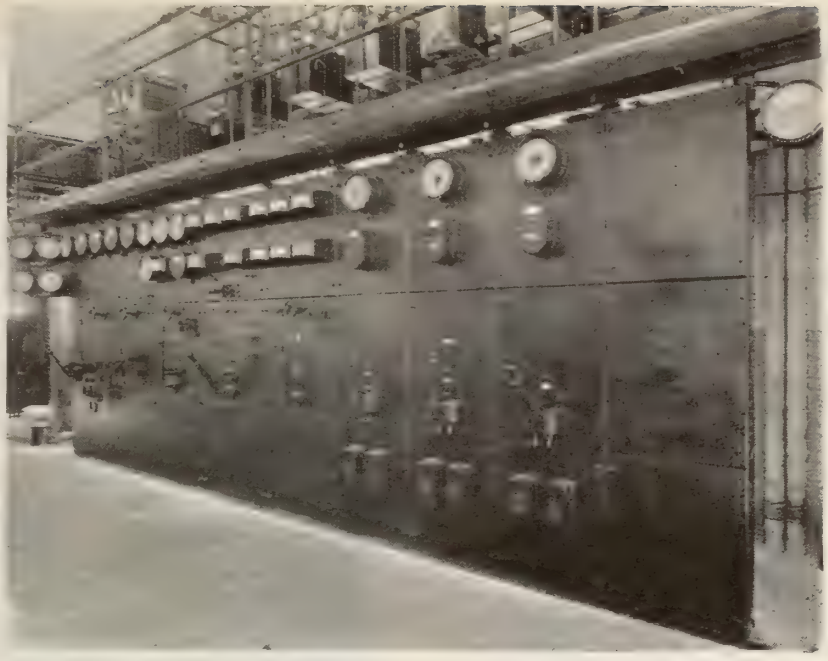
The switchboard in its present shape was installed by the Northern Electric Company, and carries the main generator control panels together with exciter panels, etc. The 2,200 volt bus-bars, and oil switches are mounted above on a gallery, and control is effected by mechanical remote control from the switchboard below.

The swinging bracket on the left of the board carries two voltmeters, a synchronoscope and a frequency meter. The panel controls the induction motor on the exciter set. It carries an ammeter, Canadian Westinghouse overload series trip relays and Condit oil switch control. A synchronizing plug and an ammeter jack for testing ammeter and relays, completes the equipment.

The next two panels are exciter panels, and both are provided with ammeter, voltmeter of Westinghouse make; field rheostat control, and a three-pole 250-volt, 1,000-amp. switch.

The fourth panel controls the 1,500 kv-a generator, and is fitted with the usual equipment, ammeters, indicating polyphase wattmeter, power factor meter, d. c. field ammeter, field switch and rheostat, and a governor control switch. A Condit oil switch of 800 amp. capacity controls the output of this generator.

The net panel controls the 1,875 K.V.-A. machine, and its equipment is in some respects different from that mounted on the one just described. Only one ammeter is mounted instead of the three on the Westinghouse panel. A temperature indicator is mounted on this panel which indicates in degrees centigrade the temperature at four different places in the coils of the generator. Temperature coils are inserted in field coils at the top, bottom and each side, and the operator controls the output solely from the indication thus furnished. A power factor indicator an indicating wattmeter, and a d. c. ammeter complete the metering equipment. The field rheostat is of the remote controlled type. An 800 ampere Condit oil switch, hand operated, remote controlled, is installed and the governor control button is also mounted.



FRONT VIEW OF MAIN SWITCHBOARD IN POWER HOUSE.

The third generator panel is exactly similar to the last one described, but without the temperature indicator.

Feeders

Three feeds run from the power house to the mill substation, and provision has been made for a fourth. The first of these is of 300 amp. capacity, and takes care of the lighting load. The switchboard panel is equipped with a Sangamo integrating wattmeter, a control handle for the Condit 300 amp. oil switch and two overload series trip relays.

The other two feeders are equipped in a similar manner, except that 800 amp. switches are installed and the wiring is increased in size to correspond.

The usual current and potential transformers, together with disconnecting switches, for isolating parts of the circuit upon which work is being done, are all installed in the switch structure above. Two static ground detectors are installed.

The feeders are carried down from the switch structure to the floor and underneath it to the wall, where they rise to the lightning arrester gallery immediately under the roof. Here they pass out and overhead to the substation. The lightning arresters are of the electrolytic aluminum cell type.

From the power plant a short pole-line carries the 2,300 volt feeders to the substation located adjacent to the mills and to one side of them.

GENERAL VIEW OF SUBSTATION SHOWING ARRANGEMENT OF TRANSFORMERS LOW TENSION DELTAS AND LEADS.

Substation Layout

The present substation is a thoroughly modern structure and represents the latest in construction and layout. It is a two-storey structure of brick and reinforced concrete. The first floor is laid out to accommodate the power transformers. This floor is provided with a mezzanine or gallery which provides access to low tension bus-bars, junction boxes, etc., and also carries a portion of the lighting transformer equipment. The second floor is laid out as a switchroom and here all the switchboards, high-tension, power, and lighting are located; the lightning arresters for the incoming high tension lines are also located on this floor.

On this level, access is had to the main mill buildings by a bridge, crossing over the tracks below. This bridge also serves to carry all the power and lighting feeder conduits to the mill.

High Tension

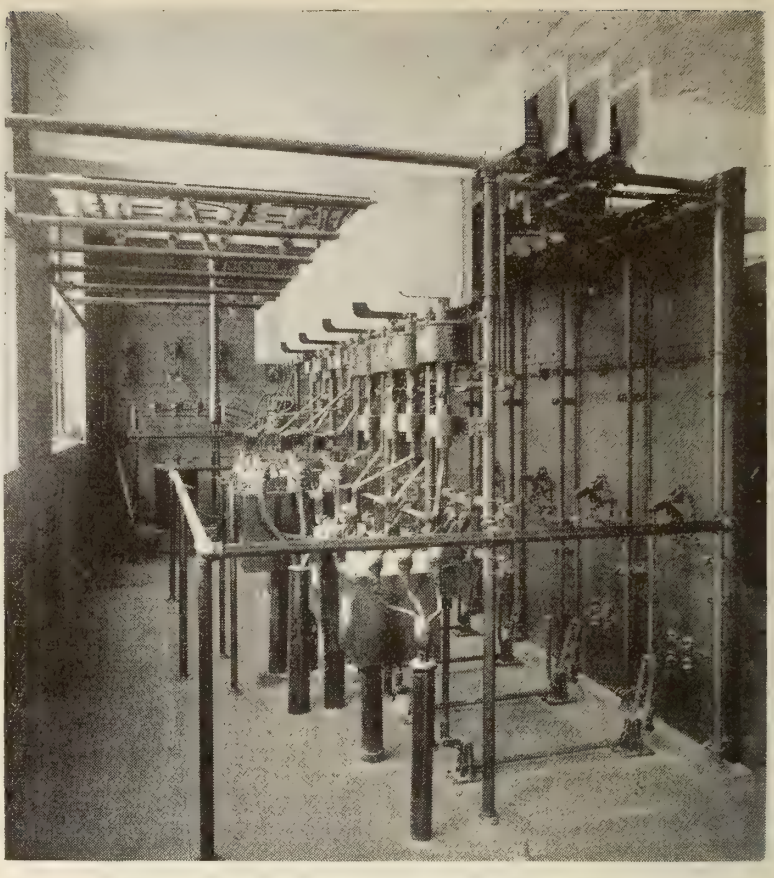
The high tension feeders for power and lighting enter below the roof

through wall bushings. Canadian General Electric lightning arresters, of the electrolytic type are provided, and the usual choke coils and disconnecting switches are installed. The two power feeders are each 500 M.C.M. cable while the lighting feeder is No. O.

2,300-Volt Switchboard

The 2,300 volt switchboard contains six panels as will be seen from the accompanying illustration. The first panel from the left controls a 2,300 volt feeder direct to the soft wheat mill and the one next to it, a similar feeder to the hard wheat mill. The equipment for both these feeders is the same, 300 amp. Condit oil switches, Westinghouse single pole circuit opening relays, Weston ammeter and Sangamo wattmeters. It will be noticed that only one ammeter is mounted on each panel although the circuits are three-phase. Only one is necessary since the feeders operate induction motors and all phases are balanced. The next two panels are equipped with the necessary oil switches, relays and ammeters for controlling the high tension side of the two banks of transformers. The switches are 800 amp. Condit oil switches equipped with the usual trip coils and in addition overload releases. These latter are not used for the opening of the breakers under overload conditions but form part of a safety trip circuit possessing some novel features.

Each bank of transformers is fed from the bus-bars through disconnecting switches and the oil switch. The secondary side is not provided with oil switch nor circuit breaker but in their stead knife switches are installed on the low tension board. It would be thus possible for an operator to attempt to open these under load with disastrous results. To obviate this, auxiliary contacts are provided on the knife switches and when the switch is opened a fraction of an inch these complete the circuit through the overload coils on the oil circuit breakers, thus tripping them. It is then impossible for the attendant to open the knife switches under load since the transformer will be cut out and the only current flowing will be magnetizing current from the low tension bus-bars. When the oil switch is opened the auxiliary trip circuit is automatically broken by an additional set of contacts located on the oil switch mechanism.



REAR VIEW OF 2200 VOLT SWITCHBOARD IN SUBSTATION

The next panel is spare and the last one controls the high tension side of the lighting transformers. It is provided with a Condit 300 amp. oil switch, reverse current relay and Weston ammeter. In this case some unbalance of load may be expected and for this reason an ammeter jack is provided by which readings may be taken on any phase.

The lighting feeder is the only one equipped with an oil switch the two power feeders being tied in solidly on the bus, disconnecting switches only being provided.

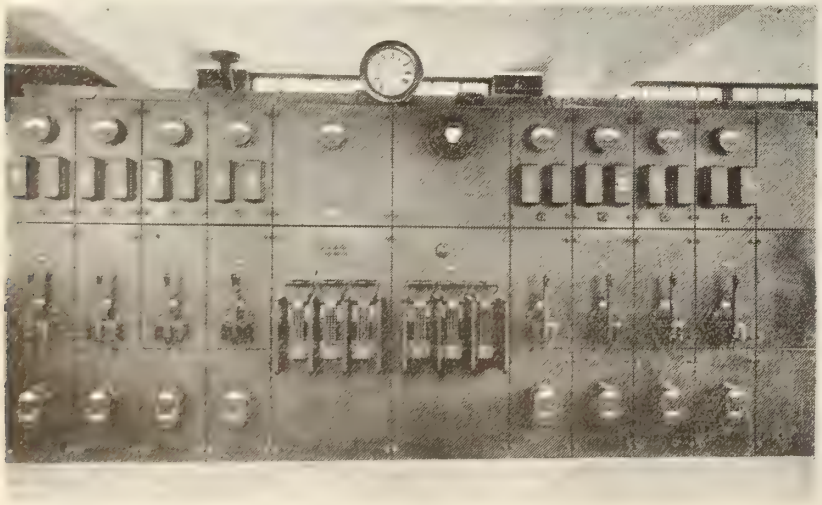
The oil switches are all pipe mounted at the rear of the board and it will be noticed that attention has been paid to the safe guarding of all live parts. The bus-bars and individual phases of the disconnecting switches are all separated by barriers. The two 2,200 volt mill feeders are equipped with two sets of current transformers, one for relay operation and the other for ammeters.

Power Board

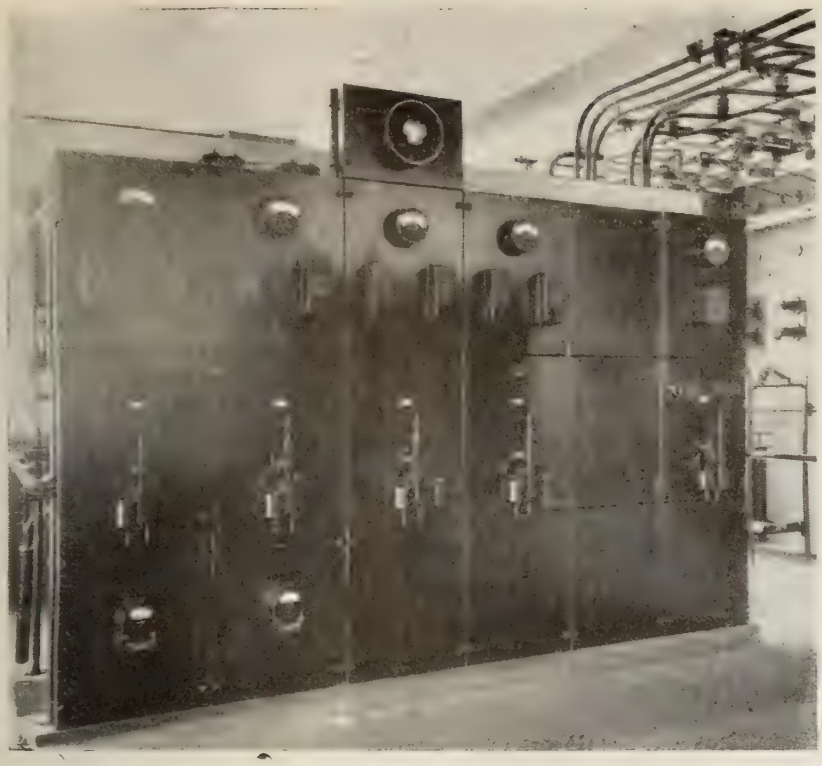
Except for the several large 2,200 volt motors all power for mill drive is supplied at 550 volts. The 550 volt board contains eleven panels, eight of them controlling mill feeders and one spare. The two remaining panels are used for the secondary transformer switches.

The feeder panels are 16 in. wide and mount the Condit oil switches, Westinghouse inverse time limit circuit opening relays, and metering equipment. One Weston ammeter and a Sangamo polyphase wattmeter serve to meter the load. Four of the oil switches are 800 amp. and the remaining four are of 500 amp. capacity.

The two transformer panels carry the transformer switches. These are of the single pole, single throw type and of 3,000 amp. capacity. As mentioned above each switch is fitted with an auxiliary contact which trips the oil switch on the high tension side if through inadvertence, they are opened under load. One of the



REAR VIEW OF 550 VOLT SWITCHBOARD IN SUBSTATION.



FRONT VIEW OF 2200 VOLT SWITCHBOARD IN SUBSTATION.

transformer panels carries a Weston volt meter and volt meter plugs while the other carries a ground detector.

The rear of this board, shown in one of the accompanying illustration, is of interest. The oil switches are mounted on pipe framework free of the slate panels and are operated by the usual pipe mechanism. Each circuit is provided with disconnecting switches placed between the current transformers and the bus-bars. Two sets of transformers are mounted on each feeder, one for the relays and the other for the metering equipment. The low tension leads from the transformers to the knife switches and from them to the bus-bars are encased in asbestos wood for protection. All live parts are securely taped or otherwise insulated where accidental contact is apt to occur.

The 800 ampere feeders are of 800 M.C.M. capacity two 400 M.C.M. leads being run in parallel for each phase. The 500 ampere feeder is of 500 M.C.M. capacity. All leads are taken in conduit through the floor to a junction box at the end of the run to the mill.

Lighting Switchboard

Mention has been made of the fact that a 2,300 volt feeder is run direct from the power plant to the substation for lighting purposes. This feeder passes through a 2,300 volt oil switch on the high tension board and then goes to the lighting transformers below. These are six in number and are of 40 kw. capacity each. The secondaries are brought out three wire 110/220 volt, each separate phase being carried to a separate bus on the lighting board.

This lighting board consists of three 24 in. panels mounting in all 18 three pole knife switches. The first panel from the left controls the transformer secondaries and mounts six switches. The remaining switches control the lighting feeders to the various departments of the mill.

One noticeable feature of this board is the absence of fuses in front. All circuits are fused and by reference to the accompanying illustration it will be seen that these are arranged in a very neat manner at the rear. Each circuit is taken off the bus-bars by means of flat copper to the upper terminal of the knife-switches and from these to the fuse-blocks by means of round copper. From the fuse-blocks the circuits are taken to the floor level where conduit is provided. The three sets of bus bars are noticeable in the illustration.

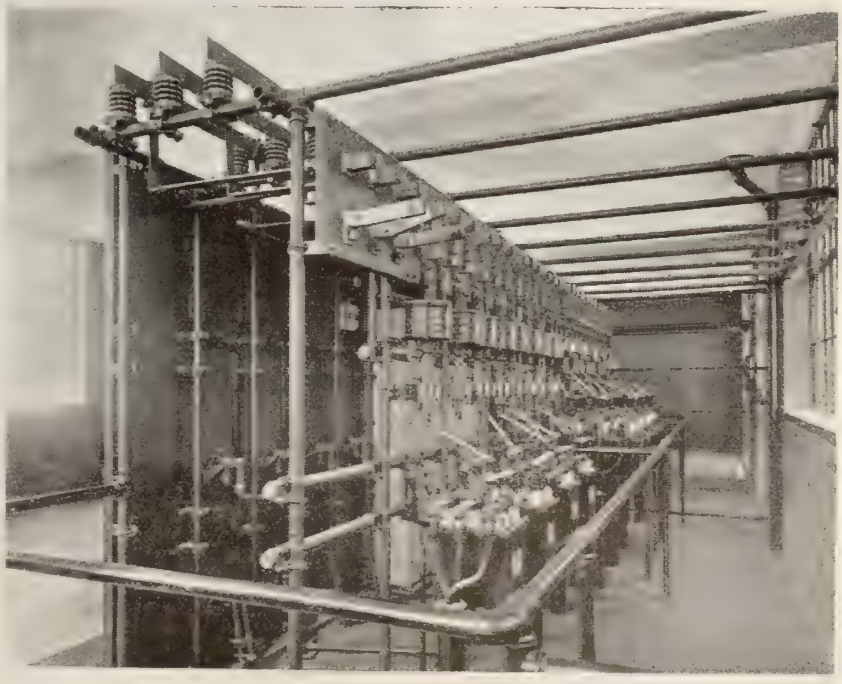
It may be mentioned in passing that all the switchboards were installed complete by the Northern Electric Company of Montreal and Toronto.

Transformer Equipment

Two banks of power transformers are installed. Each consists of three 666 kv-a single phase, oil insulated, self-cooled Canadian General Electric transformers. Each bank is connected up delta-delta. The transformers are placed on raised platforms and are mounted on wheels running on tracks which engage with tracks of a like gauge on a portable truck running lengthwise of the building. It is thus an easy matter to remove any transformer in case of failure. All transformers are provided with a two-inch connection to an oil tank. Provision is thus made for draining and filtering the oil when such is required.

The illustration in which the transformers are seen, shows the arrangement of the low tension leads and deltas to advantage. The low tension copper is suspended from the gallery and ceiling by means of a pipe framework.

A feature of the motor drive in the mill is the direct connection of two of the larger slow-speed motors to the line shafts they serve. This feature, together with other motor drives, will be described in a later article, together with some of the more interesting belt drives installed by Sadler & Haworth, Toronto.



FRONT VIEW OF 550 VOLT POWER BOARD IN SUBSTATION.

The Possibilities of Pulverized Fuel—II

Concluding Portion of an Article on Pulverized Fuel Abstracted From the Report on Pulverized Fuel Issued by the Commission of Conservation

By WILLIAM J. DICK, M. Sc.

Puget Sound Traction, Light and Power Company

In describing the results secured from the operation of a test plant for the Puget Sound Traction, Light and Power Co., Mr. Henry Hull says:

Prompted by the large amount of unmarketable fine coal, which is piled up at numerous nearby coal mines, the Puget Sound Traction, Light and Power Company has investigated the practicability of burning pulverized coal. This coal is a form of lignite particularly adapted to use in the pulverized form, owing to the high volatile constituent and the very high fusing point of the ash. To prepare this coal for burning it must first be thoroughly dried and the moisture content reduced to approximately 1 per cent. before it can be properly pulverized. It must then be ground until approximately 85 per cent. will pass through a 200-mesh screen and 95 per cent. through a 100-mesh screen if the best results are to be obtained. It should then be fed directly to the furnace, or, if transportation or storage is necessary, it should be kept air-tight so far as possible to prevent absorption of moisture.

The coal which has been investigated by the Puget Sound Company is dried and pulverized by the Pacific Coast Coal Company at its briquetting plant, near Renton, which is equipped with a Raymond pulverizing plant. It is then loaded in a box car having a metal-lined hopper. The car is spotted at the steam plant over a chute which is connected to the car by a flexible hose. The chute feeds a small metal-housed conveyor, which elevates and dumps the coal into a bunker adjoining the power plant. From the bottom of this the fuel is fed, by means of two motor-driven screws, into a 3-inch (7.62-cm.) supply pipe, through which it is then blown to the front of the furnace. At this point the fuel is discharged into the side of an injector, consisting of a 16-inch (38.1-cm.) drum, surrounding a nozzle on the end of a 10-inch (25.4-cm.) air-supply pipe. Dampers are provided in the drum and air pipe to regulate the amount of air supplied to the combustion chamber. In starting operation the coal dust is allowed to drop on an oil flame, although any small fire built under the fuel discharge pipe would have the same effect. An extended Dutch oven, with a broad arch, is used to assist ignition, as considerable combustion space is required to secure satisfactory results, a parabolic shape being most desirable. Fire cannot travel back into the fuel supply pipe as long as the rate of air supply is greater than that of fuel propagation.

A record of a 12.8-hour test on the equipment is given herewith. The duration of the test was limited by the facilities for storage and handling of the fuel. The coal was weighed in the car as delivered to the plant and the net weight determined by a subsequent weighing of the car after unloading. The test was run until all coal was consumed. The water was measured by a Venturi water meter installed in an individual feed line to the boiler, and all instruments were checked for accuracy before starting.

During the test it was noted that the boiler could be forced to 200 per cent. of rating without any apparent damage to brick setting or tubes. The stack was perfectly clear under these conditions, and there was no fusing of the ash. About one-third of the ash was found deposited in the second and third passes of the boiler, none whatever being found to have collected on the tubes.

Test of 300-Horsepower B. and W. Boiler Burning Pulverized Coal

(Coal analysis)

Moisture	5.4
Volatile	37.2
Fixed carbon	37.
Ash	10.4
Sulphur	0.56
B.T.U.	11,760

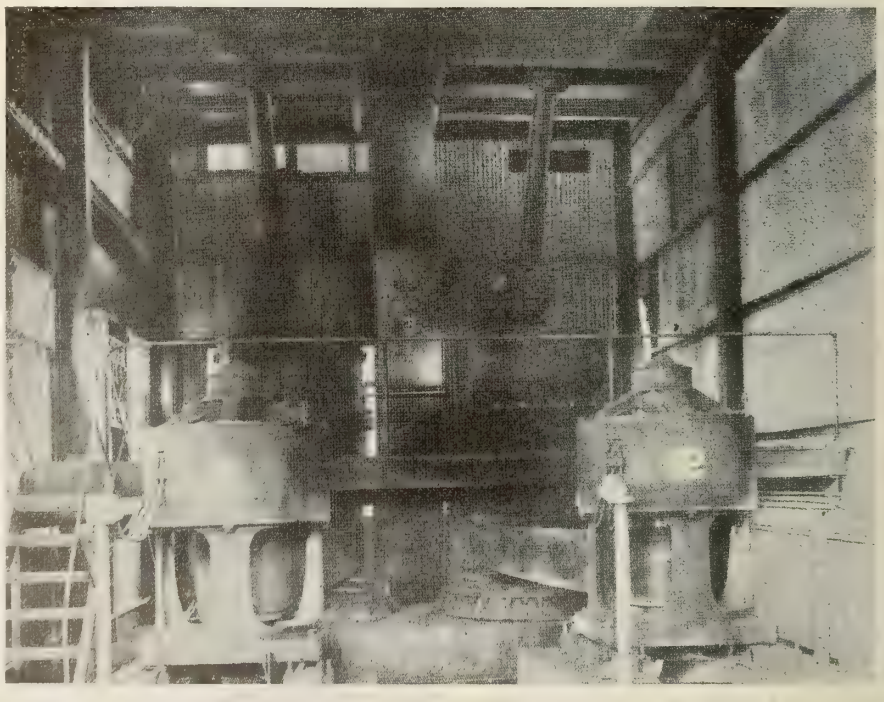
(Ash Analysis)

SiO_2	44
FeO	10.45
Al_2O_3	32.88
CaO	7.75
MgO	2.40

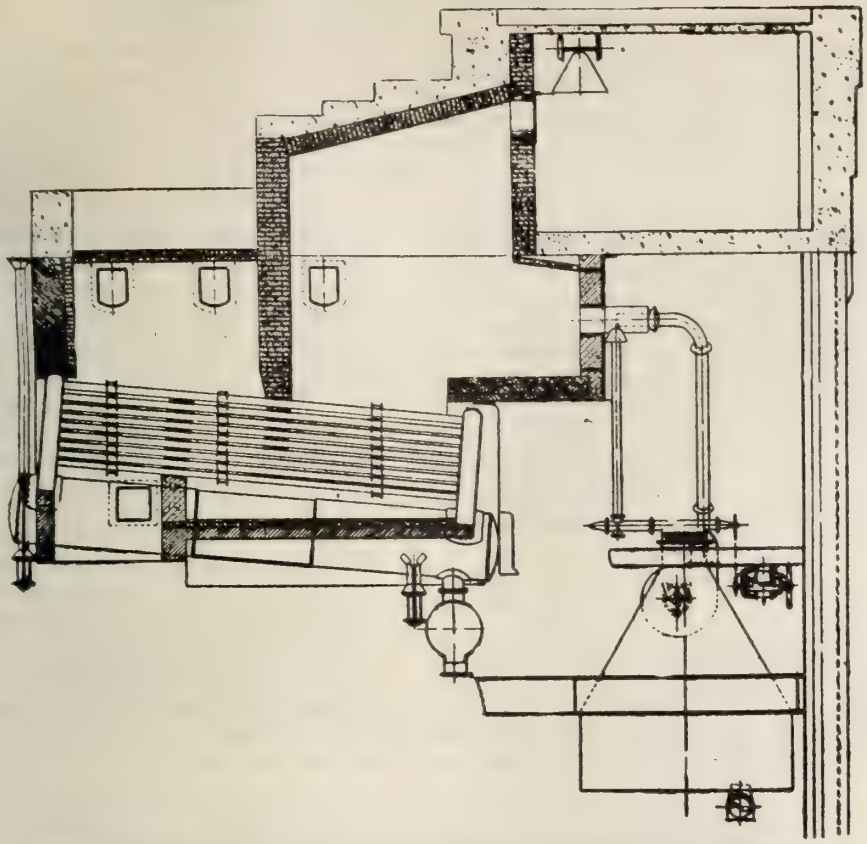
(Screen Test of Coal)

Per cent. of coal passing on 100 mesh	5.8
Per cent. of coal passing through 100 on 200-mesh	34.6
Per cent. of coal passing through 200-mesh	59.6
Duration of test (hours)	12.8
Average boiler-horsepower developed	357
Total water evaporated (lbs.)	143,231
Average temperature of feed water (deg. Fahr.)	185.
Average steam pressure (lbs. gauge)	106.5
Average temperature of steam (deg. Fahr.)	399
Average flue-gas temperature (deg. Fahr.)	528
Average draft at uptake (ins. water)	0.17
Average flue-gas analysis, in per cent.:	
CO_2	17
Oxygen	2
CO	0
Total coal burned (lbs.)	18,389
Actual evaporation per lb. of coal (lbs.)	7.8
Equivalent evaporation from and at 212 deg. Fahr. (lbs.)	8.6
Boiler efficiency (per cent.)	71

The result of the experiment tends to refute most of the adverse criticism of this method of burning coal. There was no formation of slag in the furnace or on the tubes, there was no shower of cinders and ashes emitted from the smokestack, and



FULLER LEHEIGH PULVERIZER MILLS FOR PULVERIZING LOW GRADE COAL FOR BURNING UNDER BOILERS. MISSOURI KANSAS AND TOPEKA RY., PARSONS, KAN.



CROSS-SECTION OF 250-H.P. O'BRIEN BOILER AT PARSONS, KAN., SHOWING GENERAL ARRANGEMENT.

there was no damage done the boiler from heavy overload under these conditions.

From the experiments in burning these various fuels it was found that—assuming pea coal at $1.60 per gross ton ($1.76 per net ton)—the prices which could be paid for other fuels on the basis of equal heating values are as follows: Pea coal on chain grates, $1.60 per gross ton, delivered; fuel oil 56 cents per barrel, delivered, and pulverized coal, $2.20 per gross ton, delivered.

The temporary plant was designed by E. B. Powell, of the Stone and Webster Engineering Corporation. of Boston, Mass.

The Puget Sound Traction, Light and Power Company have recently installed a pulverized fuel plant and have converted all their boilers for the use of this class of fuel.

Metallurgical Industries

The application of pulverized fuel has been developed to a very considerable extent in connection with various kinds of metallurgical work.

In the iron and steel industry some 2,000,000 tons is used annually in various types of furnaces, such as open hearth, heating, puddling, soaking pits, continuous heating, reheating, annealing, forging furnaces, and furnaces of practically every description where heat is required.

It is very evident that the future possibilities of the application of pulverized coal are now being recognized by the large steel companies as a subject worthy of their careful investigation. The Manitoba Bridge Company is installing a pulverized coal plant in connection with its open hearth steel furnace at Selkirk, Man. The Armstrong-Whitworth Company, of Longueuil, Que., has installed a plant for its heating furnaces.

A great development has taken place in the application of this class of fuel in connection with the copper industry—ore-roasting furnaces, reverberatory and copper-melting furnaces of all types. Between 1,000,000 and 2,000,000 tons of pulverized coal is used in this industry alone each year.

International Nickel Co., Copper Cliff, Ontario

When the reverberatory plant of the International Nickel Co., at Copper Cliff, Ont. was built in 1911, the furnaces were designed to be fired with pulverized coal, and the necessary machinery for preparing the coal was installed.

The original furnaces were put in commission in December, 1911, and almost from the first the new method of firing proved a success. There was some trouble from ash accumulating at the throat, but, when the furnaces had been brought up to a good smelting rate, this ceased to cause any serious inconvenience. Some ash always tends to deposit at this point, and it should be removed each day. It is in a semi-molten state when deposited, and tends to build up rapidly if not removed at regular intervals. Pulverized coal has been used in this plant ever since, and there has been no reason to doubt the wisdom of adopting it. In the last few years the use of pulverized coal in reverberatory work has almost entirely supplanted grate-firing, and in a number of instances has even replaced oil-firing.

Pulverized Coal for Power Purposes

Replying to a request for information, Mr. Blythe D. Rogers, President of the British Columbia Sugar Refining Co., Ltd., of Vancouver, B.C., gave the following data:

"We require sufficient fuel to maintain 2,500 boiler horse-power at about 175 per cent. rating, or something over 4,000 actual horse-power. The coal used is an unwashed slack coal, containing about 33 per cent. ash, and having a calorific value of about 9,300 B.t.u. For the specified horse-power, we require to pulverize about 125 tons of coal per day, spread over a period of twenty-four hours. For this purpose we have installed a dryer, heated by means of pulverized coal, and three Fuller mills, each capable of pulverizing from five to seven tons per hour. Additional equipment consists of a magnetic pulley for separating iron particles, nails, bolts, etc. from the coal, a crusher for breaking up large lumps and the necessary bins, conveyors, etc. The whole plant requires a separate building about 120 by 40 feet, and 40 feet high.

"In the boiler room the coal is fed by screw-feed mechanism to the furnace, where it is caught up by a current of air and blown into the furnace. Little alteration had to be made to the return-tubular boilers on account of their large combustion chamber, but in both sets of water-tube boilers (Badenhausen and Babcock & Wilcox) Dutch ovens had to be built, as pulverized coal requires a very much larger furnace than oil producing equal horse-power.

"As far as we have gone with the experiments to date, the installation has proved very satisfactory from an economical standpoint. At 160 per cent. of rating the combined boiler and furnace efficiency is 76 per cent. under test condition.

"The drawbacks not yet overcome consist mostly of trouble with ash, which is natural in a coal of such high ash percentage. Tubes in return-tubular boilers plug solid with ash in a very short time. Beside this, large quantities of dust are thrown out into the atmosphere from the stacks, which constitutes a very serious difficulty; this we are grappling with at present. I believe that, with this problem satisfactorily solved the installation of pulverized coal will be shown to be an unqualified success."

Pulverized Fuel Installation, Parsons, Kansas

In 1916, the Missouri, Kansas and Texas railway installed a plant at Parsons, Kansas, for preparing and burning pulverized low-grade coals, including lignite, under boilers, This installation is stated to be the largest commercial installation of its kind in existence.

The boiler plant consists of eight O'Brien 250-h.p. boilers arranged in one continuous row of three-and-one batteries, respectively, there being a space between the settings of each pair of two boilers of 4 ft. 8 inches, and a space between the two batteries of 28 ft. 4 inches for feed pumps, auxiliaries, etc. At one end space is allowed for four more boilers. The boilers carry 150 pounds per sq. in. steam pressure; the temperature of feed water is 208 deg. Fahr. Based on a boiler efficiency of 70 per cent., operating full capacity for 10 hours, and half capacity for 14 hours, about 79 tons of coal would be consumed in 24 hours by ten boilers. When the installation is complete a total of 94 tons, per day of 24 hours, will be required. The principal advantage derived from the use of pulverized coal at this plant is that inferior grades of coal can be burned successfully, also, its use in the boiler-room reduces the number of attendants to a minimum. This reduction in labor costs

partially offsets the cost of pulverizing the coal.

Pulverizing Plant

The coal is dumped directly from the cars into a concrete-and-steel hopper beneath the track. As a large percentage of the coal is run-of-mine the coal from the hopper is crushed by a 20 x 24-in. spike-toothed roll crusher. From the crusher the coal is elevated by a 20-in. belt conveyor through an inclined tunnel and discharged into the coal plant. At the discharge end of the conveyor the coal is passed through a magnetic separator and discharged into a pair of 28 x 18-in. corrugated rolls. From the rolls the crushed coal is elevated, discharged into a screw conveyor and carried to a 40-ton bin situated at the back end of the dryer. From the bottom of the bin the coal is fed by screw-conveyor to the back end of a 4 1-2 x 30—foot indirect-fired rotary dryer. From the dryer the coal is elevated and discharged into a 45-ton bin situated over the pulverizers. The pulverizing plant consists of two 75-ton pulverizing mills, furnished by the Fuller Company. From the mills the pulverized coal is elevated and conveyed by screw-conveyor to bins in the boiler house. One bin is situated in front of each pair of boilers. The bins have a capacity of 10 tons each and, therefore, provide for a run of 20 hours at full capacity. The bins are rectangular, but have divided hopper-bottoms, thus enabling the coal to be fed by separate feeders to each boiler. Each feeder is chain-and sprocket driven by a 2-h.p. variable speed motor, the control of which is situated in a convenient position in front of the boilers. The coal is discharged from each feeder, through a 3-inch pipe, into a funnel-shaped opening in the top of the burner nozzle. The burner consists of an outside cylindrical pipe, 14 inches in diameter, one end of which projects into the furnace; a 7-inch blast pipe is inserted in the other end for a distance of from 12 to 18 inches. An adjustable metal cover is fitted over the blast pipe so as to regulate the amount of air induced in the burner. The funnel-shaped opening into which the coal is fed is directly over the discharge end of the blast pipe, so that the coal will be drawn in and thoroughly mixed with the blast and induced air before reaching the combustion chamber of the furnace.

The boilers as installed at first had to be changed since, as, on account of the high ash content (22 per cent.) in the coals used, it was found that, with horizontal baffles, there was too much ash accumulation. A Dutch oven, approximately of 6-feet cube, has since been built in front of the boilers; also, vertical baffles were inserted, replacing the former horizontal ones. With these changes highly gratifying results are obtained; no slag is formed, and the ash is readily blown off the floor of the rear chamber with an air hose once a week.

WELDING OF LOCOMOTIVE CYLINDERS

By L. A. North

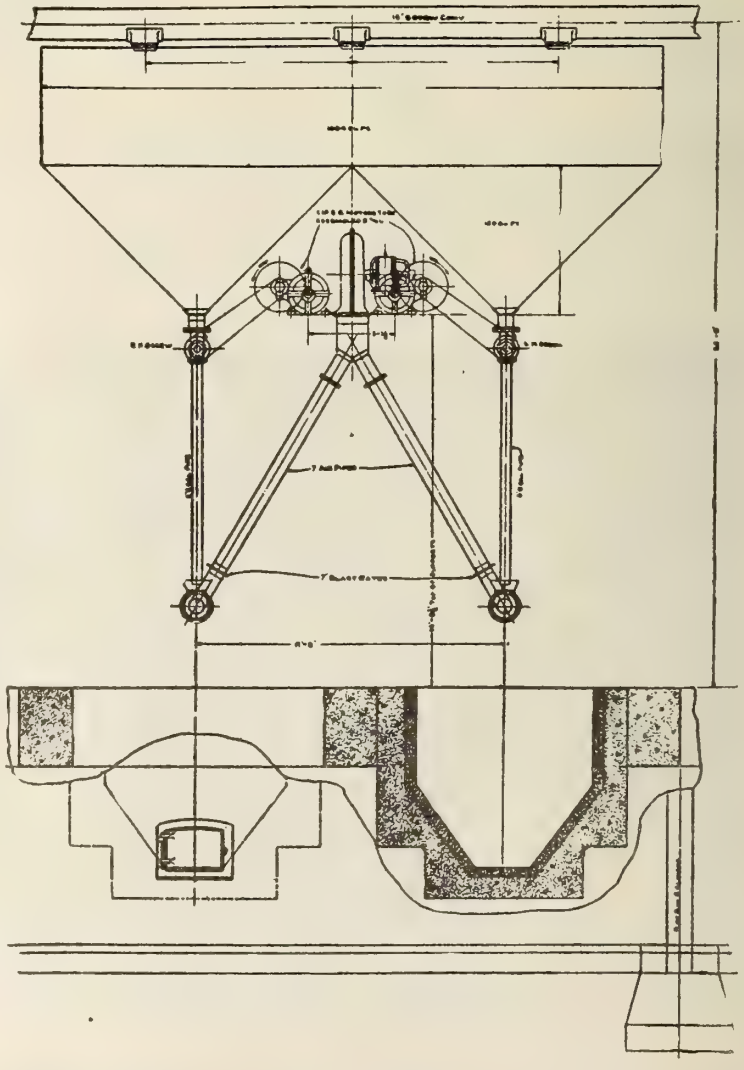
The welding of locomotive cylinders and other parts has been made possible and very successful by the introduction of oxy-acetylene and electric welding. It has been possible to weld locomotive cylinders which formerly would have been scrapped or repaired with either a brass patch or a dovetailed insert of some other metal, the weld in the majority of cases making a substantial and satisfactory job provided the expansion and contraction had been properly taken care of.

Experience has taught us that in order to properly weld a locomotive cylinder or a casting of any make or design, it is necessary to thoroughly pre-heat to insure a uniform temperature in order to properly take care of the contraction and expansion and to avoid cracking after the weld has been made and the metal has been allowed to cool off. The success of any weld of this kind depends largely on the care used in the pre-heating and the judgment of the operator making the weld. We cannot be too particular in the selection of the operator for this class of work.

Some difficult welds have come to my observation, one in particular, where the entire upper portion of the cylinder at the port area had been totally destroyed. This was repaired by having a grey iron patch cast in the foundry, fastened to the cylinder by means of clamps and welded in place. The cylinder was preheated to a uniform temperature to take care of the expansion and contraction. After the weld had been made and the cylinder had cooled down, a reinforcement was added to this weld by drilling through between the stud holes and securing the additional support by tap bolts which were tapped and screwed into the main barrel.

It is possible to weld broken bridges in slide valve cylinders successfully. Recently this was done and effected a saving of two cylinders in place of the one, which was cracked, as the cylinder which was repaired was an obsolete pattern, and had we not been able to make this weld the application of an entire pair of cylinders to this engine would have been necessary. As this engine was one that in a few years will be placed in the scrap pile, I am satisfied that the weld will outwear the present cylinders.

Not having experience with electric welding on cast iron, I am not prepared to enter into a discussion of this method to any great extent, but I have examined a number of castings which have been repaired with the electric welding process, and careful examination failed to disclose any flaw or fault in the weld.—"Welding Engineer."



PULVERIZED FUEL INSTALLATION AT PARSONS, KAN., SHOWING ARRANGEMENT OF PULVERIZED COAL HOPPERS AND FUEL FEED TO BOILERS.

Power Plant Management; Condensers

This Article Takes Up the Various Types of Condensers Seen in the Power Plant and Enters Into the Details of Their Design and Operation

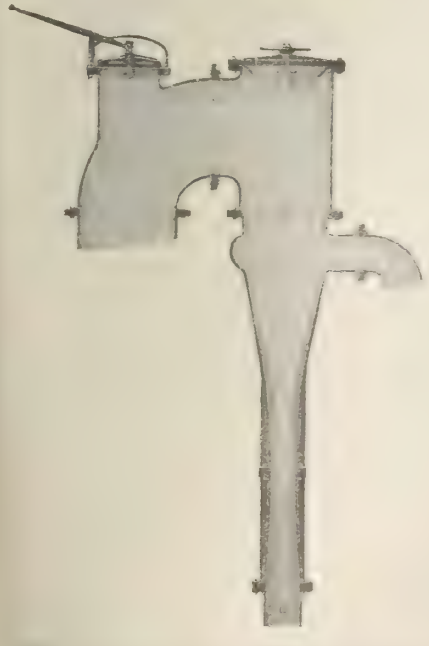
By ROBERT JUNE

THE primary reason for the installation of condensers in power plants is the reduction of back pressure on the prime mover. If saturated steam is confined in a closed vessel and cooled, condensation of the vapor, with a drop in temperature, will result. The greater the drop in temperature the greater will be the amount of steam condensed and the greater the decrease in pressure. In actual practice, all of the steam can never be condensed, since this would call for a temperature of absolute zero—492 degrees below the freezing point; hence, the pressure can never be reduced to zero.

When water is used for cooling, the minimum temperature which can be secured is 32 degrees F., which corresponds to the pressure of 0.0886 lbs. per sq. in., or 0.1804 inches of mercury. This, then, is the lowest condenser pressure which can be obtained.

In a condenser, the processes of condensation and removal of the air and condensed steam are continuous. The tightness of valves and joints, the amount of entrained air, and the temperature to which the condensed steam is reduced, are the factors which determine the degree of vacuum obtained.

There are a number of ways in common use of expressing the degree of



THE BULKLEY INJECTOR CONDENSER.

vacuum. (a) Thus to refer to a 28-inch vacuum is to indicate that the pressure of the atmosphere is 28 inches of mercury higher than the pressure in the condenser. (b) Vacuum may be expressed by percentage; thus to refer to a 90 per cent. vacuum would indicate that with the barometer standing at 30 inches, a vacuum of 27 inches had been secured. With a lower barometer, say 28 inches, it would indicate a vacuum of 25.2 inches. It will thus be seen that expressing vacuum in percentage gives an idea of the efficiency of the condensing steam.

In indicating vacuum, the point of measurement should always be stated, since the greatest vacuum will be found at the air pump intake, the next highest in the body of the condenser, and the lowest at the steam inlet.

Gain in Power Due to Condensing?

As a general proposition, an engine running condensing, will require from 20 to 30 per cent. less steam for a given work than will the same engine running non-condensing. Unfortunately, this decrease in steam consumption is not all pure gain. Steam may be used in creating the vacuum or power necessary to operate the condenser auxiliaries, varying from 1 to 6 per cent. of the main engine power, depending upon the equipment and conditions of operation. The cost of installation and of the maintenance of the condenser must also be charged up against the saving effected. Even if these deductions are made, condensing is found to be a very profitable operation in power plants where the exhaust steam is not used for heating or manufacturing purposes.

Conditions of Condensation

There are many types of condensers in use, but in general, condensing machinery can be divided into two main groups: Surface condenser, where the steam or vapor to be condensed is separated from the condensing water by metal tubes or diaphrams; and jet condensers, where the steam or vapor and the condensing water are brought in actual contact with one another. The jet condenser can further be divided into the regular low jet type, situated generally below the source of exhaust steam or vapor, in which type both the condensed steam and condensing water are discharged to the atmosphere by means of a pump working against a head corresponding to the vacuum in the condensing chamber, which, for a vacuum of 28 inches, corresponds to a head of approximately 31.7 feet, not including friction; and the barometric jet condenser, in which the condensing chamber is placed high enough above the hot well to discharge the condensate and condensing water by over-balancing a barometric column.

A vacuum which will raise mercury against the action of gravity one inch, will raise a column of water 1.132 feet. Therefore, if there were a perfect vacuum in the chamber of the condenser

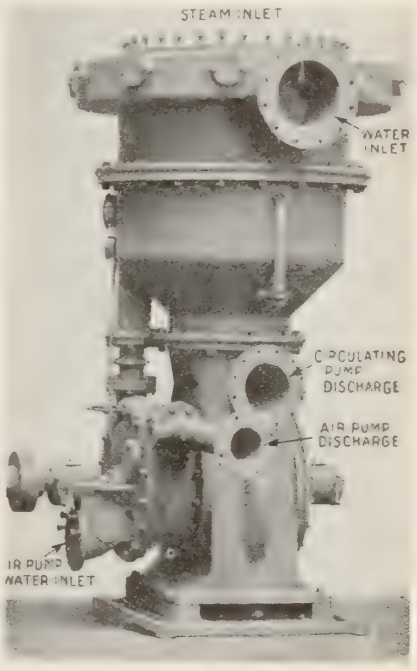


FIG. 2—WESTINGHOUSE LE BLANC CONDENSER.

it would raise a column of mercury 30 inches and a column of water 34 feet, at sea level, against the action of gravity. A vacuum of 28 inches in the chamber would, therefore, support a column of water in the tail pipe 31.6 feet high. If the condensing chamber be placed slightly higher than this from the level of the water in the hot well, any amount of water added to the top of the column will discharge a corresponding amount into the hot well from the bottom of the tail pipe. By this well-known principle of the barometric column, the injection water is discharged from the system, in a barometric condenser, without the use of a pump. The engine or turbine is protected from water being pulled into the exhaust pipe, by placing the upper flange of the condenser higher than 34 feet above the level of the water in the hot well. It is, therefore, unnecessary to rely on any vacuum breakers or check valves to protect the units from damage from this source.

If pure water vapor were delivered to the condenser, it would be a simple matter to create and maintain a perfect vacuum in the air condensing chamber, but, unfortunately, steam always carries with it air and other non-condensible

vapors, which expand in the condensing chamber after the steam has been condensed and which would eventually destroy the vacuum if not removed.

The amount of air in a condensing system varies greatly; but, roughly, the amount of air, measured at atmospheric pressure present in condensing systems on turbines ranging from 500 kw. to 200 kw. may vary from 1 to 15 cubic feet per minute, depending on the condition of the unit.

Air enters a condensing system through three sources; about 4 per cent. of the total amount of air enters through the feed water to the boilers; about 47 per cent. leaks in through stuffing boxes, joints, and porous spots in castings (this amount can be greatly reduced by a little care), and about 49 per cent. of the total amount enters with the condensing water (this figure also can be reduced by having a tight suction line, or by other means described later).

If proper care be displayed in the design, construction, erection and maintenance of the condenser and piping, the air leakage can be greatly reduced, and labor so expended more than pays for itself later. A slight leak in a vacuum line or stuffing box will cause much more waste of coal than a considerable leak in a steam line. Nobody would think of installing an extra boiler to take care of these leaks in the latter case mentioned, although many dry vacuum pumps have been installed to remove air, in the former case, entering the system through leaks. The prevention of practically all leaks in exhaust lines is simply a case of proper design, erection and materials.

To eliminate this air, which is present more or less in all condensing systems, is by far the most difficult problem connected with condenser design and all jet condensers differ from one another only in the means they employ to accomplish this result.

Jet Condensers

We have referred to air elimination as the most difficult problem in condenser design. Let us see how it is met in a few standard makes of condensers:

The Bulkley injector condenser, as the name indicates, removes the non-condensible vapors by the injector action of the condensing water flowing through a contracted throat of special dimensions and designs. The condenser which is illustrated in Fig. 1, consists of an iron casting machined to the required dimensions and fitted with a heavy brass cone.

Water enters the system at B, and circulates in the belt about the brass cone, C, falling through the annular space, G, between the outer circumference of the brass cone, C, and the inner surface of the casting, and forming a moving cone of water, D, with a sharp vortex. Steam enters at A, passing through the interior of the cone C, and meets the water at G, imparting to it what velocity it has on being condensed. This tends to force more water through the annular space. The condensed steam water and non-condensible vapors are brought down through the hollow cone of falling water, D, and the non-condensible vapors discharged through the contracted throat, F.

The lower portion of the condenser expands until it is the same size as the tail pipe, E. This allows the air and non-condensible vapors which have been brought through the contracted throat, F, to expand, thus making it impossible for them to get back into the condensing chamber. They are therefore taken down through the tail pipe and delivered to the hot well.

The Westinghouse LeBlanc jet condenser is illustrated in Fig. 2. Steam entering the top of the condenser meets an incoming charge of water and is quickly condensed; it falls to the base of the condenser and is removed by the centrifugal discharge pump; the non-condensible vapors being ejected through the medium of the LeBlanc air pump. The condenser body, of ample proportions, is made of close grained cast iron, the upper portion of which forms an annular channel for distributing the circulating water through several nozzles

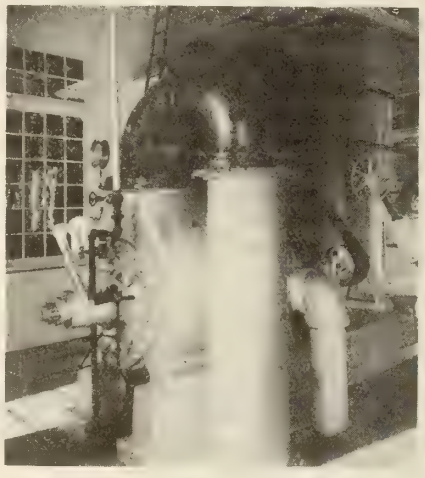


FIG. 3—THE ROTURBO ROTARY JET CONDENSER.

into the condenser. A much faster, and at the same time more intimate mixture of steam and water takes place with the sub-division of this incoming water than if the total quantity of water were passed into the condenser through a single opening. A very powerful breaker is attached to the condenser body and serves to break the vacuum in case of accident to pumps, thus preventing water from rising above the top of the condenser.

The circulating and air pump casings are placed directly beneath the condenser body, and in addition to housing the pump runners, serve the purpose of supporting the condenser. In order that either pump may be removed with convenience and dispatch, without disturbing the other, the casings are cast separately, hand holes also being provided on each pump to facilitate inspection.

In the Roturbo Rotary jet condenser, Fig. 3, the mixture of steam and water is secured by means of a revolving impeller. After the water jets have travelled rapidly some distance, so that the broad parts of the water fans have all combined to form a complete ring of spray and condensed the steam, the problem, as in the case of all other condensers, is to extract the condensate and air with certainty and efficiency, and it is at this point that this condenser differs in principle from all other types.

Instead of giving the water jets, as they leave the injection nozzles in the drum sufficient energy to extract themselves from the vacuum chamber and carry with them, without further assistance, the air and condensate, or instead of letting the condensate accumulate in the bottom of a large condenser chamber, where the air is separated, and from which the air and water are independently extracted by auxiliary apparatus, the rotating jets of spray or condensate with the entrained air are picked up by the blades of an exhaust fan, concentric with the rotating pressure drum, and of a larger diameter, and ejected with certainty and efficiency.

Surface Condensers

Surface condensers consist essentially of a cast iron shell provided with a tube set in each end, into which brass tubes are expanded. The exhaust steam fills the shell and flows around and between the tubes, while the cooling water is forced through the tubes by means of a circulating pump. Contact with the cool tubes condenses the steam and the condensate drops to the bottom of the condenser from which it is exhausted. The Wheeler condenser, which is fairly representative of the best type of surface condenser, is illustrated in Fig. 14. In the Alberger condenser, which is not illustrated, the steam enters through a deep rectangular steam distributing dome, extending nearly the full length of the condenser shell. The sides of this distributing dome slope downward and become tangent to the main shell, leaving an arc of nearly 180 degrees of the tube surface exposed to the entering steam. The construction of this steam dome evenly and effectually distributes the entering steam over the full length and breadth of the tube surface and brings it at once into contact with the greatest possible number of tubes.

With regard to surface condensers, the following points should be given care in choosing such equipment:

1. Upon entering the condenser, the steam should encounter the minimum of resistance practicable, and the pressure drop through the condenser should be just as small as possible.
2. Rapid air removal and freeing from entrained water should be provided.
3. Condensate should be returned to the boiler and freed of air as rapidly as possible, and at as high temperatures as possible.
4. There should be as little obstruction as possible to the flow of the circulating water in all parts of the condenser.

As with other types of equipment, the choice of a condenser for any given plant depends upon the individual conditions.

Engineers differ somewhat in their estimate as to the volume which a condenser should have with reference to that of the engine cylinder with which it is connected, but a generally accepted figure is that the condenser volume should be three-fourths of the engine cylinder.

The general advantages and disadvantages of the different types may be briefly summarized as follows:

Jet Condenser Advantages

1. Least expensive to install.
2. Occupy very small space.
3. Installation does not require hot well pump.
4. Cost of maintenance low.
5. Requires less water than surface condenser.
6. Acidulated or otherwise impure water may be used.

Disadvantages

1. Condensate is wasted.
2. Failure of apparatus might flood turbines.

Surface Condenser's Advantages

1. Condensate can be used for boiler feed.
2. Better vacuum obtainable.
3. Low pumping head.
4. Less chance of losing vacuum because a drop in vacuum does not affect water supply.

Disadvantages

1. High initial cost.
2. Comparatively high cost of maintenance.
3. Large floor area required.
4. Acidulated or impure water cannot be used.

Barometric Condenser's Advantages

1. First cost reasonable.
2. Low cost of maintenance.
3. No danger of flooding turbine.
4. Acidulated or impure water can be used.
5. Requires less circulating water than condenser.
6. No heat well pump required.

Disadvantages

1. Possibilities of air leaks in long exhaust pipes.
2. Loss of vacuum between condenser and turbine amounting to ½ inch or more.
3. Construction not adapted to building plan of many engine rooms.
4. Condensate is wasted.

Where there is a supply of water suitable for cooling purposes and for boiler feed, the jet condenser is most suitable. When the cooling water is not suitable for boiler feed and the separate supply of boiler feed is expensive, the jet condenser is not so desirable, inasmuch as the condensed steam is mixed with the cooling water which is unfit for boiler feed. Under such conditions, the condensate is lost, so that a continual fresh supply of boiler feed must be procured. A surface condenser would be better for this condition since the condensed steam and cooling water are kept separate, and therefore the condensate may be saved and returned to the heater, thus insuring a minimum amount of boiler feed make-up.

Notes on Jet Condensers

With the low level jet condenser, where water enters the condenser by virtue of its own vacuum, the maximum lift should not exceed 18 feet and the minimum not less than 6 feet.

If the cold well cannot be located near the condenser, the greatest care must be exercised to see that all water lines are perfectly air tight.

The amount of water required for the air pump is approximately 15 per cent. of that used for condensing purposes, that amount, as a general rule, being discharged to the hot well.

A head of any more than 10 feet is the maximum against which the air pump is able to discharge, hence, with cooling towers or spray pond installations, the air pump discharge must never be led into the main condenser discharge.

Pipe lines should be as short and as free as possible of air, thereby reducing friction losses to the smallest possible amount. Also use long radius elbows and avoid tees, using flange pipes on all lines subject to vacuum.

The quantity of water used by the air pump should be regulated by a gate valve. A check valve should be provided in the air pump discharge line to provide return flow.

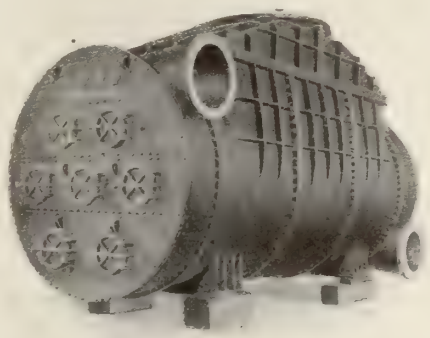


FIG. 4—WHEELER SURFACE CONDENSER.

With turbine driven condensers, a good valve should be provided in the steam line next to the governor valve on the turbine and a drain provided for this valve. An expansion joint should be installed on the exhaust line over the turbine in order to prevent pipe strains which may cause the turbine to get out of alignment with the pumps. With motor driven condensers, the motors must be protected from water. Do not use high voltage; it is dangerous to the operation of hydraulic machines as well as to the operators. Use motors with impregnated windings as a valuable protection against moisture.

The best arrangement for a barometric condenser is one where the level of the cold well is not greater than 18 feet below the centre line of the injection opening on the condenser. With this arrangement the circulating pump is unnecessary.

Avoid long horizontal lines. Make exhaust lines as large a diameter as possible, thus reducing pressure drop to a minimum. Provide exhaust pipes with atmospheric relief valve.

The injection line should be provided with a gate valve for regulating the amount of water used by the condenser. Another gate should be provided in the air line between the air pump and the condenser head.

Notes on Surface Condensers

Study the arrangement of steam paths into the tube bank. The lower tubes are surrounded with films of water and dense air which seriously impede the flow of heat.

See that your condenser tubes are kept clean. With dirty tubes the rate of heat transmission is greatly reduced and the vacuum is insufficient for the efficient operation of the prime mover.

Do not buy a smaller condenser than you need. A uniform high vacuum over operating periods is worth far more than the initial investment saved by reducing the tube surface.

READER'S QUERY

Question.—I have a steam engine with 14 by 18 inch cylinder which requires boring out. This will, of course, make the present piston too small, and I wish to know whether it would be possible to turn it off and shrink wrought iron or steel bands over it. These could be, say, ½ in. thick and could be turned down to fit the cylinder.

Answer.—While it would be possible to fix the piston as suggested, the cheaper course would probably be to have a new piston cast and turned to fit. The machining would be less in amount and the proper dimensions for the rings would be more easily secured. To fit the shrink rings to the present piston would necessitate three machining operations, the turning down of the piston, the boring of the rings and their facing off to dimension after shrinking on the piston.

NEW MONTREAL SALES OFFICE

The Engineering and Machine Works of Canada, Limited, St. Catharines, Ont., owing to increasing business in boilers of all types, tanks, plate work of all descriptions, etc., and particularly in connection with the manufacture in Canada of the Keystone light traction excavator, Model 4, have opened another Eastern sales office in the Birks Bldg., Montreal. This is in addition to their sales office in the Sun Life Bldg., Sherbrooke, Que.

How to Use and Operate Combustion Apparatus

The Following Article is Descriptive of Various Types of Combustion Apparatus Made by the Joseph W. Hays Corporation and Gives Explicit Directions for Their Use in the Power Plant

THE object of a flue gas analysis is the determination of the completeness of the combustion of the carbon in the fuel, and the amount and distribution of the heat losses due to incomplete combustion. The quantities actually determined by an analysis

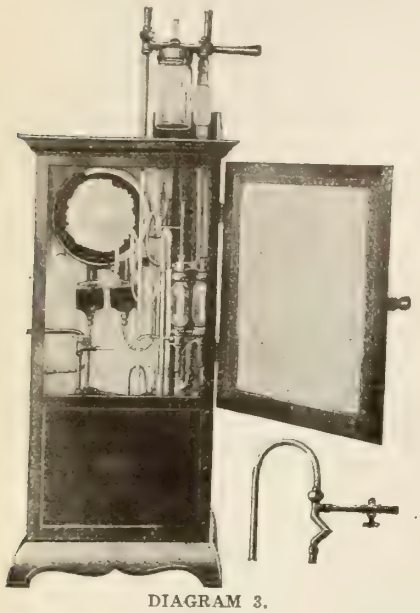


DIAGRAM 3.

are the relative proportions by volume of carbon dioxide (CO_2), oxygen (O), carbon monoxide (CO), the determinations being made in this order.

The importance of a constant record of the percentage of CO_2 in the gases of combustion cannot be over-estimated. The subject has been trimmed up one side and down the other, but to-day is considered one of the most important relating to the generation of steam.

The amount of steam generated depends upon the amount of coal burned per square foot of grate surface per hour, and the amount of coal burned economically depends upon a given draft that will release the maximum B.T.U. and burn the carbon to carbon dioxide (CO_2).

Therefore, in order to accomplish the economical combustion of the fuel we must have precise continuous record of what is taking place in the furnace.

There is some draft that will carry the load and produce the highest percentage of CO_2 without CO, and that is the draft to use at all times.

Engineers of to-day and to-morrow must become combustion engineers, instead of just engineers. The continual increase in the cost of fuel is making the plant managers the country over sit up and take notice. They are demanding to know just how their coal pile is being handled.

Some of these plant managers would not give the CO_2 salesman or the engineer a conference two years ago, owing to their ignorance of steam engineering, considering the boiler room of little importance and at that time coal was about half its present price.

Managers get together in their club rooms as do engineers. Subjects relating to proper operation of power plants are discussed. So it behooves the engineer to at least be on record, requesting instruments that will keep him posted, as his own plant manager is posted about the profit and losses of the business.

Every boiler should be equipped with a set of draft gages, one showing the draft over the fire, the other, showing the draft in the last pass. There should also be some means of recording or collecting your flue gases, keeping a daily record of same.

The first step should be to see that all excess air is eliminated, that your furnaces and grates are in good condition, and the boiler damper connected so that it can be operated from the furnace front.

The point at which the gas sample should be taken is in the centre of the gas flow, and at the point where the gases leave the last possible heating surface. A ¾-in. black pipe should be used, the end of which should be in the centre of the gas flow. An indicating or recording flue gas pyrometer

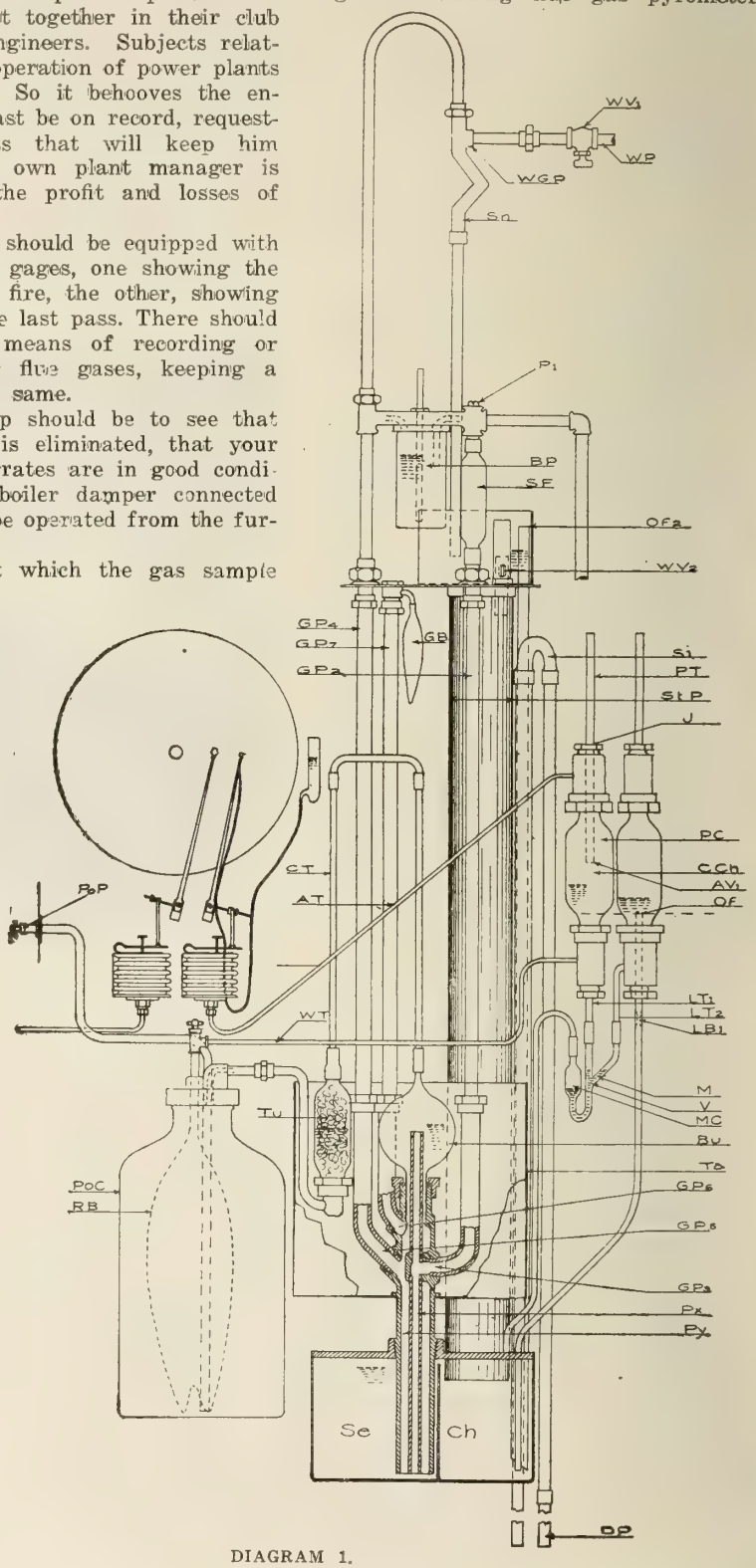


DIAGRAM 1.

should be provided, and the engineer will be prepared to get information as follows:

The percentage of CO_2 being produced is found, from which in turn we can compute the temperature in the combustion chambers. Knowing the temperature of the escaping gases leaving the boiler, it is possible to very readily determine the percentage of generated heat being absorbed, and from this information calculate the relative efficiency.

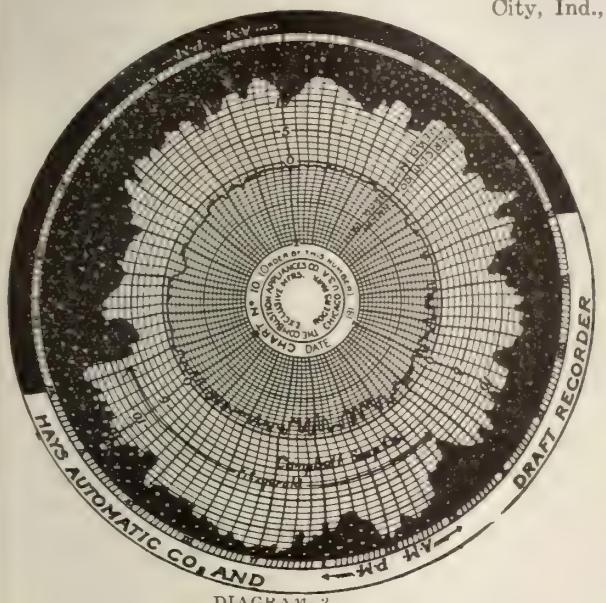


DIAGRAM 2.

The amount of CO_2 that will be the best to maintain depends upon individual conditions, but in general practice it will be somewhere between 12 to 14 per cent. The fireman cannot be expected to give the maximum B.T.U. out of the fuel unless they are provided with instruments to guide them. Many a fireman has been condemned on account of steam failures when he was in no way to blame. Firemen have been seen condemning the coal pile when it was difficult to maintain the steam pressure, but investigation proved that he was endeavoring to heat 300 per cent. of excess air plus the water in the boiler. After this very wasteful condition was eliminated the fireman was having things easy.

Don't be too positive that the excess air is not sufficient to hurt considerable. The engineer will be surprised when he finds out how small an opening it requires to admit sufficient air to lower efficiency to quite a degree. Leaks are bound to spring up in all boiler settings at any time, but with constant knowledge as to the percentage of CO_2 it will be possible to detect them at once, whereas, they otherwise exist and increase without the engineer's knowledge until expensive fuel bills arrive or a serious shutdown occurs.

In the analysis of combustion gases a great variety of mechanisms have been used at various times, and a number of different principles have been used in design. For the complete analysis of the gas recourse is usually had to the "Orsat" type of apparatus, while for boiler operation and the usual routine of the plant CO_2 records are usually sufficient. The indication of the amount by some means while useful is not so valuable as the recording of the varying percentage of CO_2 on a chart. The automatic CO_2 recorder, here described, is that manufactured by the Joseph W. Hays Corporation, Michigan City, Ind., and we are indebted to them for the material upon which this article is based and for illustrations which accompany it. The directions given for the operation of the different type of apparatus shown are all practical and since they apply to actual apparatus in service, more value attaches to them for this reason.

In the description which follows, the engineer is supposed to be present and listening to a description or a lecture on the various instruments and their operation, and by following the text in conjunction with the illustrations, the reader can very quickly gain an insight into the subject.

Referring to Diagram 1, the Hays automatic CO_2 recorder is operated by a jet of water flowing into the aspirator, WGP. The speed of operation is governed by the amount of water admitted through the valve, WV. The range of adjustment is from one to four minutes, but the most satisfactory chart will be produced at the rate of one analysis every two and a half minutes. By the inspirating action of the aspirator, gas is drawn in through the lines and secondary soot filter, SF. At the beginning of the operation the gas passes down through the glass tube GP2, through the burette, Bu, and out through the glass tube GP4, to the aspirator, WGP, where it is caught by the water flowing from the aspirator into the overflow tank, OF2, from whence the water flows into the standpipe, StP.

Both the measuring burette, Bu, and the absorption bulb, Tu. are immersed in water to insure uniform temperature. As the water flows into the standpipe from the overflow tank, the level of the water in the seal chamber, ScCh, below the burette and connecting tubes begins to rise and when it has risen sufficiently high to cover the tube traps, GP3, GP5, and GP6, the flow of gas is sealed off and a charge of gas is measured in Bu at atmospheric pressure. The flow of gas from the boiler continues, but is by-passed through the by-pass valve, BP. The water continues to rise in the tubes and in the burette, and the gas sample, which has been trapped off at atmospheric pressure, is pushed out of the burette through the connecting capillary tubes, CT, over into the absorption bulb, Tu, where the CO_2 gas is absorbed by coming into contact with the freshly exposed surfaces of the steel wool which is packed into the caustic or "absorption" bulb. The fibres of the steel wool are thoroughly wet by the caustic solution, which is forced out of the absorption bulb by the action of the apparatus. Inside the caustic chamber, PoC, is a rubber bag, RB, which holds a definite quantity of water and which is connected to the pressure chamber, PC, by means of a metal tube, WT.

When caustic is displaced from TU

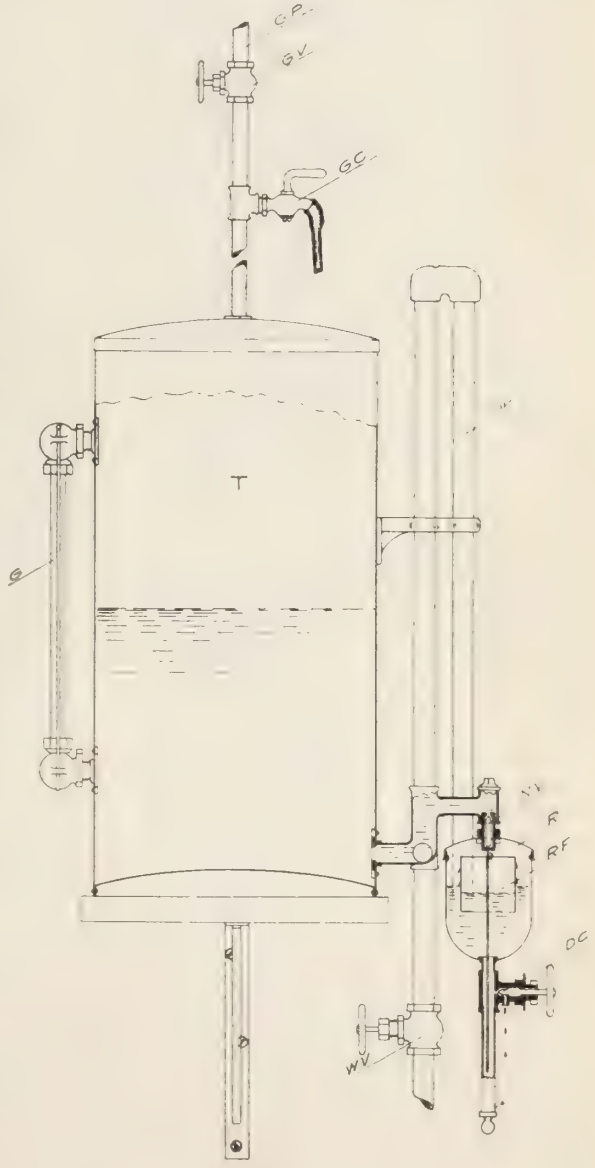


DIAGRAM 1.

into PoC, by the action of the apparatus, pressure is exerted upon the rubber bag RB, and water is displaced therefrom into CCh. Nothing happens until the rising water seals the lower end, AVl, of the tube PT, when the diaphragm with which PC is connected by the tube, AT, is expanded and the pen moves upon the chart of the recording gage.

The recording gage is so calibrated that if there is no absorption of CO_2 by the absorbing caustic solution the pen will travel entirely across the chart from the 20 per cent. line to the zero line. If any of the gases absorbed by the solution (which will absorb CO_2 gas only) the pen will not travel so far and the percentage of absorption will be recorded on the chart.

When the accumulating water reaches a predetermined height in the standpipe, the syphon, Si, starts, the water is discharged and the water and caustic return to their normal levels.

Adjacent to the compression chamber, CCh, is a levelling tube. The two are connected by the mercury valve, V. There is an "overflow," OF, in the levelling tube, connected by copper tube with the bottom of SeCh. The bulb of the mercury valve, MC, is connected with the top of SeCh. The arrangement is such that air pressure is exerted, on each operation upon the mercury in MC, thereby closing the valve, V, and water is forced from SeCh, up into the levelling tube. When the syphon, Si, discharges the mercury valve opens, making a communication between the levelling tube, and CCh, and as the result the normal level of the water in CCh is fixed by the overflow, OF. The levelling arrangement, which is a feature of this CO_2 recorder, enables the apparatus to make its own adjustments and to run continuously with very little attention.

These recorders are provided with "low efficiency alarms." A simple attachment causes a bell or series of bells to ring whenever the percentage of CO_2 is too low. Provided upon the same chart is a record of the draft which can be recorded from any point desired, same being calibrated for inches of water.

Diagram 2 shows reproduction of a Hays CO_2 recorder chart.

Diagram 3 shows the CO_2 and shaft recorder completely assembled.

Diagram 4 shows cut of this firm's automatic gas collector, which may be set up wherever desired, but in the preferred installation it will be placed upon a shelf about three feet high in order that the various valves may all be within reach of the operator. If convenient it is placed at the rear of the boiler. This will admit a short pipe connection between the flue or last pass of the boiler and the collector.

A connection is made with the cold water system of the plant, as shown, and a tight valve, WV, is placed on the water line. The tank of the collector is next about half-filled with water, and a pint of engine oil poured in at the top. The oil will act as a seal to prevent the absorption of gas by the fresh water taken into the tank.

Gas should be brought from the boiler to the collector through a quarter-inch pipe. Gas should be taken at the point where it leaves the heating surfaces of the boiler.

The valve, GV, is provided on the gas line near the collector, where shown in the diagram. The pipe connecting the top of the tank with the gas cock, GC, is furnished with the apparatus. This pipe is about eighteen inches long.

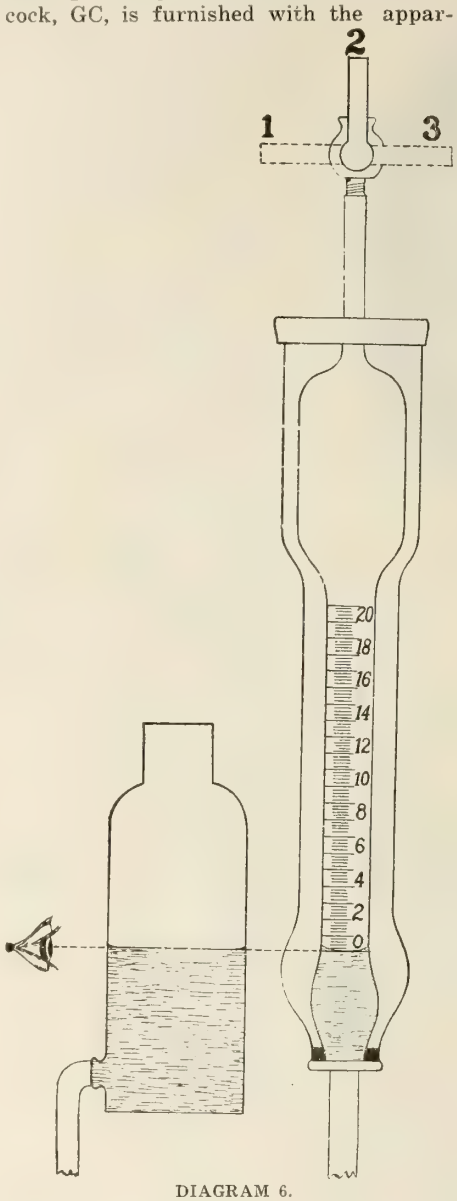


DIAGRAM 6.

All the connections having been made as above described, the valve, GV, is closed, the gas cock, GC, is opened, and the water turned on by opening the valve, WV. Should the water overflow through the overflow pipe, OP, before the tank is full, the plug of the gas cock, GC, is removed, and it is made sure that the opening is not stopped with grease or dirt. If there is no stoppage and the water continues to overflow through OP, before the tank is filled, the valve WV is closed gradually until the overflow ceases. The water must not be admitted to the tank faster than the air or gas can be driven out through the gas cock, GC. When the tank has been completely filled water will overflow through the pipe, OP.

The procedure is as follows when collecting a gas sample:

Having first closed the water valve, WV, and the gas cock, GC, the operator opens the gas valve, GV. Water will then flow from the tank, T, into the flow regulator, R, and be discharged through the drip, DC. The rate of discharge is constant without regard to level in T and will be proportional to the opening of the valve, DC.

The drip cock, DC, should be set to just about fill the tank with gas in the sampling period, whatever that may be. Analysis should be made at the end of each watch. The drip cock is provided with a dial and pointer. When the desired rate of flow has been determined by experiment, the position of the pointer is noted; thereafter the valve may be easily set for that rate at any time. It is not necessary to close the valve DC, after the collector has been put in service. In operating the collector it is necessary to use the valves WV, GV, and the gas cock, GC, the sample may be taken from the collector and the tank T, refilled with water without disturbing DC.

Assuming that the collectors have all been properly installed one on each boiler the chief engineer, head fireman or some one else who has been selected for the purpose next proceeds to the boiler room with the gas analyzer, and make an analysis of the gas trapped in each collector.

To analyze the gas that has been trapped in the tank, the valve GV is closed, the gas cock GC and the valve WV is opened. Water will flow into the tank of the collector and force gas out of same into the analyzer. If the water tends to overflow through OP, the leveling bottle is taken in the hand and lowered as far as the connecting rubber tube will permit. This will reduce the resistance. If the water continues to overflow, the valve WV is checked up. Gas should bubble out through the leveling bottle. When satisfied that enough gas has been passed through the analyzer to expel all the air from the connecting tube, and the burette, the rubber tube connecting the gas cock GC with the analyzer is disconnected, and the analysis proceeded with. (Instructions for the operation of the analyzer are taken up a little further in this article).

The tank of the collector will continue to fill with water, and by the time the analysis is finished water will be overflowing through OP.

If WV and GC are closed and GV opened, the apparatus will start at once to collect another gas sample. Gases when confined in a closed space will defuse and mix with each other. The sample in the tank of the collector will accordingly be uniform throughout.

Gas Analysis

A mixture of gases is analyzed by the "Volumetric Method," that is, a measured volume of the mixture is taken and one of the gases is removed by absorption. The volume remaining is then measured and the shrinkage indicates the percentage of the gas absorbed. The residue volume is then exposed to another absorber which removes another gas. On re-measurment the volume of that gas becomes known, and so on until all the gases have been determined. The volumetric method is employed because it is exceedingly difficult to weigh gases. If the weights are desired these can be easily computed when the percentages by volume are known.

Gases expand or contract very rapidly when subjected to changes of temperatures. The volume of a gas also depends upon the pressure to which it is subjected. For these reasons it is necessary that all measurements of volume during the process of analysis must be made under the same conditions of temperature and pressure. It makes no material difference what the temperature or pressure may be so long as neither is subject to change while the sample is being analyzed. The burette in which the gases are measured, is water jacketed. This controls the temperature. All measurements are made at atmospheric pressure by means of the leveling bottle.

Referring now to the illustration of the analyzer, and to diagrams 5 and 6, a tube at the right of the instrument case will be observed, having a scale from 0 to 21 etched upon it. This is the burette. The scale reads upwards from 0 to 21 per cent., and the divisions are in fifths of a per cent.

The burette is enclosed in a glass tube known as the water jacket, the latter being closed at the top with a rubber cap. The leveling bottle is attached by a rubber tube to the bottom of the burrette.

The instrument is stood upright upon a table and the leveling bottle removed from the clips (when in use in the boiler room or elsewhere, the instrument should be hung upon a nail using the hole in the back of the case near the top, the leveling bottle may then be hung by its hook upon the flanges at the bottom of the case, as shown in the illustration).

It will be noted that the instrument is provided with three absorber containers. The bulbs of two of the containers are packed with steel wool. The bulb of the third one is packed with copper wire and there is some scrap copper in the bottle below.

The container nearest the burette is charged with the absorber for CO_2 (a solution of caustic potash). The middle container is for the oxygen absorber (a solution of pyrogallic acid and caustic potash), and the one containing the copper is for the carbon monoxide (CO) absorber (an ammoniacal solution of cuprous chloride).

Preparing the Instrument

1. Fill the leveling bottle with clear water.

2. Note the three-way cock at the top of the instrument case, immediately above the burette. The cock has three positions, see diagram 5 and 6.

When operating the instrument you will stand on that side of it upon which the scale of the burette appears. When the handle of the cock is in a horizontal position, pointing towards you, gas can be pumped through the burette and will bubble out through the water in the leveling bottle. When the handle is in the vertical position as shown in the

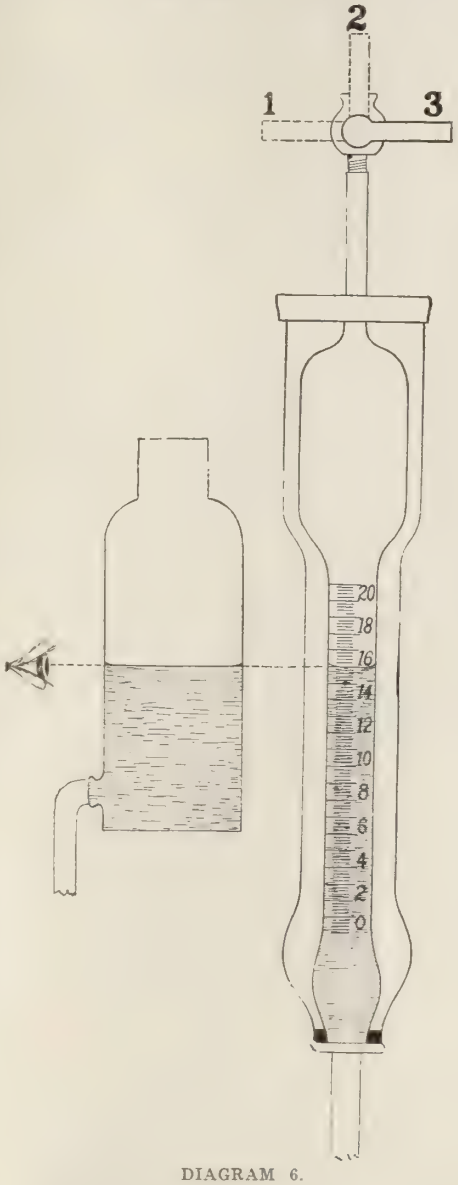


DIAGRAM 6.

illustration, the burette is open to the air, and when it is in a horizontal position pointing away from you, the cock is closed.

3 If the cock does not operate freely use a few drops of oil, applying it to the plug of the cock.

4. With the handle of the cock in a vertical position, raise the leveling bottle. This will cause water to flow from the bottle through the connecting rubber tube into the burette. The air in the burette will be expelled through the cock. Fill the burette in this manner until the water pinches out in the capillary tube at the top, then turn the handle of the cock into the horizontal position, pointing away from you. This closes the cock and if everything is tight the water will hold in the burette after you have lowered the leveling bottle. If the water falls in the burette turn the three thumb cocks of the needle-valves at the top of the instrument case to the right.

5. Lift the rubber cap at the top of the water jacket and fill the latter with clear water. Make sure that the cap is properly replaced after filling the jacket, otherwise the water will spill out when you are carrying the instrument. The water will last indefinitely as the cap will prevent evaporation.

6. Remove the stopper from the tube at the rear of the absorber container nearest the burette (the one for the CO_2 absorber).

7. Turn the thumb cock of the needle valve to the left and lower the leveling bottle. The caustic solution will be drawn into the absorber container. When the water reaches the bottom of the burette close the needle valve and raise the water again to the top of the burette, as described in paragraph 4. Re-open the needle valve and draw in the remainder of the caustic. When properly filled the caustic will stand in the capillary glass tube above the bulb and the container and will seal the glass tube in the lower bottle at least one-quarter of an inch. If there is not sufficient caustic add a little water.

8. The other solutions are introduced into their containers in the manner described in paragraph 7. The beginner is advised to become very familiar with the use of the instrument in the determination of CO_2 before changing the oxygen and CO containers. These solutions deteriorate on exposure to light and air. Keep the bottles stoppered and in a dark place.

9. In ordinary practice an operator will have little use for the oxygen and CO analysis. There is little danger of CO in the boiler furnaces gases when the CO_2 is less than 15. The first problem is to find the conditions that will produce 15 per cent. CO_2 and actually get that per centage.

Operating the Instrument

When this is done it will be well to learn whether CO is present.

10. Drive a nail in the boiler setting, or wherever is the most convenient, and hang the instrument upon it, opening both doors connect the rubber aspirator tube to the three-way cock and hang the leveling bottle upon the instrument case, as shown in the illustration. Be sure also that the caustic is standing in the capillary tube about midway and that the bulb of the container is full. It is possible that there may be some caustic in the capillary tube and that the bulb may be partially empty. In such case, partly fill the burette with air by lowering the leveling bottle, the handle of the cock be-

ing in position 2. Place the cock in position 3, raise the leveling bottle and open the needle valve. This will force the caustic out of the capillary tube into the bulb. Next close the needle valve and fill the burette with water, then open the valve and lower the leveling bottle (first setting the cock in position 3). This will draw the caustic up to its proper position. Be careful and do not draw any caustic over into the burette.

11. The aspirator tube is supplied with a filter, pack with cotton waste. This is to remove the soot and other foreign matter from the gas before it enters the instrument. The cotton should be changed from time to time. The aspirator tube is connected to the sampling pipe and the latter inserted in the last pass of the boiler.

12. Having connected the sampling tube, place the handle of the three-way cock in position 1 (see the diagram) and work the aspirator bulb. Gas will be pumped through the burette and will bubble out of the leveling bottle. Watch the bulb of the burette closely, and if there is any moisture in the gas (usually there is some) you will see it condense in a whitish vapor. When this happens you will know that you have pumped the air out of the tube, and are getting gas in the burette. You will soon learn about how much pumping it takes to get a fair sample of gas into the burette, this depends upon the distance pumped.

13. You are now ready to make a determination of the percentage of CO_2 in the gas sample that you have pumped into the burette. Now if you wish to learn how much chaff by volume there might be in a bushel of wheat you would first carefully measure out an exact bushel by volume of the mixed chaff and wheat. You would probably take a bushel measure, fill it heaping full and run a straight edge across the top of it. You would then remove the chaff and carefully measure the wheat. The steps that you take in making a gas analysis are exactly analagous.

You have gas in the burette but more of it than required. Take the leveling bottle in your left hand and hold it close to the burette steadying your hand against the instrument case. Get your eye into the position shown in diagram 1, and turn the handle of the three-way cock in position 2. Now, keeping your fingers on the handle of the cock, raise the leveling bottle until the water is on a level with the zero mark on the scale of the burette. Water will flow from the bottle into the burette and drive the excess gas out through the air vent of the cock. Keep the water level in the bottle in the same horizontal plans as the zero mark. To do this you will have to raise the bottle slowly as the water flows out of it.

You will notice that the water in the burette has a curved appearance. When the bottom of this curve, or meniscus as it is called, is on the zero mark, push the handle of the cock into position 3. You have now made an exact measurement of the gas and atmosperic pressure, and the gas is at the temperature of the water in the jacket.

Making the first gas measurement is the most "ticklish" thing connected with a gas analysis. You must not lower the leveling bottle while making the measurement as this would cause water to flow from the burette into the bottle and air would be drawn in through the vent of the cock. This would mix with the gas and spoil the sample.

Having made the measurement and locked the gas in the burette you will find that the leveling bottle is raised, that the gas is compressed, and the volume diminished, and that if you lower the bottle the gas is rarified and the volume increases. If you put the bottle on the zero mark the water in the burette will return to zero. This experiment should make it very clear to you how important it is to exercise care in making the original measurements and how necessary it is to make all measurements at atmospheric pressure.

14. The next step is to remove the CO_2 from the gas in the burette. Raise the leveling bottle with the left hand and turn the needle valve above the caustic container to the left. The gas will flow from the burette into the bulb of the container. Watch the water in the burette closely paying no attention to the container. You may push the gas over very rapidly until the water nears the top of the bulb of the burette, when you must slow it up with the leveling bottle and proceed very slowly. When the water pinches out in the capillary tube above the burette, close the needle valve by turning to the right. If you cannot pass the gas from the burette to the container it will be because you have forgotten to remove the stopper from the tube at the rear of the container. The gas has now been transferred to the caustic container and the caustic solution has absorbed the CO_2. The gas passes into the bulb over the fibres of steel wool which is wet with the caustic. The absorption of very rapid and you can immediately return the gas to the burette.

15. Open the needle valve and lower the leveling bottle. Pay no attention to the water in the burette. Watch the caustic closely. You may bring the gas back very rapidly until the caustic nears the top of the bulb when you must slow it up with the leveling bottle, and bring the solution up into the capillary tube.

Stop the solution about midway of the tube, being careful that none of it is drawn over into the burette.

16. Now bring your eye, the surface of the water in the bottle and the bottom of the meniscus in the burette into the same horizontal plane as shown in diagram 2, and read the scale of the burette (reading on the bottom of the meniscus). Let the water in the burette come where it will. Bring your eye and the water in the bottle into line with it. The gas is again at the temperature of the water in the jacket and it is at atmospheric pressure.

17. If for example, you find that the meniscus is resting upon the second mark above the 10 per cent. line. The reading is 10 2-5 per cent. Write it decimally, 10.4 per cent.

18. To take another gas sample for analysis, throw the handle of the cock into position 1, and work the aspirator bulb. The fresh gas will flush the stale gas out of the burette. A determination of CO_2 can be made every 45 seconds with this improved gas analyzer including the time taken to jump the gas into the instrument.

21. The absorption of oxygen and CO proceed very slowly and great care must be exercised in making the measurements. The solution used for oxygen will absorb CO_2 and that used for CO will absorb all three gases. For these reasons the CO_2 must first be taken out before trying for oxygen and the oxygen must be taken out before analyzing for CO.

20. To determine oxygen you first make a memorandum of the CO_2 reading and then pass the gas into the middle container, which you have charged with the pyro solution. Allow the gas to remain for about one-half minute, then return to the burette and measure, noting the reading. Return again to the container and repeat the operation until you get two readings that are the same. You then proceed in like manner to absorb the CO.

Suppose after the CO_2 absorption the reading is 16 per cent., after the oxygen absorption 20 per cent., and after the CO absorption 20.6 per cent. The analysis would be as follows:

CO_2 .....16 %
Oxygen ..... 4 % (20 % less 16%)
CO ..... 0.6% (20.6% less 20%)

Be sure that all of the CO_2 has been removed before trying for oxygen, and be doubly sure that all of the oxygen has been removed before trying for CO.

One exposure is all that will be necessary to get all of the CO_2 when the caustic solution is fresh. The solution will be good for about 500 absorptions. If you think that the solution may be getting stale pass the gas over a second time. If you get an additional absorption give the gas a little more time in the caustic container or change the solution.

The council of the city of Montreal, at a meeting held last week, voted a sum approximating two and a half million dollars for the purpose of completing the partly finished aqueduct for better water supply and the construction of a new low level pumping station. Two 30,000,000 gallon electric driven pumps, which will eventually be located in the new plant, have already been ordered and will be placed in the old plant pending the erection of the new building. With this equipment the capacity of the low level station will be about 140,000,000 gallons daily.

The Consulting Engineer in the Steam Plant

The Following Article Points Out Some of the Advantages to be Derived From the Retaining of a Consultant in an Advisory Capacity and Shows Where His Services Are Well Worth While in the Securing of Efficient Design and Operation

By F. A. COMBE

THE present high costs of fuel and labor have directed the attention of factory owners and managers towards methods of greater economy in power plant operation.

The possibilities of waste or economy are so immense, not only in the generation of steam but also in its utilization for industrial processes, that the subject calls for the most careful attention.

Lack of competent engineering advice on the initial design of the boiler plant is largely the cause of the inefficient way in which the majority of steam plants are operating to-day.

The practice of having a plant designed piecemeal by the different contractors supplying the machinery can be expected to produce only a composite lay-out which is extremely unlikely to give economical results.

In many industries waste material and waste heat may be employed to great advantage in place of coal, but their value depends on a careful study of each individual case and on correct design. The same is true of the possibilities of using oil, powdered coal, and the various lower grades of coal, coke breeze, etc.

These things should be taken into consideration when the plans are first drafted. Many of the older plants could be remodelled with advantage in view of changed conditions.

During the last few years considerable legitimate advance has been made in methods of efficiently burning fuels and in plant equipment for utilizing the steam thus generated. But unfortunately this advance has been accompanied by an influx upon the market of numerous inferior devices for which extravagant claims are made. Thus the owner or purchasing agent, if he is not an engineer is largely at the mercy of the most plausible salesman, whose main object, however conscientious he may be, is rather the sale of his product than the best interests of the purchaser. And further, the best equipment may not be the most suitable for a particular set of conditions.

It is a function of the consulting steam engineer to protect both the management and the operating force from such unsatisfactory equipment by giving an unbiased opinion on the best apparatus to be selected after an exhaustive study of the requirements and conditions, and from practical experience of the various apparatus offered.

Realizing the value of expert service in these matters, many of the larger corporations employ the services of a resident consulting steam engineer. The smaller firms who do not need the whole of such an expensive official's time, find it to their advantage to retain the services of a firm of practising engineers proficient in economical power plant design and operation. They rely on them not only to design new lay-outs and extensions, but also to act in an advisory capacity in connection with operation, to make periodic inspections and tests, and on this basis to suggest the institution of such systems and improvements as they may consider beneficial.

Unfortunately cases have been known where consulting engineers who are technical men without practical experience have made impracticable suggestions based on insufficient study of the plant and only partial knowledge of local conditions. Such reports are either paid for and pigeonholed, or, if acted upon, prove ineffective and a source of annoyance to the working staff, and so do more harm than good. This is particularly likely to occur when the consulting engineer is located at a point so far distant from the plant which he is supposed to study, that expense precludes anything but a short visit.

Such work should always be carried on in co-operation with the plant-operating engineer, not as a criticism of his methods but as a help to him as well as to the management. A progressive operating engineer will welcome a consulting engineer who knows his business and will work with him towards securing improvements. Usually he realizes very keenly that he is hampered by poor equipment and by lack of instruments and facilities to help him in obtaining efficiency. Almost invariably he feels that such handicaps make his work harder and less effective than it need be.

In addition to the recognized duties of other consulting engineers, which are to report on new schemes, prepare estimates, lay out new plant, issue specifications, recommend equipment and supervise construction, the consulting steam engineer goes further and deals with operation. Therefore he must be a man of peculiarly wide experience.

Not only must he be technically trained, but he must have practical experience also. He must be used to actual plant operation and the operating man's difficulties. He must have made a special study of furnace design, the combustion of different fuels, the utilization of refuse and waste heat—in fact of all that pertains to the economical generation and utilization of steam.

He should be constantly in touch with the latest practice and with changing conditions. He should know the value and limitations of various instruments and should have had first hand acquaintance with operating and bonus systems.

In addition, he must have analytical business ability to judge the value of expenditures from a financial point of view.

With these qualifications he will be of real assistance to both the operating engineer and the owner, and he will effect savings many times greater than the cost of his services.

ALCOHOL AS A MOTOR FUEL

Alcohol, which has been considerably discussed as the much-sought-for substitute for gasoline as a motor fuel, receives possibly more consideration than other proposed substitutes because there appears to be no limit to the possible sources of supply of alcohol.

The British Government, viewing with concern the rising price of gasoline, appointed a special committee to inquire into the production and utilization of alcohol as a motor fuel. This committee has recently submitted its report and we learn from "Power" that it found that while alcohol is obtainable from molasses, potatoes, wood pulp and other vegetable products, the yield, contrary to popular opinion, is not large.

The usability of alcohol in internal-combustion engines with a properly designed carburetor and slightly modified compression is well recognized, so that there is no obstacle from the engineering standpoint. It is purely a commercial problem. Owing to the somewhat lower heat value of alcohol a correspondingly greater quantity must be used per horse-power-hour, so that in order to compete with gasoline the cost per gallon must be proportionately less.—Houghton Digest.

ELECTRIC CRANES

In general design overhead electric cranes for engineering works have tended to become standardized, but a large British firm have introduced a notable departure which carries many advantages. Instead of the usual double-girder arrangement, giving a square appearance, there is a triangular girder, the apex of the triangle being downwards. This design gives a very rigid yet light girder and enables the load to be lifted one or two feet higher than would be possible with the usual type of girder. The driver also has a clearer view of the load from his "cab" than is otherwise possible. The firm has installed this new type in its own works and finds it most suitable for comparatively light loads on long spans—the very conditions which are least suited to the ordinary girders.

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII TORONTO, APRIL 5, 1920 No. 7

PRINCIPAL CONTENTS

Power Plant Features of the Quaker Oats Mills 151
The Possibilities of Pulverized Fuel 156
Power Plant Management: Condensers 159
How to Use and Operate Combustion Apparatus 162
The Consulting Engineer in the Steam Plant 167
Editorial 168
New Equipment 170
Graded Certificate Correspondence 171
Operators' Point of View 172
Selected Market Quotations 42

Enthusiastic—Sometimes

THE WHISTLE blew in a Toronto industrial concern a few days ago, as it has done for a good many years. There was more action in the next three minutes than there had been all day, with the possible exception of the noon scramble.

There was vim, ginger, push, pep — all these things and more — crowded into the few brief minutes following the tooting of the whistle.

A few nights ago young men started to line up outside the box office where tickets were going to be sold at 10 o'clock the following morning for a championship hockey match.

They stood in line all night and kept on standing until 10 o'clock in the morning.

There was surely perseverance, determination, and a keen desire to succeed in this demonstration.

But why is it that certain of us can pump up a heap more enthusiasm around quitting time, or over a hockey match, than over the great big task of making a success of our daily work?

Certain it is, were the same steam turned into business as was turned into the 5 o'clock quitting hour or the all-night stand for a hockey ticket there would be much greater successes and fewer people tossed out into the discard as very average or no good at all.

The Growing Scarcity of Anthracite

WITH anthracite at $17 a ton and even then with no assurance of adequate supply, the lot of Mr. Average Man will not by any means be an easy one during the next winter. If present indications are in any way reliable, they seem to point toward the gradual elimination of anthracite as a fuel for Ontario and Quebec and its replacement by some other fuel from domestic sources.

Apropos of all this, it is interesting to note that the "Canadian Mining Journal" in a recent issue published an exhaustive summary of the subject, going thoroughly into the available supply and also into the probable demand for the next few years.

The anthracite coal fields from which Canada obtains her supply are three in number, and while in some of these ample reserves appear available for a good many years to come, the cost of mining will make anthracite an even more expensive luxury. It is estimated that thirty years will see a decline in the production of the Wyoming field, and since this field supplies the major portion of Canada's requirements, a corresponding stringency in our supply.

The growing scarcity of hard coal is already starting a search for suitable substitutes and of these coke and oil would seem to be the most feasible for domestic use. The use of these in turn would make Central Canada dependent on a foreign source of supply to a large extent and would in turn leads to periods of scarcity and fuel famine.

The burning of briquetted Western lignite would be perfectly feasible, although the long rail haul would be expensive. The peat resources of Ontario and Quebec will undoubtedly be of high value when the necessity for their use has been fully appreciated.

In the meantime the householder in the central provinces will have some interesting scurrying to do in the getting in of his winter's supply. Not only so, but it may prove to be the golden opportunity for some enterprising manufacturer in the developing of an economical and cleanly method of burning other forms of fuel in the house.

The Small Waterpower

THE VALUE of the smaller waterpowers of the country is well brought out in the leading article of this issue. The development, while small in comparison to Niagara, is yet of sufficient size to furnish ample power for the operation of a large textile mill, and by good design and operation very economical power is available. The combination of power plant, transmission line and substation is particularly worthy on account of the excellent care with which the work has been carried out and the manner in which the various parts have been fitted together.

The installation mentioned serves to point out the value of the smaller waterpowers in the industrial development of their immediate neighborhood.

Doctoring Our Lignite

CANADA has had enough coal experience in the past two or three years to make the nation stop and think. The trouble with these stopping and thinking seasons is that they are brief and evaporative.

When we are up against the real thing we stop and think and promise.

When the real thing has been removed, we at once forget about the stop-think-and-promise session.

That is what happens to the average Canadian in regard to the coal supply of this country. As soon as he gets a supply, or as soon as his fire is out for the summer, he proceeds to forget it.

The industrial section of Canada is more apt to remember the problem, and for this reason should appreciate the work that is being undertaken by the Lignite Utilization Board of Canada. Industrial sections are interested in domestic fuel as well as in power and heating provision. If the employees can get only a little coal, and pay a very high price, they are going to be dissatisfied and the firm employing them suffers.

The Lignite Board for the present is chiefly concerned with the deposits of lignite in Saskatchewan and Alberta, although Saskatchewan would be the more strategic point from which to work, either east or west. The order creating the board says in part:

"That by carbonizing this lignite, a coke or charcoal is obtained which briquettes readily and, without consideration of the by-products such as oil, pitch, ammonia sulphate, gas, etc., the result is to turn two tons of inferior fuel into one ton of briquettes approximating, in heating value, anthracite coal with practically the same heating value in the domestic furnace as the two tons from which it was made."

A study of machinery, processes, etc., for briquetting this coal is being made, and the matter of using any other by-products will be considered.

Western Canada has heretofore imported about 500,000 tons of anthracite from Pennsylvania at a cost of about $5,000,000 per annum.

Canada's coal resources are greater than those of any country in the world, with the exception of the United States. Much of Canada's coal, however, requires treatment before being available for satisfactory domestic use.

It is expected that a successful outcome of the development undertaken by the board will result in the establishment of an industry of national importance.

The Smallest Screw Made

DURING wartime we heard much of working to fine dimensions. People who used to romp around the shop with a foot rule and measure eighth-inches only in a pinch began to think and measure in terms of thousandths.

A writer in a current magazine speaks of the smallest screw used in the smallest watch made in this country.

Now put down your monkey wrench, screwdriver, hammer and can opener, step over and hear what is said about this screw:

It might be possible, under some conditions, to hear the proverbial pin drop, but no ear could catch the sound of the dropping of one of these screws.

The screw can be definitely seen only with the imagination or a watchmaker's glass. This tiny screw is of brass, of the following dimensions:

Total length, 28 thousandths of an inch.
Diameter of head, 26 thousandths of an inch.
Diameter of the thread, 12 thousandths of an inch.
Number of threads per inch, 360.
Weight, 12 thousandths of a grain.
It takes 583,333 of the screws to make a pound.

The machines for producing these screws are different in design from any other screw machine that is known of. They are of a positive cam action type and have proved very satisfactory to their users.

There is but one chuck to a machine of this type and a single piece of stock is used. These machines are so accurately made and the parts so closely fitted together that it is necessary for them to be warmed up in order that the oil may work in all of the bearings before they start to produce. Otherwise they would not operate.

The machine is belt-driven. Compressed air is used on these machines for the purpose of forcing oil to the different parts of the machine and also to blow out the finished work after it has been cut off. These machines are electrically controlled and are so arranged that they stop whenever the stock is used up or the finished screw not blown out of the machine.

Is Good Design Worth While?

IT IS often a question in the power plant owner's mind whether money spent on fixing up a power plant, on things from which no immediate results may be obtained, or in the improving of the plant appearance, is worth while. The power plant, it goes without saying, should be one of the neatest and cleanest portions of any industrial works or other concern, and money spent in the initial stages of its design will be well repaid later on if by its means the plant can be kept and maintained in better shape. For a power plant in trim condition is most likely a well managed and economical one, and in the long run neatness and efficiency go together.

A MAN who likes variety can surely get it by thumbing over the pages of the seed catalogue after shaking down the furnace for the evening.

TOMBSTONE carvers in some United States cities are asking $1 per hour for their work. So it will pay more than ever to build each day such a monument in the minds of your associates that the work of the stone cnippers will be unnecessary.

From "Passing Show," London.

CRUEL TO BE KIND

Lloyd George:—"Hold your noise! I've brought you here to enjoy yourselves, and enjoy yourselves you shall."

Progress in New Equipment

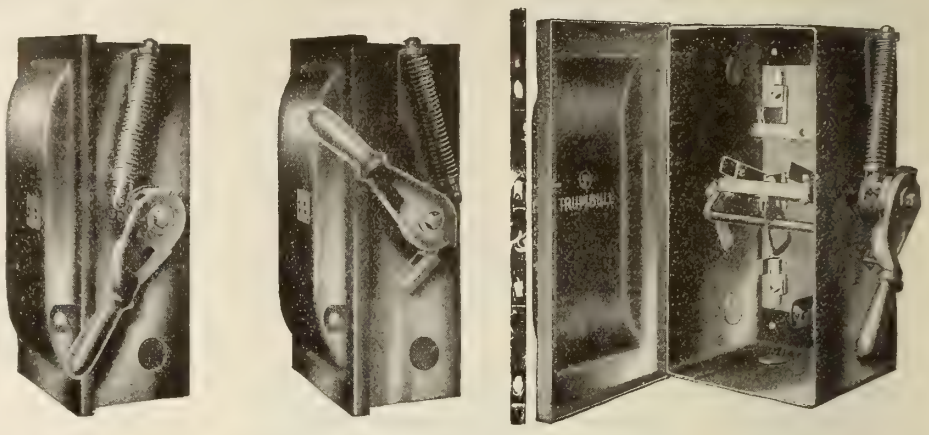
"SAFETY" SWITCHES

THE "safety" switch is one of the ramifications of the safety movement that has gained such tremendous headway in the last few years. It is common sense to prevent accident to life and property, because it is a matter of human decency and because it is a paying investment. The proper safeguarding of points where accidents are liable to happen and the proper protection of mechanisms, which in themselves are potential danger hazards also, means better insurance rates and fewer law suits. Industrial plants are pretty well in touch with the situation, having learned through real experience the need to protect life and property at every turn of the wheel. They do not think so much in terms of first cost as in terms of safety and the secondary expense of accidents.

One of the hazards to which attention was early drawn was the open knife switch, and to-day these are almost a thing of the past, insofar as industrial plant applications are concerned. It is now customary to enclose switch and fuses in steel boxes, so arranged that switch operation is possible from the exterior.

A switch externally operated may suggest to a man that he should throw off the switch before he puts his hand in the box, but an interlocking safety device, which prevents his opening the box until the switch is off makes him keep his hands away from live switch blades.

This latter accident prevention feature has been developed by the Trumbull Electric Mfg. Co., Plainville, Conn., in a line of externally-operated switches recently placed on the market.



SAFETY SWITCH SHOWING MECHANISM.

By reference to the accompanying illustrations a very good idea of the arrangement of these switches may be gained. The box cannot be opened until the switch is in the off position. A catch prevents the switch from being closed with the box open, although the catch can be manipulated by a tool if necessary to close the switch with the box open for inspection, by an experienced man. It will thus be seen that with fuses and blades always dead whenever the switch is exposed, the fire and shock hazard are eliminated.

All single throw switches are equipped with an outside handle stop as a means of indicating when switch blade is in full contact. A further advantage is seen in the fact that the switch can be locked open.

There is a growing demand for a safety switch with quick make, as well as quick break, particularly where a careless operator might neglect to follow the handle through and so leave the blade in partial contact with the jaw post. The switches shown in our illustrations are equipped with this feature. A further device is seen in one of the types illustrated where a "100 per cent. safety shield" is shown. This is a further protection to the operator or electrician when the cover is open for fuse replacement.

VIEWS SHOWING SAFETY SWITCH OPEN AND CLOSED AND WITH COVER OPEN SHOWING 100% SAFETY SHIELD.

THE "MATTER WITH AMERICA"

What's the matter with America these days?

Too many diamonds, not enough alarm clocks.

Too many silk shirts, not enough blue flannel ones.

Too many pointed-toed shoes and not enough square-toed ones.

Too many serge suits and not enough overalls.

Too much decollete and not enough aprons.

Too many satin upholstered limousines and not enough cows.

Too many consumers and not enough producers.

Too much oil stock and not enough savings accounts.

Too much envy of the results of hard work and too little desire to emulate it.

Too many desiring short cuts to wealth and too few willing to pay the price.

Too much of the spirit of "get while the getting is good" and not enough of the old-fashioned Christianity.

Too much discontent that vents itself in mere complaining and too little real effort to remedy conditions.

Too much class consciousness and too little common democracy and love of humanity.—Fargo S. D. Forum.

Re the Ontario Graded Certificate Act

Correspondence

DOES THE ACT HOLD THE GOOD MAN DOWN?

This correspondent argues that as the man deserves so shall he be rewarded, and that the Act in itself does not limit his scope for employment nor does it force him to remain in whatever plant he may happen to be in.

The Editor.

I have been reading the letters re graded certificates that have appeared in the POWER HOUSE for some months past with increasing interest. In Feb. 5 issue, James Scotch says: "Forcing the second and third class men to stick to small plants is the one big injustice." I don't see that the law forces anybody to stay anywhere. Have we not got to rise mainly by our own efforts? If not, who will be the first to give the helping hand? The profession of engineering cannot be learned in a day, nor a year, nor 5 years. To quote Ella Wheeler Wilcox: "The fault of the age is a mad desire to leap the heights that were made to climb." In Feb. 20 issue, Justice II gives a good practical letter. What was wrong with 55 out of the 60? Were they confident and prepared to hold a better position? With what did they expect, then, to hold it? not air and daylight.

Some men rise by years of hard work and close application to study and details. Others rise (or attempt to), by knocking others down. Others, when they do get up there, promptly kick the ladder away, so to speak, so that none may equal them. Last two are knockers and soreheads, and there are lots of them. Envy, the enemy of progress, always seeking to destroy what it can't equal, let alone surpass.

These seem to me to be the lines along which a lot of men are working, and they are not good lines for anybody, especially engineers. Just forget petty jealousies, and work, study, live and let live. There is always lots of room at the top.

"HORATIO."

THE WORD "WOP" IS UNFORTUNATE COGNOMEN

While engineers are blessed with various degrees of book knowledge, the present writer argues that nothing is to be gained by calling those with little theory by derogatory names.

The Editor.

I notice in your issue of Feb. 20 a letter from James E. Noble and wish to say that I agree with him to a word as to size of power plants to be operated by the different grades of engineers. I also agree with his suggestion as to the first class certificate, but I wish to take exception to his remark regarding the man he calls a wop. I myself have only a public school education and I could not possibly pass the required examination for a first class certificate without undertaking a further course of study. Yet I can operate the boiler room efficiently and with the minimum amount of coal, and, taking my indicator, can set my valves as correctly as James E. Noble, or anyone else. So I do not consider myself a wop and I do not think the above term is one that can be used in connection with a good many engineers who are unable to qualify for the first class certificate.

Another thing I wish to say is, theory and practice do not always go together. This is a fact known to any practical engineer. As an instance in point, take the following: During the present winter I have had under my charge a boiler feed pump of well known make. The same was receiving hot water from an overhead tank and was in first class condition, yet it would not feed the boiler. There was no obstruction in the delivery since an injector was feeding through the same line. The pump was made to work successfully by the writer in about three hours' time after it had failed. Let the theoretical man tell me what was the matter. The question will be easy enough for the practical man.

I also wish to say a word or two in reply to Chief. He states in one of his letters that at the time certificates were first granted, any old hole was good enough for a man to qualify in and obtain a certificate. He thinks that an old-timer should be granted a first class certificate without any writing for it. Is he looking for a chance like the one above, which he intimates was the case when he obtained his first certificate. Like Justice II, I think the examiners are going to call the bluff of a lot of our chiefs. I did not intend to be sarcastic, but reading some of the letters some things are bound to get under one's skin, no matter of how mild a temper he may be. I hope to hear some more good-natured grumbling. WM. H. LONG.

THE STATUS OF THE STATIONARY ENGINEER

IT has been said "If a man can do any one thing better than anyone else, the world will wear a beaten path to his door, no matter how deep in the woods that door may be located." Have the stationary power plant engineers considered and thought about this saying as they should? Is there any truth in the saying? Personally I believe it has been proved beyond controversy.

If this is so, is it any wonder the operating engineer always has been and always will be counted or considered as "small potatoes" no matter how large or how small is the plant he has charge of. The operating engineer is a jack of all trades; to become a specialist in any one of these trades requires many years of practice and study. It requires no superfluity of brains to understand that not one man in a million can be an expert in a large number of mechanical trades and professions; a man with a smattering of each—which closely describes the best class of engineers in charge—is nothing greater than an apprentice in any one of them, therefore he gets the credit and honor due an apprentice and nothing more. When the time comes that engineers generally will recognize this truth and work for conditions which will enable experts to be in charge of different parts of the plant the engineer will then take a limelight position in the world's view. Take the electrical specialist. He is honored, respected, and highly paid for his advice and services. Ask him about line shaft installation, steam-heating, superheating, or one of a hundred other things the power plant engineer has to erect, instal and control. He will probably say: "My dear sir, I am an electrical specialist; I prefer not to pass any opinion upon subjects outside my special line." He is perfectly right at that. Probably he knows about these things but he is not taking chances by giving advice upon matters about which he is only partly informed.

During an analysis of salary problems which occurred in a public utility hearing, the point was brought out that the assistant superintendent received a yearly salary exceeding that of his superior. As the manager explained, the assistant happens to be a specialist, therefore he is entitled to extra pay for his superior knowledge. When the boiler room is placed under the responsible charge of one man, the engine room under specialists, steam and electrical, and the shafting and other machinery under properly trained men, each and all being directly responsible for the operation and condition of the equipment in their charge reporting direct to an executive head, such as a manager, then the power house staff will begin to receive some honor and respect. No doubt the plant costs for labor would be greatly increased, due to the extra remuneration received by the specialists in charge, but the increased production, elimination of plant waste, the absolute absence of danger so far as humanly possible, and such like important matters, would many times overbalance the extra cost in salaries. So long as the power plant operator has to prove that he is a "jack of all trades" by passing such a mixed examination as he is doing to-day in many places in Canada and the United States, just so long will he remain in the background.

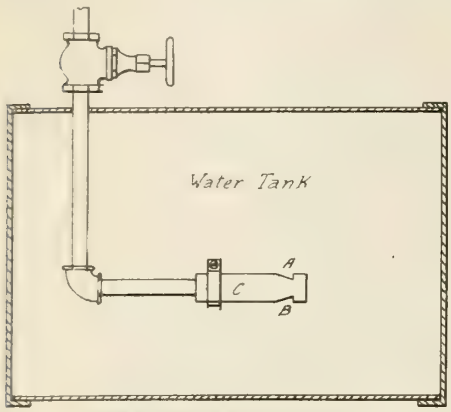
J. E. NOBLE.

The Operators' Point of View

NOISELESS WATER HEATER

I am enclosing a few more simple ideas that I use or have used. I expect every engineer has heard about the noiseless steam-water heater, however. Some of of them do not know how to make one, if a person is to form an opinion from the racket heard in some places where they are heating water with live steam.

A short piece of hose, a jack knife and a hose band is all that is required. In Fig. 1, C is the hose. Cut two pieces from the hose, as at A and B, fasten the



NOISELESS WATER HEATER.

hose to the steam pipe, that's all. Iron pipe will do instead of the hose.

Often when an air cock is wanted in a hurry there is none at hand. Take any sized bolt, file a groove in it, as shown in Fig. 2, place a rubber or fibre washer under the head, as shown in Fig. 3 at A. Screw the bolt down into the air cock hole. When it is necessary to let air out unscrew the bolt a turn or two. Fig. 4 shows a bolt with a hole drilled up the centre and through the side, a washer is also used under the head of this bolt. When it is necessary to let air escape the bolt is unscrewed until the small hole at the side comes up to the atmosphere side.

The proper way to grind cold chisels is shown in Fig. 5. Most fellows grind their cold chisels as shown at A. Next time grind them as at B, and note how much more service can be got out of them without breaking corners off. The convex shown is rather exaggerated to show the idea plain. The edge should be only slightly off the true, also have one of your chisels ground as at C, for a close cut it is just the thing, and be sure and have a bent chisel as shown in D; this one is for difficult corners. It sometimes helps to have this chisel ground the same

C. JOHN PORT.

CONVERTING A BREAST DRILL INTO A DRILL PRESS

By W. S. Standiford

One of the most useful devices that every mechanic or experimenter has in his home workshop is a breast drill. The drawbacks of this instrument are that it has to be held very carefully if a straight hole is to be bored; and also that it requires considerable "brute force" to make the drill feed into the work. After using a breast drill in the usual manner for a number of years, the writer decided to convert it into a drill press, and thus make it not only easier to operate, but also to do more accurate work than a drill pressed against the body is capable of.

The photographs show the general construction clearly, no dimensions being necessary, as each breast drill made varies so in size that the construction will have to be made to suit the user's instrument; the only thing to do is to follow the shape as depicted in the photographs. Fig. 1 shows the completed apparatus ready for a drill to be inserted. It will be seen that the feed is automatic, it being done by gravity when using a 1-16 inch drill, but wide rubber bands are used to assist the weight of the drill rack and round bar iron weight when larger sizes are used. The bands are put on the projecting lower ends of drill rack (only

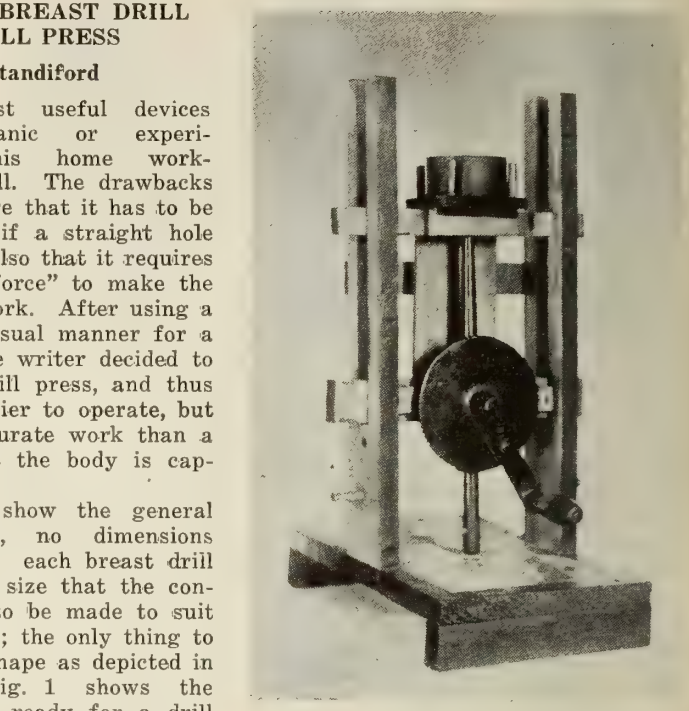
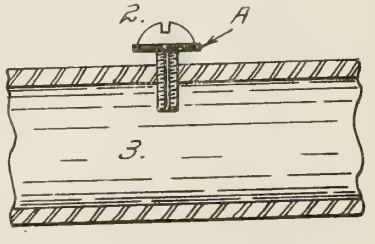


Fig. 1

side being shown in the photograph) and a round pin on the sides of the standards. As this press has been in use for a number of years, using rubber bands, the writer intends to replace them with closed-coil springs fixed to



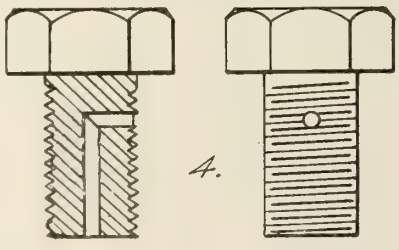


FIG. 4.

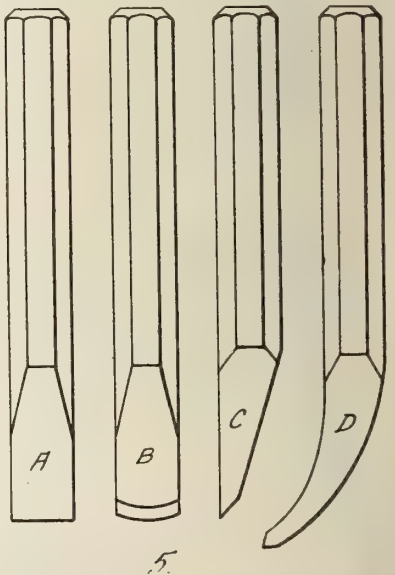


FIG. 5—METHOD OF GRINDING COLD CHISELS.

a hinge on their lower ends, so as to be disconnected when the press is used for boring small holes, as too speedy drilling dulls the drills quickly. Closed-coil springs are better than the rubber bands when working with larger drills, as more pressure can be obtained, the amount depending upon the diameter of the wire thickness in the springs.

Fig. 2 shows the standards with the drill rack out, while Fig. 3 illustrates the rack itself, the round bar iron weight being removed from its retaining prongs. The upright wooden standards should be made out of hardwood and have the slots that drill rack slides in carefully made and fitted to the former, so as to have just enough play to let it slide freely up and down. Rub dry graphite on the bearing parts of standards every once in a while, so as to get the wood saturated as much as possible. Use a square when fastening standards on the baseboard. Put cleats upon the cross bars of drill rack, so as to prevent any side play, thus insuring that the holes bored will be straight. This apparatus will be found to give good service in the home workshop, mine being in use over ten years. It is still in good condition, with the exception of the rubber bands, which occasionally get hard and lose their elasticity; the latter being restored by soaking them in kerosene oil. I would advise any other constructor to use closed-coil springs, as it is a nuisance to be fooling with rubber bands. Closed-coil springs will give no trouble.

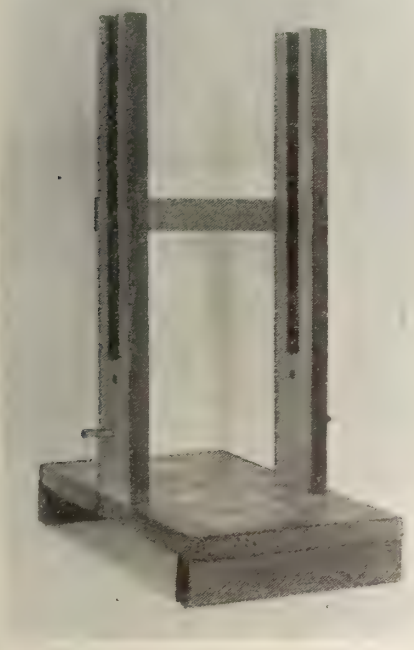


FIG. 2.

LUBRICATING OILS
A New Theory

Ever since the introduction of mineral oils for lubricating purposes, it has been recognized that their behaviour as lubricants is markedly inferior to that of the animal and vegetable oil. In virtue,

FIG. 3.

however, of their cheapness, and in some instances of their non-emulsifying qualities, they have come to play a largely preponderating part in the lubrication of machinery. The defects of pure mineral oil as a lubricant have resulted in almost all commercial lubricating oils containing an admixture of some organic oil of animal or vegetable origin, in order to give them the necessary physical properties. The organic oils in practice, however, always contain, even when highly refined, a certain proportion of what are known to the chemist as "fatty acids." These weak organic acids, because of the fact that they are acids, have always been looked upon with the greatest distrust as components of a lubricating medium, and the maximum permissible amount has been the subject of rigorous specification.

From a paper on lubrication read before the London section of the Society of Chemical Industry by Messrs. H. M. Wells and J. E. Southcombe, it would appear that these much distrusted fatty acids play a hitherto unsuspected part in the process of lubrication and may almost be considered essential factors in it. This view, which appears to be confirmed by practical experiments on a commercial scale, is not only interesting scientifically but of material practical importance. If, as appears, it is the fatty acid and not the organic oil as such which gives to a compounded mineral oil its lubricating qualities, the recognition of this fact will result in rendering available for human consumption and other purposes vast quantities of edible animal and vegetable oils now used in the lubricating oil industry.

Surface Tension

The discovery by Messrs. Wells and Southcombe was the outcome of experiments undertaken to determine the factors on which the lubricating value of an oil depends. Ultimately the conclusion was arrived at that surface tension is the dominating factor, and as the surface tension between oil and a solid surface is not measurable by any known means, the authors decided to measure the surface tension of oil in contact with an immiscible liquid. It is difficult to admit the logic of the conclusion that oils in contact with metal should behave in the same way as when in contact with water, nor is it very easy to see what bearing the behaviour of oil and water has upon lubrication. However, when various kinds of oil were allowed to rise in drops from an orifice submerged in water, a marked difference was observed between the behaviour of organic and mineral oils. It was brought out clearly that the inter-facial tension, which is inversely proportional to the number of drops into which a given volume of oil would divide itself, is very much less in the case of the organic oils than in that of the mineral products.

Thus a difference between these two classes of oils has been discovered, which is independent of viscosity, density, etc., and, moreover, appears to be in conformity with the lubricating qualities of the oils. The next step was to find the reason for the difference in surface tension, and it was eventually proved that the slight quantity of free fatty acidity present in the organic oils is the cause of their reduced surface tension. When the fatty acids were removed the tension rose, and when they were added it became lowered. However carefully ordinary commercial organic oils are purified there is always a small amount of free fatty acid present in them, as hydrolysis sets in and produces such acids in a short time. It is to the presence of small quantities of these acids that, in the opinion of the authors, the superior lubricating qualities of the organic oils are due, and by adding a very small percentage of such acids to mineral oils they have improved the lubricating properties to the same extent as if a very considerable bulk of organic oil had been added.

Effect of Fatty Acid

Figures were given by Mr. Archbutt in the discussion on the paper which showed how powerful is the effect of a very small quantity of fatty acid. He used a Thurston oil-testing machine to carry out the experiments and worked it with a journal speed of 7 ft. per second and under a pressure of 270 lb. per sq. in. Under these conditions he found the frictional coefficient of pure mineral oil to be .0066, and the effect of adding free fatty acid up to 2 per cent. is shown by the following table:

Percentage of mineral oil	Percentage of fatty acid.	Coefficient of friction.
100	0	.0066
99.5	0.5	.0049
99	1.0	.0045
98	2.0	.0042
100	0	.0066

The effect of adding rape oil, from which all trace of fatty acid had been removed by treatment with lime, was next exemplified by Mr. Archbutt by the following figures:

Mineral oil.	Rape oil.	Coeff. of friction
100	0	.0066
90	10	.0065
80	20	.0062
60	40	.0053
40	60	.0047
20	80	.0041
0	100	.0045
100	0	.0062

In each case the last test given in the table is a check test to verify the conditions.

It will be seen from the first table that only half of 1 per cent. of free fatty acid added to pure mineral oil causes a very marked improvement in its lubricating power, and that 2 per cent. appears to be about as much as it is advantageous to use. Comparing the two tables it will appear that the effect of adding 1 per cent. of free fatty acid to a pure mineral oil improves its lubricating qualities fractionally more than the addition of 60 per cent. of neutral rape oil. This is a very striking result, and appears to justify the contention that the lubricating qualities of the organic oils are very largely dependent upon the free fatty acid which they contain. The natural corollary is the manufacture of lubricating oils by the addition of fatty acids to mineral oils, and this is being carried out on a commercial basis by the inventors. The process was patented about two years ago, but publication was forbidden by the authorities until after the war. However, the Admiralty accepted large quantities of marine engine oils made by the process, for duties for which a compounded oil containing 20 per cent. of rape oil was previously considered essential.

Physics of Lubrication

The scientific interest of the matter lies in the light it may shed on the ultimate physical mechanism by which lubrication is accomplished. The very small quantity of fatty acid which brings about the results seems to indicate that some absorption process may be at work, the fatty acid molecules attaching themselves to the metallic surfaces and in some way altering its condition. The acidity may be necessary for the purpose of producing some metallic salt on the faces of the bearings, the presence of which causes a reduction of friction. Many other speculations may be advanced, for the matter is very obscure; yet it is something to have got a little farther with the empirical solution of the problem of lubrication, even if the underlying theory is not elucidated.

EFFECT OF HYDROGEN ON IRON AND STEEL

German technologists have continued their researches since the armistice, one of these being the effect of various gases on iron and steel. The results suggest, says the London "Ironmonger," that if the gases could be conveniently and safely applied, some of them, and particularly hydrogen, might be employed with advantage in certain metallurgical operations, as in the cementation process of making steel and in refining and hardening. The use of hydrogen with iron at high temperatures, however, unfortunately is difficult and dangerous, apart altogether from its high cost, and it is not likely therefore that it will be used for any of these purposes on any commercial scale, though it may continue to be used for research. When that gas is forced through molten iron it is found that any non-metals present such as arsenic, carbon, phosphorus, silicon, sulphur or oxygen are converted into gaseous hydrides while the hydride itself in any particular case may be split up again and the nascent hydrogen set free, under which conditions it will reduce any silica present in the metal, even at so low a temperature as 1,292 deg. Fahr., the gaseous silicon hydride resulting.

From the practical point of view the most interesting of the results of this particular research lies in the revelation that a malleable iron may be made directly by means of oxygen and hydrogen, not only from molten iron but from solid pig. The inert character of nitrogen is confirmed by this research, that gas having no effect on the non-metals in iron, either in the solid or liquid state, notwithstanding the view very generally held that the carbon in iron will diminish if the metal be heated in an atmosphere of nitrogen, the real explanation of this diminution being the action of small portions of oxygen retained in the vessel with the nitrogen.

EDMONTON CONTEMPLATES NEW ELECTRICAL SYSTEM

At a meeting of the Edmonton city council held on March 9, the following resolution was passed:

> "That the City Commissioners do immediately invite proposals from such persons or companies as have signified a desire to negotiate to supply power to the said City of Edmonton, and that such proposals should contemplate the bringing up of our present power plant to a proper standard of efficiency and installing of a further unit of agreed capacity and type; and that the commissioners do at the earliest possible date report to this council a general outline of the respective terms and conditions upon which such persons or companies would be prepared to supply power,"

and referred to the city commissioners, and at a subsequent meeting of the city commissioners, the question dealt with in the resolution was referred to Joseph A. Clarke, mayor, for such investigation as was directed by the city council.

It is stated that whatever rights the Edmonton Power Company have under their agreement or franchise with the city, must be considered by any person or company making a new offer to the City of Edmonton. The suggestion was made that the Edmonton Power Company would surrender their franchise, and probably also sell any work or development that they have already undertaken, but this would have to be considered by any who are making an offer to the city to manufacture power as set out in the resolution of council above referred to.

The power house is not equipped at present with machinery enough to supply all the electrical energy which is required for the customers of the City of Edmonton and the city is now submitting a by-law for the purchase of another unit, which will be either of 7,500 kw. or 5,000 kw. capacity. The by-law is being submitted for approximately $700,000.

If any scheme is suggested which contemplates anything in the nature of a hydro-electric development the terms would have to include the maintaining of the present power house as enlarged in accordance with the above information as a stand-by, and the fixed charges upon this power house would have to be considered in any new agreement or arrangement that is contemplated.

The amount of electrical energy consumed during the past year in Edmonton was 23,400,000 kw., and it is estimated that within two years the consumption will be 35,000,000 kw.

Further information may be obtained from the mayor of the City of Edmonton, Joseph A. Clarke.

BOOK REVIEWS

Corona Discharge, by Earle H. Warner and Jacob Kunz, the University of Illinois Equipment Station, Urbana, Illinois.

In view of the high voltages in use to-day and being considered for use in the transmission of power, the subject of corona loss becomes of much importance. This publication of the University summarizes and discusses the results of experiments which have been conducted at the University for some time past by the means of high tension direct current.

Schweitzer and Conrad, Inc., Chicago, have issued a folder relative to the electrical equipment necessary for providing the farm with electric power from transmission lines of moderate voltages. In particular the S and C type XW switching and protective combination is featured. This includes horn gap arrester, disconnecting switch choke coil and fuse mounting, grouped in one single unit and adapted for regular service on lines up to and including 25,000 volts.

C.A.S.E. WILL MEET IN WOODSTOCK

The annual convention of the Canadian Association of Stationary Engineers will be held in Woodstock on June 22, 23 and 24. The secretary-treasurer of the convention is John McCalley, 20 Riddell St., Woodstock, Ont.

The India Alkali Works, India Wharf, Boston, Mass., have issued a four-page folder descriptive of their soap powders, grit powders and cleaning powders.

Put a Farnsworth System to Work in Your Steam Plant

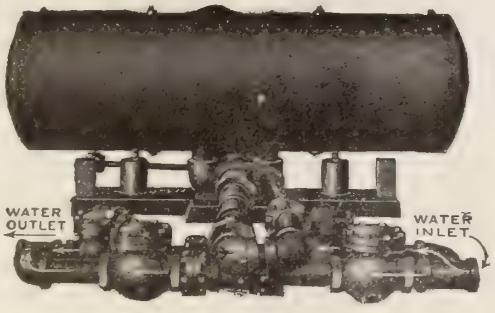
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no trunnions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE

Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
⅛	$ 6 00	$ 8 00	$.....	$.....
¼	4 83	6 96	5 31	7 44
⅜	4 83	6 96	5 31	7 44
½	6 42	7 99	7 10	8 67
¾	8 11	10 24	9 03	11 16
1	11 99	15 13	13 35	16 49
1¼	16 22	20 47	18 06	22 31
1½	19 39	24 48	21 59	26 68
2	26 09	32 93	29 95	35 89
2½	41 24	52 07	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank ..... add	$1 50
Nuts, square, tapped ..... add	1 75
Nuts, hexagon, blank ..... add	1 75
Nuts, hexagon, tapped ..... add	2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs ..... 40 and	5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals ..... 0 18 to	0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

REGISTERED COPPUS U.S.PAT.OFFICE *In Paper Mills*

STEADY steam pressure is a vital factor in making good paper. A sudden drop at the gauge might mean serious loss in the mill. Keeping up steam is a matter of prime importance.

That is why modern paper mills are equipping their power plants with COPPUS Turbo Blowers to maintain constant steam pressure under varying conditions of load, fuel, and weather.

For instance, the COPPUS Blowers shown above operating in the plant of the Hampshire Paper Company, makers of good paper, at South Hadley Falls, Mass., have kept steady steam pressure with very satisfactory results. Peak loads are quickly met, steam pressure is always constant, and cheap fuel is economically burned.

COPPUS Turbo Blowers are helping out engineers and speeding up boilers in power plants the country over. Their good work is not confined to the paper industry—it extends wherever power is used and coal is burned. If they are not already working for you it is likely that they could save time, money and labor in YOUR boiler room.

Write for Blower Catalog.

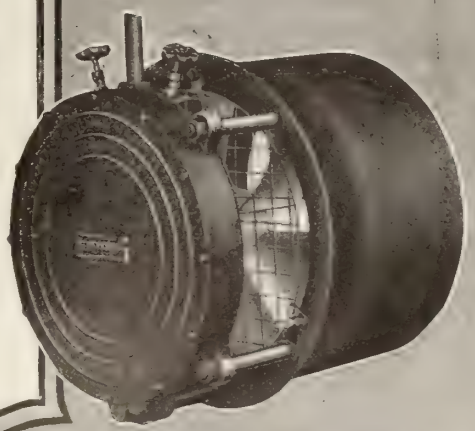
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta



COPPUS TURBO BLOWER

OPPORTUNITIES

BOOKS

on all branches of Engineering and every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT.
Books Bought. Best Prices Given.
W. & G. FOYLE, Ltd.,
121-125, Charing Cross Road, London, England.

STATIONARY ENGINEERS

Those who wish some practical tuition for their Graded Certificates from a practical power house engineer holding highest certificates are invited to communicate with T.H.F., Box 208, Power House.

WANTED—5 TO 7½ H.P. A.C. 25-CYCLE 110-volt Induction Motor in good condition. Box W.F.S., Power House, Toronto.

Do you know of a Power House man who is not reading

POWER HOUSE

The Power Plant Journal of Canada

Then tell him what he is missing. You know how POWER HOUSE keeps you thoroughly informed on Power News — how it keeps you informed of everything pertaining to the Power Field in fact. No power plant man should be without POWER HOUSE. The subscription price is only

$2.00 Yearly

ISSUED TWICE A MONTH

New Canadian Enterprise.—The Diamond State Fibre Co. of Canada has been incorporated to engage in the manufacture and sale of vulcanized fibre, known under the name of "Diamond Fibre." In the electrical field it is used for insulating bushings, gaskets, washers, wire conduits, etc., while in the mechanical field it is used for noiseless gears, discs, wheels, timer rings, etc. A mill will be built in Canada as soon as conditions warrant such a move. Mr. T. Elwood Webster is managing director of the company, and is located at 455 King St. W., Toronto.

An important improvement in the manufacture of coal gas has been perfected by the engineers of a gas company in London, Eng. They have contrived to extract from the gas all the carbon bisulphide—a substance which, when burned, had a deleterious effect on health and also on various materials. Throughout most of the nineteenth century, chemists and engineers strove to solve this problem, but success did not come till the year 1914. The war prevented the erection of plant to carry out the process, but the way is now open for the general adoption of a method which will make a gas flame as harmless to its surroundings as a candle.

TENDERS

The St. Thomas, Ont., Board of Water Commissioners offer for sale one Allis-Chalmers horizontal compound steam pump, two Worthington duplex pumps, one centrifugal pump direct-connected to engine, and one 7 h.p. vertical engine. Particulars can be obtained from the City Engineer, St. Thomas.

The City of Moosomin, Sask., will receive tenders up till May 5 for the supply, delivery and erection of internal combustion engines, generator, exciter, switchboard, street lighting apparatus, pole, wire and line material, power station and cooling chamber. Plans and specifications can be obtained from the Consulting Engineers, Saskatoon; Town Clerk's Office, Moosomin, Sask.

HELP WANTED.

DESIGNING ENGINEER—IF YOU ARE EQUIPped to take hold of an established line of Pressure Reducing Valves and push them to perfection, you have an opportunity before you. Answer clearly and fully on the following points.

(1) Have you basic knowledge of designing and actual experience? This is absolutely essential.

(2) Can you design special Valves such as Relief, Globe, Check-Reducing Valves for High Pressure. Any experience?

(3) As designer and Production Engineer, could you take active charge of mechanical end and maintain maximum production? Any experience?

(4) Give age, experience, full references, and salary expected. Strictly confidential. Will not write references without your consent.

The business is established, located in the Middle West. A good paying proposition with a bright future. Write immediately. Apply Box 1, A.P.H., Power House, 143 University Ave., Toronto.

Use The LONG STEAM for TRAP SATISFACTION

Automatically drains jacket kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with great success. **Read this letter.**

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson, Superintendent

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

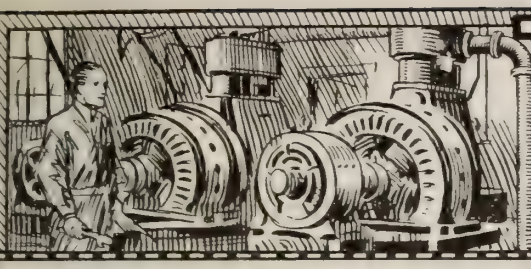
J. T. LONG
48 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.
4

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 TO 244 SOUTH ST. NEW YORK U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

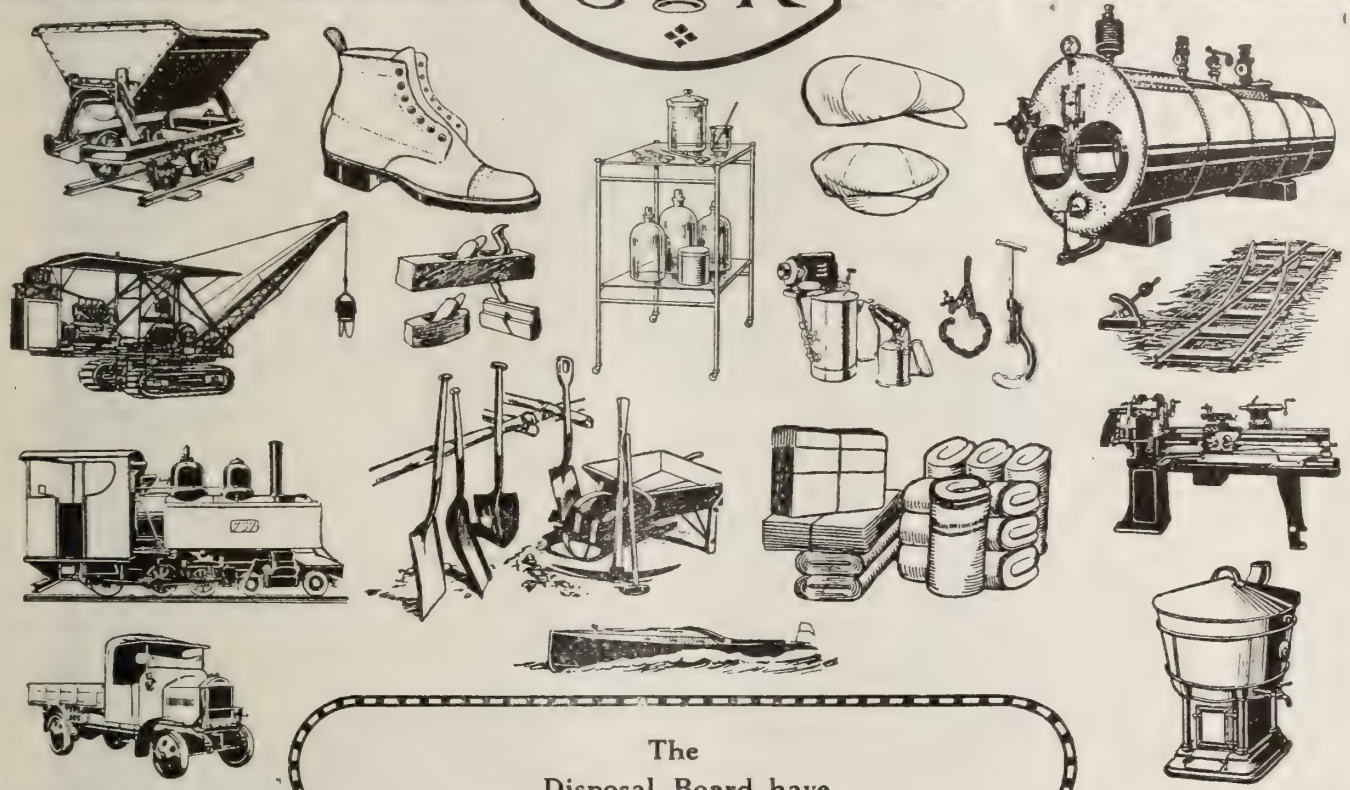
E. H. KELLOGG & CO.,
New York, U.S.A.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)



MINISTRY of MUNITIONS

G R



The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

MORSE CHAIN

In a Big Railroad Shop

Where Every Ounce of Power and Inch of Space Count

This Morse Chain is delivering power to an 80" boring mill from a 15 H.P. G-E Motor running at 1200 R.P.M. The chain is exposed to all the grit and dust of the shop. It is 4" wide and connects a 17 tooth pinion with a 120 tooth wheel directly below—a distance of only 33" between centers.

No record has been kept of the age of this particular Morse Drive but the boring mill is known to be one of the oldest in the shop and one of the first to be individually driven, so it is safe to state that this Morse Chain has been many years in service of the most unexacting nature.

Shouldn't you bear these facts in mind when you plan your next transmission drive?

MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD **Ithaca, N. Y.**

Morse Engineering Service — *Write for 1920 Vest Pocket Memo and Diary* — *Assistance Without Obligation*

Address Nearest Office

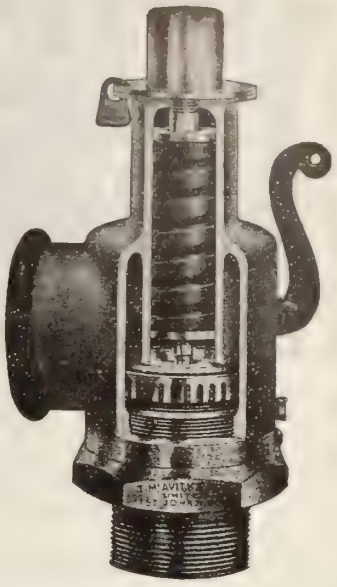
BOSTON, MASS.	141 Milk Street	SAN FRANCISCO, CAL.	Monadnock Bldg.
CHICAGO, ILL.	Merchants L. & T. Bldg.	ATLANTA, GA.,	Candler Bldg. Earl F. Scott, M. E.
CLEVELAND, OHIO	Engineers Bldg.	CANADA	Jones & Glasco, Regis'd
DETROIT, MICH.	1003 Woodward Ave.	MONTREAL, St. Nicholas Bldg.	Toronto, Traders' Bank Bldg.
GREENSBORO, N. C.	805 Ashboro Street	KANSAS CITY, MO.,	Long Bldg. Morse Engineering Co.
NEW YORK, N. Y.	50 Church St.	MINNEAPOLIS, MINN.,	413 3rd St., S. Strong-Scott Mfg. Co.
PITTSBURGH, PA.	Westinghouse Bldg.	ST. LOUIS, MO.,	Chemical Bldg. Morse Engineering Co.

"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

SAFETY AND *SERVICE*

"McAVITY"

Improved Brass Pop Safety Valves



¾" to 2"

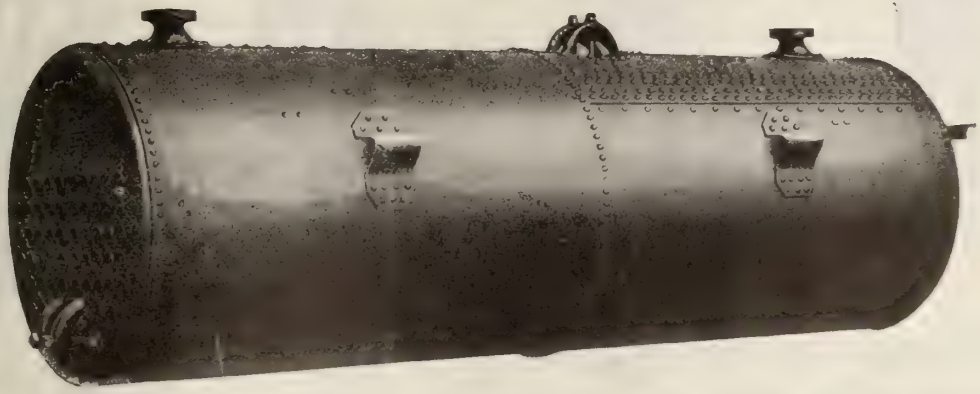
INCORPORATE A HIGH FACTOR OF SAFETY WITH A NEVER FAILING SERVICE THROUGHOUT THEIR LONG LIVES

Approved by their Governments for use in Ontario, Alberta Saskatchewan, British Columbi a

MADE BY ***T. McAVITY & SONS, LTD.***

ST. JOHN, N.B., CANADA

MONTREAL TORONTO WINNIPEG VANCOUVER



"The fame of Good Service lingers long after mere Price is forgotten." We do not claim that our prices are necessarily lowest — nor, on the other hand, are they loaded with unnecessary "overhead"—but our Workmanship, Quality and Service are certainly Right!

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Birks Bldg., Montreal, and Hall Machinery Co., Sherbrooke

Let Us Show You How To Get This License FREE

You don't have to be told what this license will mean to you. You know that well enough. A steady job at a good salary—a chance to use your head instead of your body—a position that is worth holding—yes, you know that you *WANT* this license and you know *WHY*. Will you let us show you how to get it? Then sign the coupon below and mail it right now. This does not obligate you in any way. Simply gives us a chance to show you how to get your license.

The Growth of the Steam Engineer's WEEKLY PAY ENVELOPE

1900
$16.00

1905
$18.00

1910
$20.00

TODAY
$75.00

WE WILL INCREASE YOUR PAY

THE JOSEPH G. BRANCH
SCHOOL OF ENGINEERNG :: CHICAGO

COMPLETE COURSE IN STATIONARY ENGINEERING

covering every branch of power-plant work, including Steam Engineering, Practical Mathematics and Electric Wiring. The Course has been prepared by a staff of experts working under the personal supervision of Joseph G. Branch, B. S., M. E., for many years Chief Engineer of the City of St. Louis and head of the Examining Board of Engineers for that City. Although complete in every detail, the Course is written so simply and clearly that anyone can understand it. No useless theory—but all the straight facts you need to pass the Engineer's Examinations and hold down a good job.

Special Offer—Mail Coupon Quick

The price of the course is extremely low and just now we are making a special limited offer to those who reply to this advertisement. This remarkable offer reduces the cost of the complete course to a very low figure. You will be astonished to find how little this tremendously valuable training will cost you. Mail coupon at once for full particulars and special monthly terms.

FREE COUPON

Joseph G. Branch School of Engineering,
542 S. Dearborn St., Chicago.

Without obligation, please send me information how to get a Stationary Engineer's License and full information about your Course and Special Terms.

Name .....
Street and No. .....
City ..... State .....
Present Position .....

Save Your Plant
And 10 to 15% of Your Coal Bill

Two Causes of Disastrous Boiler Explosions

I. Cold water was fed to boiler, thereby weakening the structure.

II. The feed water contained a large amount of inorganic matter.

WHERE THE BOILER-HOUSE ONCE STOOD

The feed water contained a large amount of inorganic impurities and was fed cold to the boiler. It was the practice to blow some water out twice each twelve-hour shift.

From POWER April 1, 1919

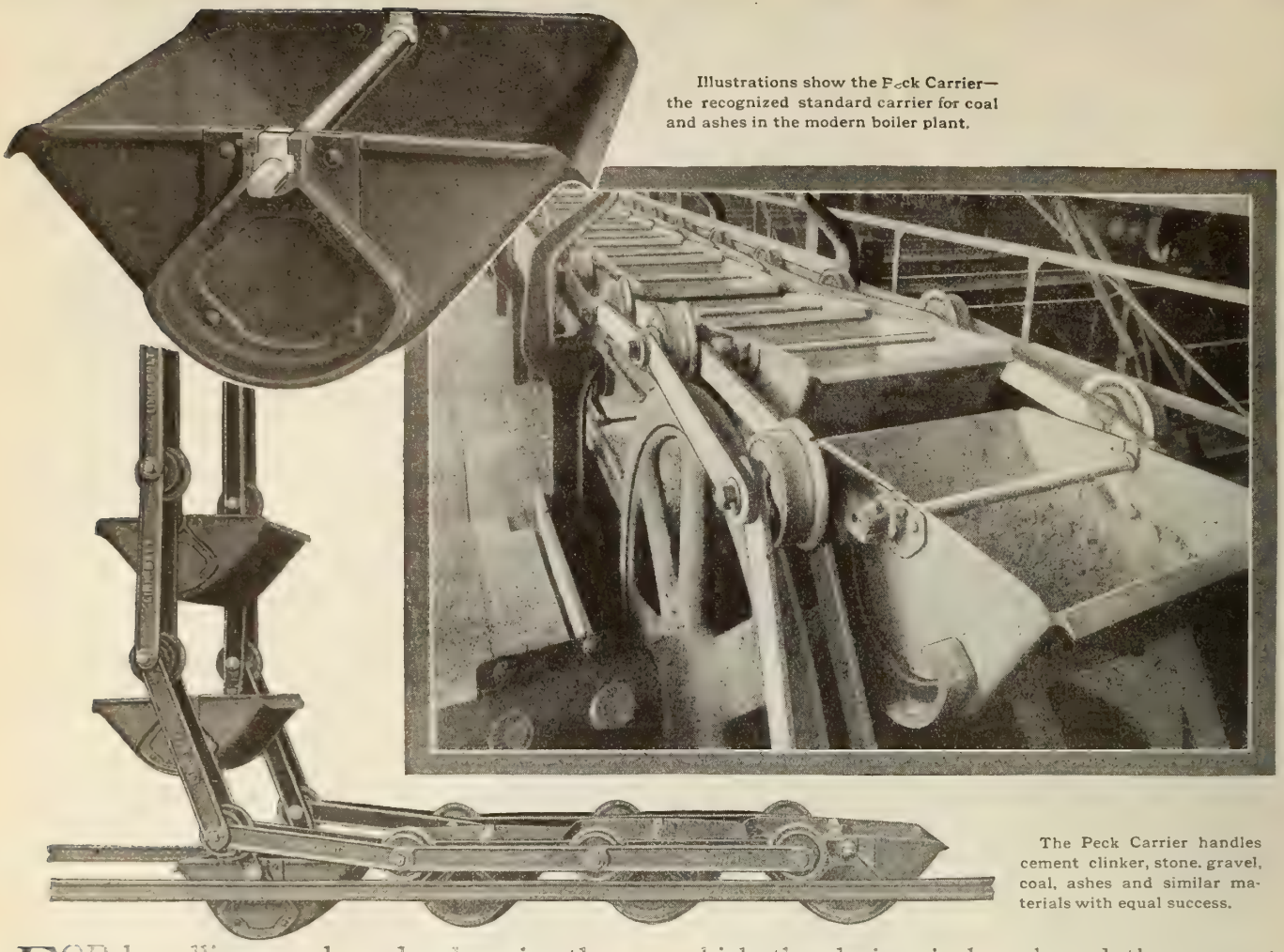
GREEN'S ECONOMISERS

I. Will heat your feed water from available heat in the flue gases which would otherwise be wasted, thus eliminating stresses which are set up when cold water is fed directly to the boilers, as wll as saving fuel and increasing boiler capacity.

II. With their slow circulation of water through the tubes, allow scale forming impurities to settle in the form of a sludge in the bottom headers, which can be blown down or washed out with a hose.

Our engineers will be glad to submit data showing the savings that have been made in other plants where economizers are installed, and will tell you what might be accomplished in your own plant.

GREEN'S ECONOMISER, LIMITED, TORONTO



Illustrations show the Peck Carrier—the recognized standard carrier for coal and ashes in the modern boiler plant.

The Peck Carrier handles cement clinker, stone, gravel, coal, ashes and similar materials with equal success.

FOR handling coal and ashes in the boiler house the Peck Carrier maintains a uniform record for low-cost per ton carried, and exceptionally low upkeep cost.

During the first three years of its operation, the Peck Carrier maintenance charges should be almost negligible.

This is due to the correct design of the entire machine, the correct principle upon which the design is based, and the rugged, sturdy construction of all parts entering into it.

Back of the Peck Carrier stands the reputation of this Company—and hundreds of successful installations. Read our Peck Carrier Book No. 220. Address nearest office for copy.

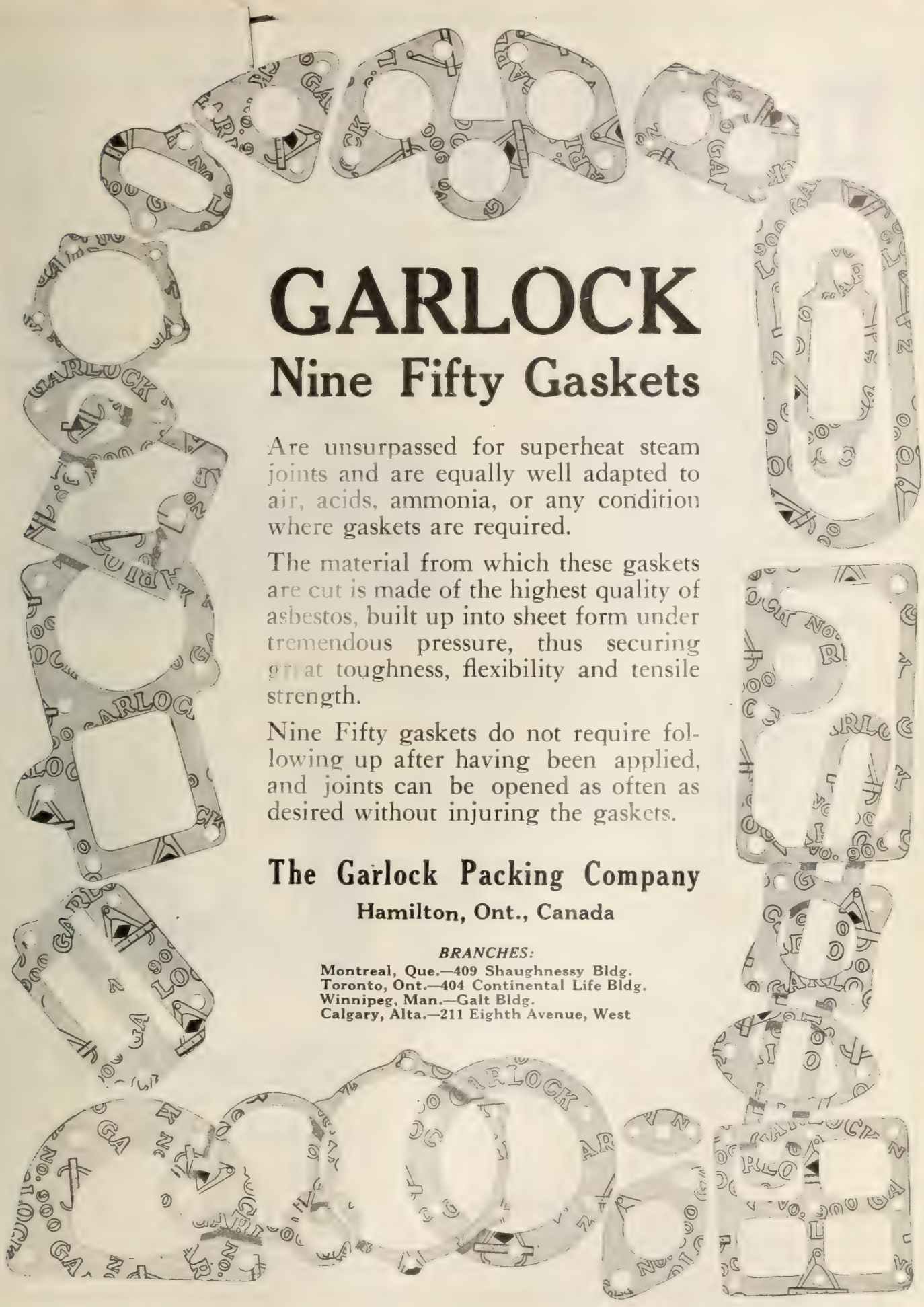
CANADIAN LINK-BELT CO., LIMITED
WELLINGTON AND PETER STREETS
TORONTO

LINK-BELT
Elevators and Conveyors

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets

Write for Catalogs
Place X in Square



GARLOCK
Nine Fifty Gaskets

Are unsurpassed for superheat steam joints and are equally well adapted to air, acids, ammonia, or any condition where gaskets are required.

The material from which these gaskets are cut is made of the highest quality of asbestos, built up into sheet form under tremendous pressure, thus securing great toughness, flexibility and tensile strength.

Nine Fifty gaskets do not require following up after having been applied, and joints can be opened as often as desired without injuring the gaskets.

The Garlock Packing Company

Hamilton, Ont., Canada

BRANCHES:

Montreal, Que.—409 Shaughnessy Bldg.
Toronto, Ont.—404 Continental Life Bldg.
Winnipeg, Man.—Galt Bldg.
Calgary, Alta.—211 Eighth Avenue, West

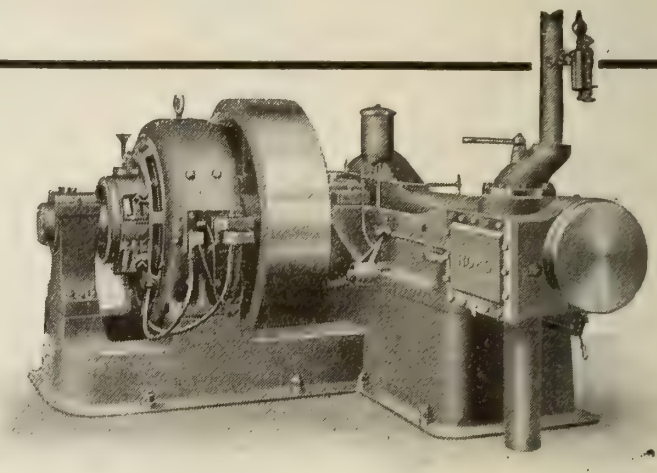
ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market — remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office: Phone Westmount 6800

Toronto Office: 20 Victoria Street

Tell it to the front office

Tell the boss that you are tired of fussing with troublesome traps that waste your time and his money. Send him that new book we have for you—and let him see why the Dunham Trap has been installed in so many prominent residences, public buildings, apartments and industrial plants.

Tell him that the Woolworth Building and many of the largest office buildings in Canada use Dunham Traps exclusively. Remind him that it was the first thermostatic disc trap; has been standard since 1903; has only two parts; is permanently adjusted at the factory; makes jet water unnecessary.

First, send for the book, "Data on Dunham Heating." It's worth having.

The DUNHAM HEATING SERVICE

Made in Canada

C. A. DUNHAM COMPANY, Limited, Toronto, Canada

HALIFAX OTTAWA VANCOUVER MONTREAL WINNIPEG CALGARY

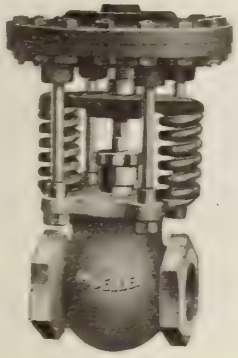
London. 64 Regent House, Regent Street, W. 1

MADE IN CANADA

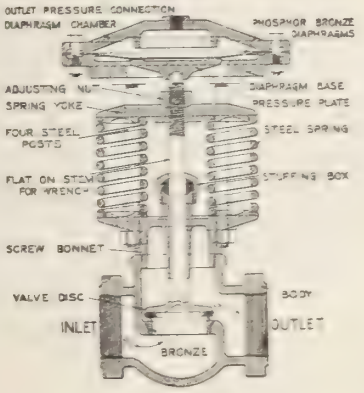
MUELLER

Reducing and Regulating Valve and Pump Governor

For Steam and Oil; Single Seat; Direct Operated



No. A5120
Code—*Ranchero*



This valve is for protection against abnormal rises in initial pressure and where a reasonable variation in the delivery pressure is not objectionable.

For pump governors, power purposes and blower engines it is unexcelled.

It operates most efficiently where the initial pressure is constant and the required reduction is not too great.

Regulators of this description are suitable for pressures up to 150 pounds. For pressures in excess of 150 pounds, submit specifications.

WE MAKE MUELLER

Basin and Bath Trimmings, Bibbs, Sill Cocks, Ferrules, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps; Regulators and Reducing Valves for Water, Air, Steam and Oil; Bubbling Fountains, Gas Cocks, Globe, Angle and Check Valves, Etc. Forgings in Brass; Castings in Brass, Bronze and Aluminum; Specialties for Automobile Companies, including Bronze Bushings, Gasoline Cocks, Etc.

H. MUELLER MFG. CO., LTD.
SARNIA CANADA

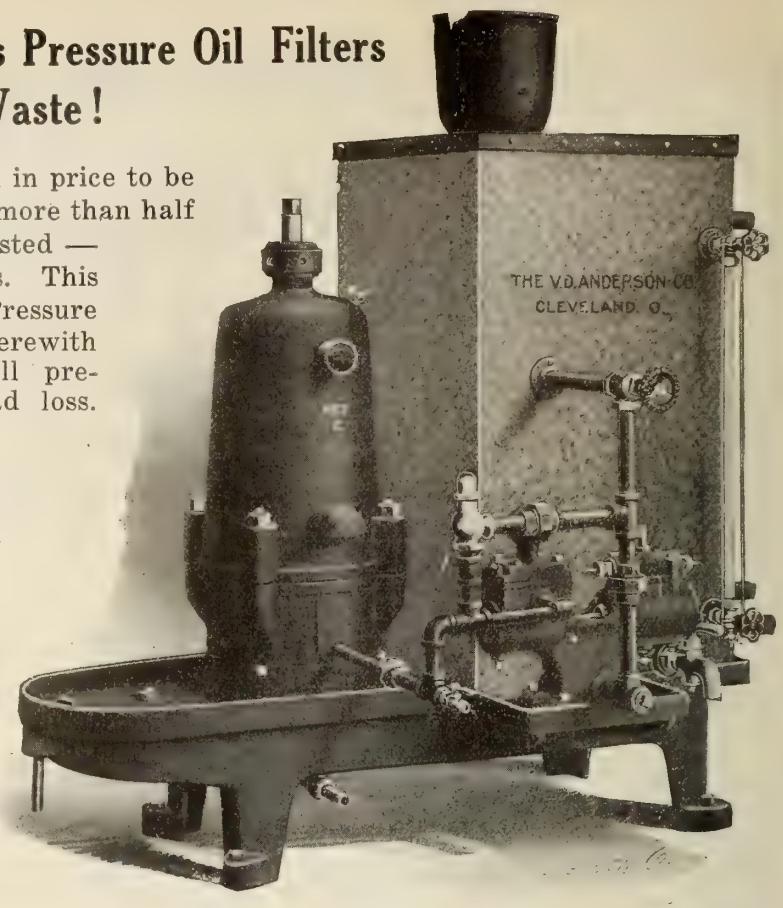
Are you on our Mailing List

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS

Why Waste Oil?

Anderson's Pressure Oil Filters Prevent Waste!

Oil is too high in price to be wasted. Yet more than half your oil is wasted — lost on wipers. This Anderson Pressure Oil Filter herewith illustrated will prevent this dead loss.



Place drip pans beneath engines and machinery. Then pass this oil through the **Anderson Filter** and you will have oil just as clean and as pure as the new oil you purchase.

You can use oil over and over again with the **Anderson Filter.** No other filter will do the work so thoroughly.

There are a few more points about the Anderson that we would like to take up with you. Pleased to have you drop us a line.

The V. D. Anderson Co.
West 96th St., Cleveland, Ohio

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co

27 COTE St MONTREAL, QUE

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

When Writing to Advertisers
Kindly Mention this Paper

POWER HOUSE SOLVES THE PROBLEM

It is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

LINCOLN ARC WELDER

Don't Let a Defective Boiler Shut Down Your Plant

Of all the untoward occurrences that happen in every plant, the most serious is the defective, leaky boiler.

In most plants this means a "shut down" —usually for some days.

Every efficient organization will be interested in knowing that we can make the most complete boiler repair, in a few hours—that, by any other method would take days.

We maintain special equipment for hurried calls, which we can bring at once to your door.

In the list opposite are the classes of plants that are today employing the Lincoln Arc Welding Process because it means a distinct saving of time to them —and time is money.

It will not obligate you in any way to get in touch with us. Phone Main 3768 if convenient, or write or wire for complete particulars.

Do this now — you will be surprised at the wide variety of work that is done with Lincoln Electric Welding.

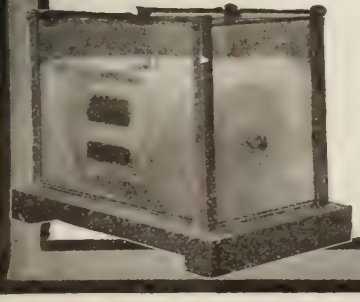
"Link up with Lincoln"

The Lincoln Electric Company of Canada
Limited

1111 Temple Bldg., Toronto

Branch:
Coristine Bldg., Montreal

- Automobile Manufacturers
- Agricultural Implement Manufacturers
- Boiler Shops
- Car Builders
- Drop Forging Manufacturers
- Fan and Blower Manufacturers
- Industrial or Shop Tractor Manufacturers
- Locomotive Manufacturers
- Metal Specialties — Sash, Lockers, Wheel Barrows, Barrels, etc.
- Pressed Steel Frame Manufacturers
- Safe and Vault Manufacturers
- Steel Mills
- Switch and Frog Manufacturers
- Ship Yards
- Railroads
- Tractor Manufacturers
- Transformer Manufacturers
- Foundries
- Oil Refineries
- Steam Pump and General Machinery Manufacturers



ECONOMIC Carling BLOWERS SUPERIOR

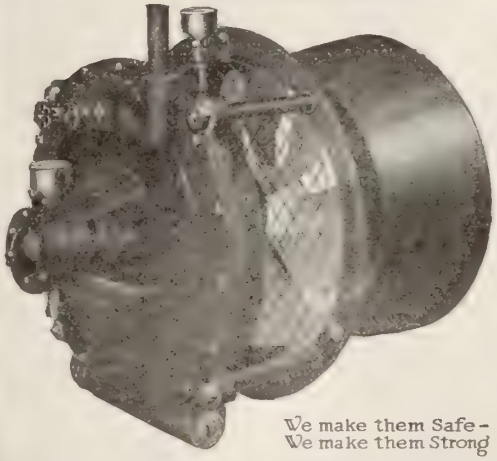
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe –
We make them Strong

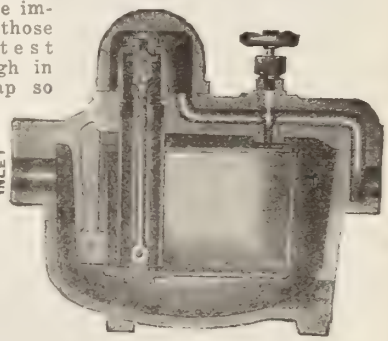
KIELEY

IMPROVED HIGH AND LOW PRESSURE

STEAM TRAP

For General Service

No power plant should be without a dependable steam trap. It is the great economizer of fuel and promoter of power plant efficiency. The KIELEY Improved Trap is the latest development in the art of steam trap construction, and is suitable for all service, either high or low pressure. The important parts and those subjected to greatest wear are placed high in the top of the trap so that by removing two nuts and the small cap all parts are easily accessible and removed for repairs — no breaking of connections necessary, neither do you have to remove the cover. Seats and discs are of best metal, absolutely non-corrosive; for exceptionally severe service seats and discs are constructed of nickel or monel metal, and the bodies of cast iron. Kieley traps never leak when in service—our water seal assures you this.



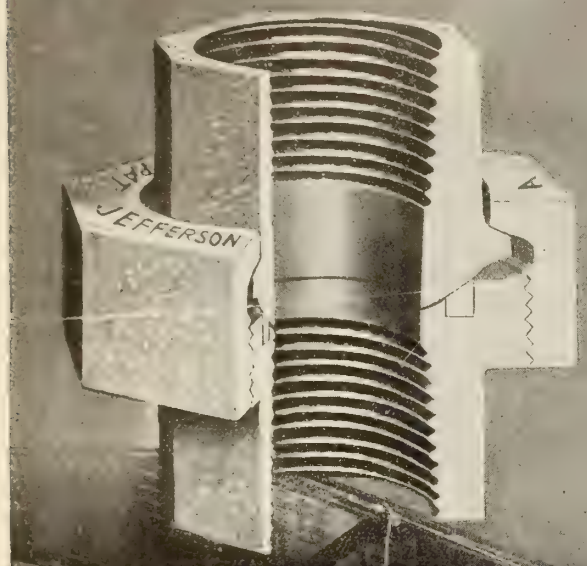
Leaky, unreliable steam traps are expensive. Adopt the KIELEY and be certain of efficient, economical service.

THE ARTHUR S. LEITCH CO.

Kent Building, TORONTO

JEFFERSON

"Look for the Name on the Nut"



Insurance Against Breakdowns!

To make long, heavy pulls without faltering the **power behind the HOIST** must be absolutely certain. The steam pressure in the great cylinders must be constant and steady.

Jefferson Unions play a mighty important part in the steady and safe operations of HOISTS and other machinery.

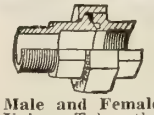
Once you put a JEFFERSON UNION on the line, you can say "Good-bye forever" to union troubles because a Jefferson gives perfect service just as long as the line holds out.

Your jobber will supply JEFFERSON UNIONS. Talk them over with him—ask him to explain the difference between a JEFFERSON and one of the "just-as-good" variety.

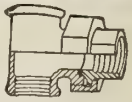
Write TO-DAY for our Catalogue "UNIONS" which shows the complete JEFFERSON line.

The Jefferson Union Co.
Lexington, Mass.

Union Elbow, an economizer of the most pronounced type. Also made all female.



Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.



Union Tee, with union on the outlet. Made also with male end on outlet.

VULCABESTON

TRADE MARK
"VULCABESTON"
REG. IN U.S. PAT. OFFICE
RED FIBRE

STEAM
M'F'D. EXCLUSIVELY BY THE JOHNS-PRATT CO. HARTFORD CONN. U.S.A.
AIR-ETC. AMMONIA
SHEET PACKING

COMPRESSED ASBESTOS

The Vulcabeston Trademark

The Vulcabeston trademark on a sheet of packing establishes the genuine worth of that sheet of packing.

The Vulcabeston trademark identifies the permanent packing that has never failed when the mechanical conditions were correct.

The Vulcabeston trademark identifies "The Universal Packing" that stands firm under the ravages of superheated steam, acids, oils, compressed air, ammonia and alkaline solutions.

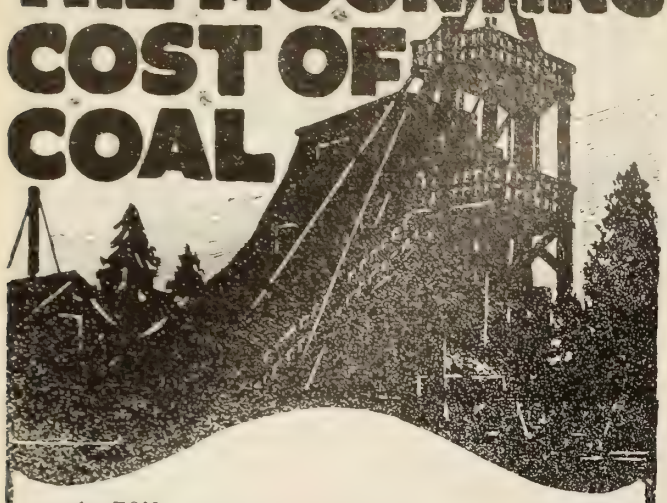
It is by far the cheapest packing from the operating point of view.

The Johns-Pratt Company
Hartford, Conn. U. S. A.
Dealers in all large cities

20-4

TRADE MARK
"VULCABESTON"
REG. IN U.S. PAT. OFFICE
RED FIBRE
STEAM
AIR-ETC. AMMONIA
SHEET PACKING
COMPRESSED ASBESTOS

THE MOUNTING COST OF COAL



A TON of bituminous coal costs to-day nearly 250% more than in 1914. Of course, you can't get 2½ times as much heat out of that ton as you did six years ago—but you can get at least as much. Do your boiler room records enable you to check up on your heat per ton? Are you satisfied that every pound of fuel is being utilized to the best possible advantage?

There is no surer or more positive way of ascertaining than by installing a

YARWAY-LEA V-Notch METER

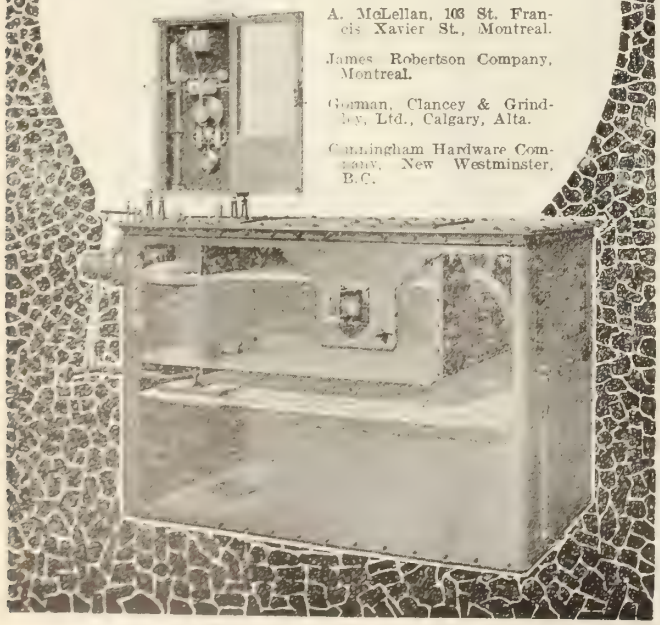
for it measures **accurately** the amount of water evaporated by the boiler, and records the figures in a permanent, easily-referred-to form. You can run your power-plant under a continuous, self-recording test, with every fluctuation in steam output shown as it occurs. With a complete record of performance it requires but a moment to discover whether or not that costly fuel is autually doing its duty.

We shall be glad to explain more fully the advantages of the Yarway-Lea V-Notch Meter, if you are interested, and to give you the names of some of the prominent users who have signified their satisfaction by reorders.

Shall we send Bulletin L40? It contains some interesting information on boiler room records.

Yarnall-Waring Co.

7604-20 Queen St., Chesnut Hill
PHILADELPHIA, PA.



A. McLellan, 103 St. Francis Xavier St., Montreal.

James Robertson Company, Montreal.

Gorman, Clancey & Grindley, Ltd., Calgary, Alta.

Cunningham Hardware Company, New Westminster, B.C.

ECONOMY renewable FUSES

Were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be approved ***in all capacities*** by the Underwriters' Laboratories. This honor was not won on laboratory tests alone but largely because for many years millions of Economy Fuses have been giving dependable protection, high efficiency and working marked economies.

¶ When you order fuses insist on ECONOMY.

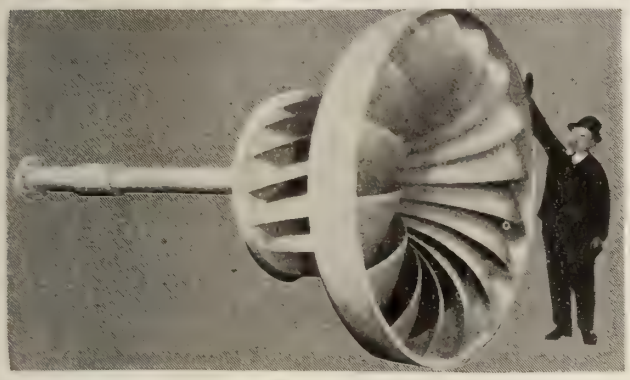
¶ ***For sale by all leading electrical jobbers and dealers.***

Economy Fuse & Mfg. Co. of Canada, Ltd.

Unity Bldg. Montreal

Manufacturers in Canada of S. & C. High Potential Fuse--to 150,000 Volts

HYDRAULIC TURBINES



Type Z Runner for Montreal Cottons Ltd., at Valleyfield, Que.

We also built and installed all Turbines for Quaker Oats Co. plant at Peterborough, Ont.
See p. 152

We are also fully equipped to furnish all kinds of

STEEL PLATE WORK

Structural Steel Work
Riveted Steel Pipe
Boiler Breechings
Refuse Burners

Smoke Stacks
Stand Pipes
Steel Tanks
Steel Bins
Hoppers
Flumes

Send us your specifications

Send for our Bulletin No. 54

WM. HAMILTON CO., LTD.
PETERBORO, - ONT.

MEAD-MORRISON

CANADIAN MM CO

Coal
and
Ash Handling Machinery

Manufactured in Canada

McCaslin Gravity Bucket Conveyors

Weighing Larries

Coal Crushers

Reduce costs by handling your coal and ashes with "MEAD - MORRISON" Dependable Service Equipment.

Contractors for complete coal and ash handling plants.

Our engineering staff will gladly help you solve your problems.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

In cold dollars and cents

—how much is 25% of your coal bill?

We are specialists in combustion engineering. We manufacture other boiler instruments besides the recorder illustrated, and we are ready at all times to answer your enquiries on any phase of the subject.

Is it worth saving, or would you prefer to keep on throwing it away?

Don't think we're making a rash statement. **Innumerable results have shown that 25% of all the fuel burned under steam boilers is wasted by preventable heat losses in the boiler furnace alone.** These losses **cannot** be prevented by "efficient," up-to-date equipment. **"Efficient" equipment is only as economical as its operation allows it to be,** and it's operation we're talking about. Even the most modern and up-to-date power plant will waste 25% of its coal bill, just as we say you are doing, unless proper steps have been taken to prevent the waste.

To save that 25%, you need accurate information of the furnace conditions at all times. Then you need the knowledge to apply this information to prevent the losses.

The Hays Automatic CO_2 and Draft Recorder obtains an accurate and continuous record of the two essential furnace conditions. Our book, "How to Build Up Furnace Efficiency" helps you to interpret these readings, to locate and measure the losses. It shows you how to stop these losses once they are located, and how to keep them stopped.

We suggest that you send for this book. It's good enough for your library, it's interesting and entertaining — in no sense a catalogue— and it's gone through 14 editions.

The Jos. W. Hays Corporation

Michigan City, Indiana, U.S.A.

General Representatives for Canada:
Stephen H. Payne, 30 Church St., New York

REPRESENTATIVES IN CANADA:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto
Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal
Wm. Goold, 701 Merchants Bank Bldg., Winnipeg

If It's Rubber We Make It

Rubber has become probably the most universally used material in the world. In every factory, office, store, and household, some article of rubber is used daily as an important part of the equipment. Few users recognize its utility or its quality—to them the important item is price.

When you buy rubber goods be certain that you get a Dominion Rubber System product. It is your assurance of superior quality and satisfactory service. These products include Rubber Goods for every conceivable purpose in standard stock sizes, or specially made to meet your needs, in factory, mill, mine, lumber camp, shipbuilding, marine, or other industry.

Dominion Rubber System Products

BELTING—For power transmission, conveyor, and elevator service. Bucket belts, Vanner belts, belts for brick-making machinery, lumbering, and all exposed or outside work.

HOSE—For steam, air, water, oil, acids, suction and sand—fittings and nozzles.

PACKINGS—Sheet packings and special packings for high and low pressure service, and for every other purpose.

MOULDED RUBBER—Plumbers' supplies, matting, tiling, special moulded and cut goods.

FIRE EQUIPMENT—Hose, coats, covers, reels, brass fittings, helmets, etc. Also a complete line of fire-fighting necessities for factory and home.

Our technical experts will gladly assist you, without cost, to select such equipment as you may require for regular or special service.

Phone or wire our nearest service branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Dominion Rubber System

Service Branches

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

The Practical One Piece Boiler Furnace Lining

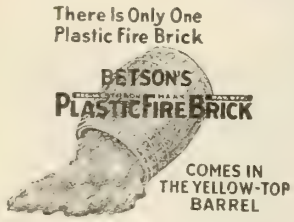
No excuse now for laying up fire brick again and again, repeating the costly experience year after year.

You've seen Betson's Plastic Fire Brick advertised for many years, showing that it has long since proved practical, successful and satisfactory.

Betson's Plastic Fire Brick stands the stress and strain of a one-piece lining for an entire boiler setting, and for large blocks or arches because expansion and contraction is taken up internally and automatically. Plastic Fire Brick is compounded of the highest grade materials, and by processes proven best by twenty years of experience.

Betson's Plastic Fire Brick is the PIONEER one-piece boiler furnace lining material. Try it the next time—order to-day and shipment will be made from our nearest branch or warehouse.

Our Pamphlet showing how you can form a monolithic boiler furnace in place with no separate bricks to work loose, is yours for the asking.



Betson Plastic Firebrick Co.

Postoffice Box 386-6 ROME, N.Y.

Prompt deliveries from warehouses in many cities.

Canadian Distributor:

International Chemical Co.

44 Lombard Street, TORONTO, ONT., CANADA

Really Troubleproof

DART

Truly Economical

UNION
PIPE COUPLINGS

A trial is convincing Your Jobber sells them

anufactured in Canada by DART UNION CO., Limited, TORONTO, ONTARIO

T
H
E

Consideration due Condensation,
Offers considerable food for discussion along
Lines opening up in the Engineering Field.
Efficiency; First Cost; Saving to be effected.

Saving should always be the Engineer's Aim.
You can't go too far with this saving game.
Start at the coal pile, or wherever you will,
Then you can show either Tom, Dick or Bill.
Engineers will succeed, if a hand you will lend.
Methodical means surely win in the end.

GEO. W. COLE, LIMITED

2002-4 Dundas Street West, TORONTO

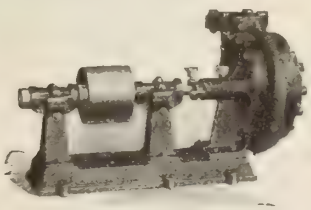
Montreal, Que. ***Winnipeg, Man.***

AMERICAN-MARSH PUMPS

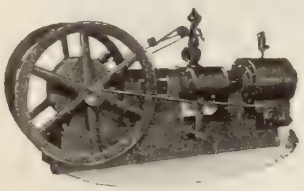
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

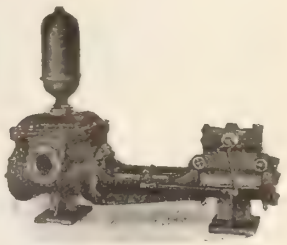


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

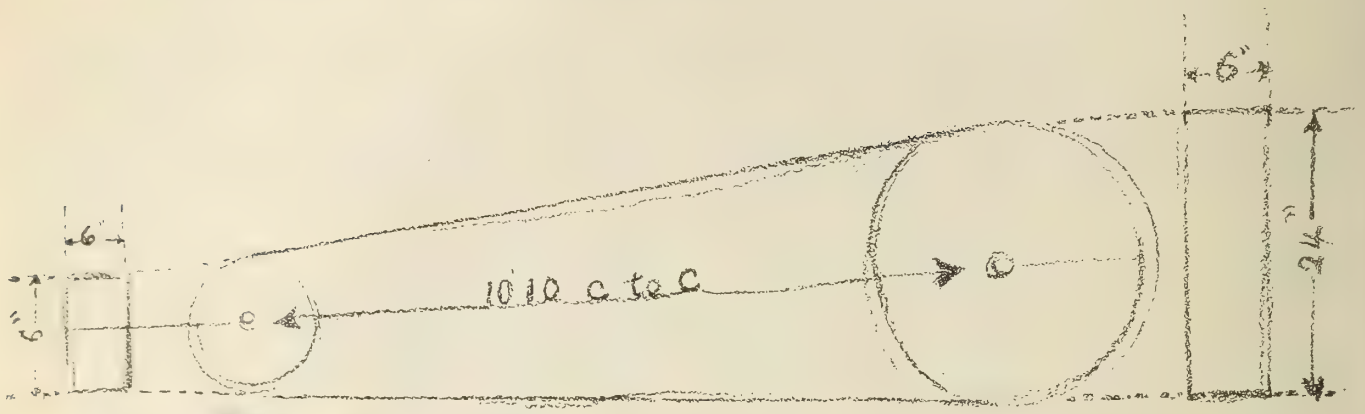
CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

OUTLINE OF JORDAN PUMP

SPECIFIED — PULLEY FACES 8"

GOODYEAR EXTRA POWER — R.P.M. DRIVING PULLEY 500

6" x 5 PLY 25'6" — H.P. 10



A Goodyear Belting man will survey your plant with no obligation to you.

GOODYEAR

MADE IN CANADA

Where Belts Meet Dampness!

Goodyear Extra Power Belt Delivers Power and Lasts

Damp or wet belts usually slip more easily than dry belts.

Water and moisture form a thin film between pulley and belt.

Here "Extra Power" Belting especially displays its advantages.

Where there is water, moisture or steam — around the beaters in paper mills, for instance—Goodyear Extra Power delivers the power load just as under more favorable conditions.

Because Goodyear Belting has a rough friction surface which bites through the film of water and clings to the pulley, costly slipping is overcome.

Moisture rots belts, if it gets into them.

Goodyear Extra Power is rubber-sealed against moisture.

Not just enclosed in a rubber envelope.

The high-grade rubber in Extra Power is forced through and through the fabric, surrounding and protecting every strand, making the belt practically a solid unit.

That Goodyear Extra Power Belting is just as efficient and just as economical in damp or wet places as in other transmission uses, is proved by these satisfied users:

> The Provincial Paper Mills of Thorold got 16 months' service from Goodyear Extra Power on a Jordan Pump where they had been getting about one month's service. They also say — "In the room where our beaters are located, the air is constantly damp. Here we have found Extra Power so superior that we use it exclusively."

Some other firms who will be glad to tell you of the satisfactory service of Goodyear Extra Power under damp conditions are:

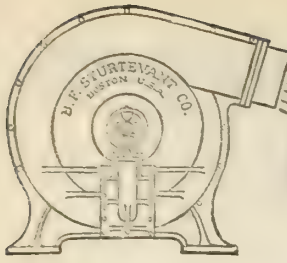
Mittagami Pulp and Paper Co., Smooth Rock Falls, Ont.
Port Arthur Pulp and Paper Co., Port Arthur, Ont.
North-West Laundry Co., Winnipeg, Man.
Dominion Pulp Co., Chatham, N. B.
Bathurst Lumber Co., Bathurst, N. B.
Gloucester Lumbering and Trading Co., Bathurst, N. B.

If you use belting, it will pay you to hear about the Goodyear way of supplying it. It will cost you nothing to have a Goodyear man call and show you how to overcome your problems. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

BRANCHES:—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service Stocks in smaller cities.

EXTRA POWER BELT



Sturtevant

REG. U.S. PAT. OFF.

PUTS AIR TO WORK

THE NEW A-7 TURBINE-TRANSMISSION

A BRAND-NEW DRIVE FOR STOKERS—FANS—PUMPS

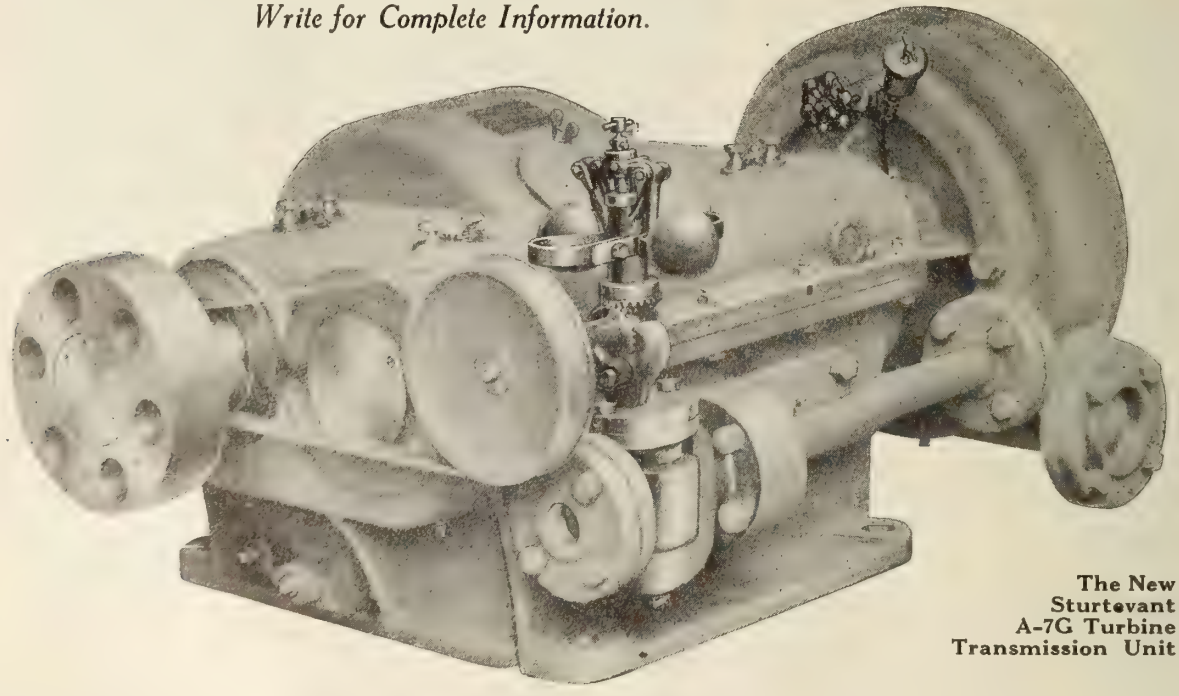
The cumulative experience of 60 years is expressed in the design and construction of this new unit. The unique features allow highest turbine efficiency while the stokers, fans and pumps are working at their most economical speeds.

The turbine is supported directly from the transmission casing—flexible couplings are eliminated—no sub-base is necessary—alignment trouble is impossible—and lubrication is automatic.

Much time has been spent in carefully designing this unit. Thorough tests were made in our shops long before anyone outside of our organization was asked to prove its merits under actual working conditions. For over a year a number have been in use, by several of our customers, with remarkable satisfaction.

It is with confidence and readiness that we ask you to acquaint yourself with the possibilities of this practically tested driver. You will find our Turbine Department always prepared to co-operate with you.

Write for Complete Information.



The New Sturtevant A-7G Turbine Transmission Unit

B. F. STURTEVANT COMPANY OF CANADA, LTD.

HEAD OFFICE AND WORKS: GALT, ONT.

SALES OFFICE: TORONTO AND MONTREAL.

Make this Book Your Buying Guide

It will keep you in touch with every phase of mechanical equipment, no matter what your business may be. It will keep before you the advantages of concentrating your buying in one place, where everything mechanical needed for the factory, power house, machine shop, garage or farm is obtainable.

It should be permanently on the desk of every purchasing agent—every buyer of mechanical goods. Write to-day for your copy of

General Catalogue No. 20

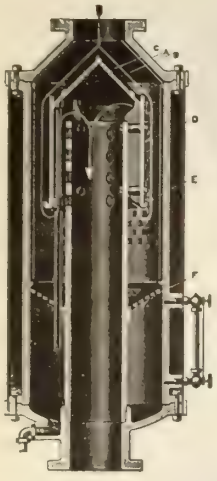
the most complete compilation of information for the Canadian buyer of mechanical goods, departmentalized, conveniently thumb-indexed, and cloth-bound.

The Canadian Fairbanks-Morse Co., Limited

St. John Quebec Montreal Ottawa Toronto Hamilton Windsor
Winnipeg Saskatoon Regina Calgary Vancouver Victoria

Scales Valves Steam Goods Oil Engines Pumps Electrical Machinery Machine Tools
Transmission, Railway and Contractors Equipment Automotive Equipment

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Did you ever wonder why you had to repack the globe valves so often?

It's because you use a packing that has no lasting qualities?

TRY

"PALMETTO" Twist Packing

You will find it has the quality that gives long service, and true economy is only found in long service.

Let us send you a sample spool to test — no charge.

GREENE, TWEED & CO.

Sole Manufacturers

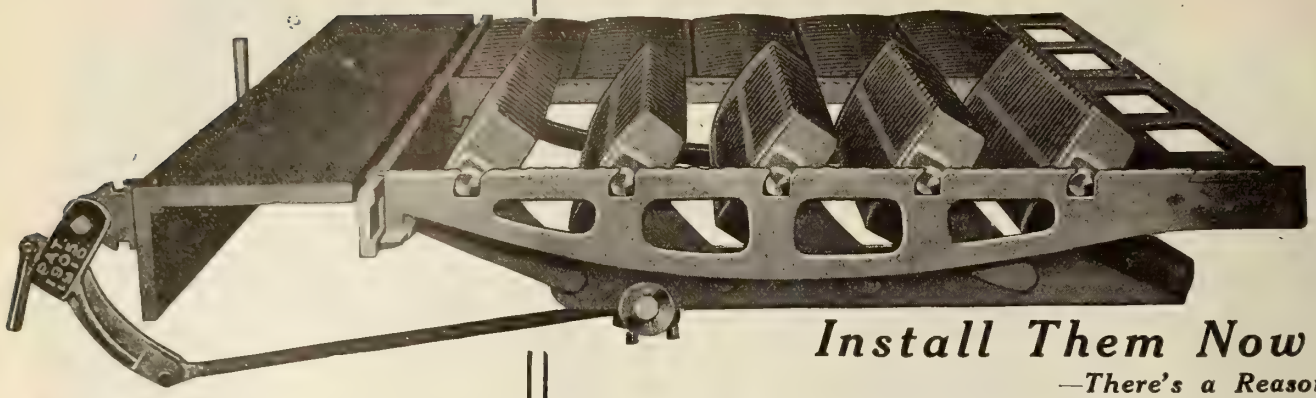
109 Duane St. New York

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

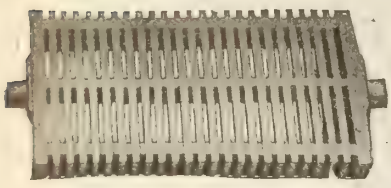
The real expense of packing a valve is the labor.

The amount of packing used is small.

It's economy to use the packing of long service.



Cyclone Grates



Install Them Now!

—There's a Reason

Think of the price you are paying for coal! Think of the price you will pay when fuel takes another jump. Then think of this — Cyclone Grates will save you at least 10% of your fuel costs, because they provide for 60% air space and 90% underdraft, which enables you to burn every bit of fuel that goes into the furnace, and at the same time enables you to burn the cheapest grades of coal and secure maximum results. Cyclone Grates help you to meet the high cost of fuel — install them now and save expense!

SPECIAL NOTICE—We are prepared to install Cyclone Grates on genuine 30-day trial basis. Details gladly furnished.

The Canadian Steam Boiler Equipment Co. Ltd.

20 McGee Street - 'Phone G 2660 - Toronto, Ont.

AGENTS :

St. JOHN, N.B. : F. W. Blizard, 239 Charlotte St. MONTREAL : Mason Regulator and Engineering Co. Ltd., St. James St. HAMILTON : Robt. Fitzsimmons, 8 Grove St. CALGARY : The Western Foundry & Metal Co. WINNIPEG : Vulcan Iron Works

METLSKIN

prevents boiler-scale

by a process which is mechanical, rather than chemical. It forms a minute, grayish-white coating which keeps scale-forming solids from adhering to the boiler metal, and, therefore, these solids must settle to the mud-drum, whence they may be discharged through the blow-off.

METLSKIN is distinctly **not a compound,** nor does it contain any soda ash, graphite, kerosene, or tannin. It works by expansion, without harm to anything save boiler-scale itself.

The Two Months' Test

may be adopted by any reputable concern troubled with scale. METLSKIN will remove the old incrustation safely, but gradually, will ultimately produce clean boilers and then **keep them clean.**

Send a post card for terms and full details.

NOPORO

air-proofs boiler-settings

by maintaining an air-tight seal on the exterior surfaces of the brickwork. After a thorough application, by means of a trowel, NOPORO forms a covering that looks and feels very much like coarse, black grain leather. The surface may be whitewashed after an interval of 6 to 8 days, while the material below the surface retains its plasticity. It will not peel, check, or disintegrate, and will stay put for years. No further attention need be given it.

An Immediate Saving

may be effected, since NOPORO promptly prevents the entrance of cold-air into the furnace chamber. That means better fuel-combustion, less firing, less coal. NOPORO pays for itself from the first.

Mail a card for prices and descriptive folder.

METLSKIN CO., Inc. Sole Manufacturers ROCHESTER, N.Y., U.S.A.

Exclusive Canadian Distributors

CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John, Montreal, Quebec, Ottawa, Hamilton, Toronto, Windsor, Winnipeg, Calgary, Vancouver, Victoria, Saskatoon

HOMESTEAD
Quarter-Turn Valves

There's a Homestead for every purpose

Whenever you are in need of tight, efficient, positive-acting valves—order "Homesteads."

They are all constructed with the patented "Homestead" principle which locks the valve tightly to seat when the valve is closed, and which limits the operation of the valve to a quarter turn of a convenient handle.

Only one quarter of a turn is required to open or close these high-grade valves. Adopt them. You'll save time, trouble, and expense. Our catalogue contains some interesting information.

Homestead Valves are made in Straightway, Threeway and Fourway patterns.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

Water Filters

for

Municipal, Industrial or Residential Uses

We are Ontario Representatives of

ROBERTS FILTER MFG. CO.

Water Problems

Submit your water problems to us. We have many years' experience in this line and can give expert service.

E. J. PHILIP & SONS

57 Queen Street West
TORONTO, - CANADA

ENGINEERING EQUIPMENT

DON'T THROW AWAY YOUR VALVES

Like many other concerns, you probably have been in the habit of throwing away your old valves. This, of course, is a necessary practice with valves of the ordinary type. As soon as the seating is too far gone for service they become worthless.

With an equipment of Pratt & Cady Renewable Seat Gate Valves, it no longer becomes necessary to consign a valve to the scrap heap when the seat is worn out.

Renewable seat rings — to take the place of the old ones — give the valve a new lease of life, and a long lease, at that. All parts, being of the best grade of pure metal, possess tremendous endurance and give the utmost service. This combination insures an unusually long life.

In the course of a year more valves go out of commission in the average plant than you realize. Add up their cost, large and small, and you will be surprised at the total. Pratt & Cady Renewable Type Valves will save you the greater part of that total!

Ask us for the names of satisfied users.

Booklet on request. Write for it to-day.

Canadian Representatives

The Canadian Fairbanks-Morse Co.
Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Pratt & Cady Co., Inc.

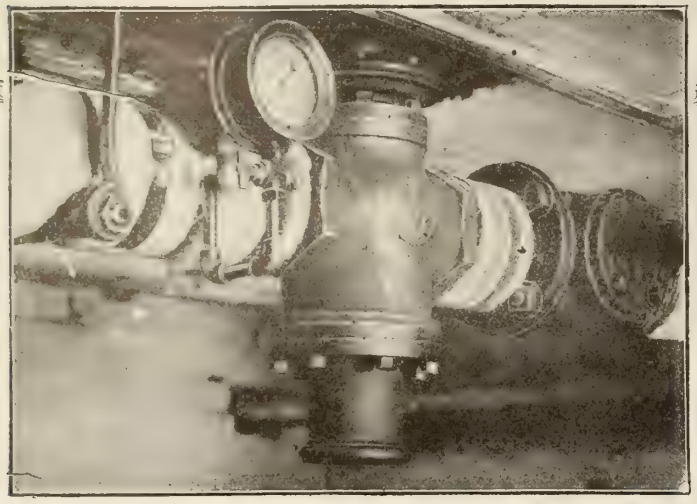
MANUFACTURERS OF VALVES, FEED WATER HEATERS, HOT WATER GENERATORS, HOT WATER SERVICE HEATERS, POWER PUMPS & ASBESTOS PACKED COCKS

BOSTON NEW YORK
CHICAGO DETROIT
CLEVELAND PITTSBURG
HARTFORD PHILADELPHIA
SAN FRANCISCO

P&C CO
TRADE MARK

MASON

POWER HOUSE SPECIALTIES



Stand the Test of Time

No better proof of the quality embodied in **Mason** Specialties is needed than this: in 1896 the **Mason** Standard Reducing Valve shown in the illustration was installed in the Protestant Hospital for Insane, at Verdun, Montreal. It was repaired for the first time in September, 1919, and is giving as efficient service now as the day it was installed.

Mason Standard Bronze Reducing Valve.

Three Valuable Factors

To Be Considered in Choosing Equipment

Choosing the finest material for the purpose and employing the best of skilled hands in making and assembling the parts assures a standard of excellence in **quality** in all **Mason** specialties. This quality means long, dependable service. Last but not least, our salesmen are practical engineers. They are trained to give valuable service to prospective buyers; they advise the best equipment for the purpose — from experience, not catalogue!

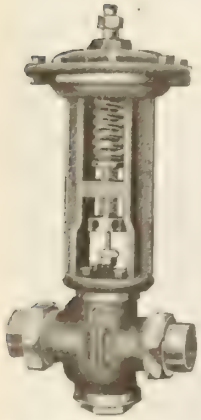
1 Quality

2 Dependability

3 Service

The "Mason" Line

"Mason" Reducing Valves (genuine); "Mason" Pump Governors; "Mason" Pressure Controllers; Bundy Steam Traps for every service; Coppus Turbine-driven Blowers; Coppus Turbine-driven Boiler Feed Pumps; Sims Hot Water Generators; Sims Storage Heaters; Sims Open Feed Water Heaters; Bundy Oil Separators; Ashton Gauges and Safety Valves; Everlasting Blow-off Valves; Babbitt Sprocket Rims; Stratton Steam Separators; Reilly Feed Water Heaters; Reilly Evaporators and Distillers; Reilly Feed Water Filters.



Mason No. 55 Pump Pressure Regulator

The Mason Regulator Co.

BOSTON, MASS.

Made in Canada by

The Mason Regulator & Engineering Co., Limited,

MONTREAL AND TORONTO

(Look for this trade mark)

GUTTA PERCHA & RUBBER LIMITED

TRADE P.M.S MARK

PAPER MILL SPECIAL

TORONTO — CANADA

The Belt that Set the Pace

For Cone Drives and other Difficult Transmission Service

Manufactured solely by

GUTTA PERCHA AND RUBBER LIMITED

Head Offices and Factory:
TORONTO

Branches in all the leading cities of the Dominion

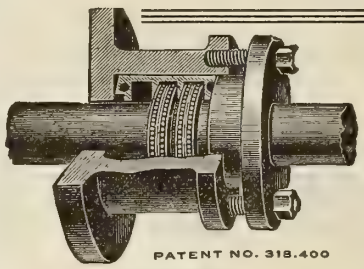
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,630
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	905,103
" "	775,194	" "	934,829
" "	791,300	" "	979,208
" "	805,689	" "	1000,75

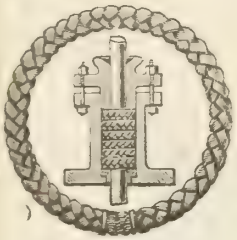
Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

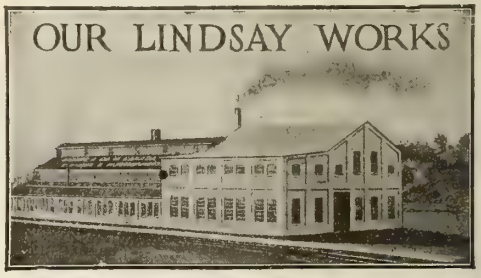
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

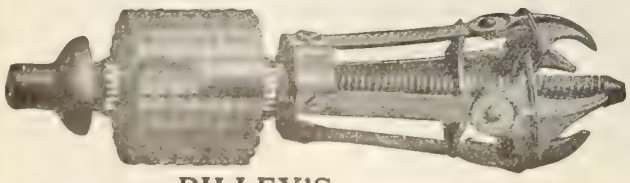
Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

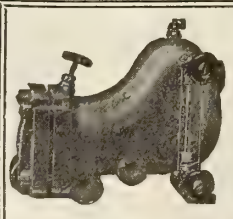
For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.



McDANIEL IMPROVED STEAM TRAP

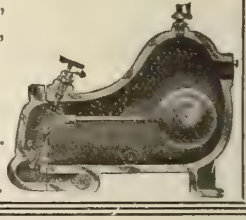
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY

26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.

No. 146 N. 7th Street, PHILADELPHIA, Pa.

DEPARTMENT OF LABOUR

Ontario Government

Minister: Hon. W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

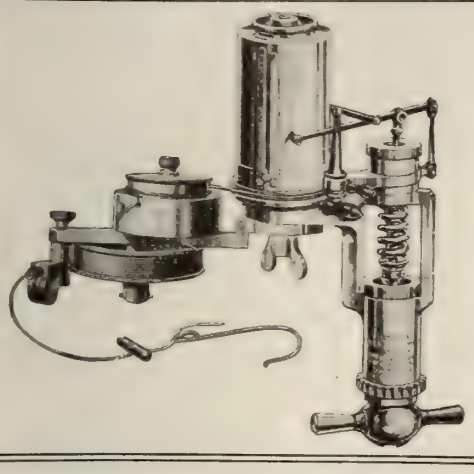
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



LEARN AND EARN
START TO-DAY! DON'T WAIT!

Learn the exact condition of the engine in your charge.

Find out all about it by using an

American-Thompson Improved Indicator

Then correct any troubles you may find and report to your employer.

He will appreciate your efficiency and reward you accordingly.

Send for catalog to-day.

Canadian Agents: Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, St. John, Calgary.

American Steam Gauge & Valve Mfg. Company

New York Chicago BOSTON Atlanta Pittsburgh

A HELPING HAND

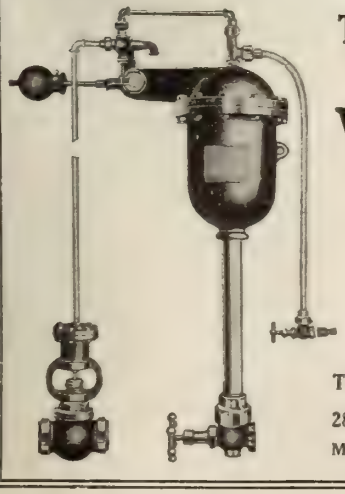
Engineers, firemen and other power plant operators are earnestly requested to take up any matters upon which they desire information with the Editors of POWER HOUSE. This applies particularly, at the present time, to the grading of certificates in Ontario. Any new development of this kind naturally gives rise to a period of uncertainty and information is often desired by those who are most intimately concerned. We are in a very advantageous position for extending a helping hand to those in doubt as to what to do under the new regulations. Questions regarding the Act, its regulations and their interpretation, requirements for the different grades, studies to be undertaken, etc., will be cheerfully answered.

CRANE VALVES

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices: Halifax, Quebec, Ottawa, Calgary.



THE REGULATOR
THAT MEANS SECURITY

VIGILANT

Feed Water Regulator

Safeguard against explosions. It cannot fail to operate and keep the boiler supplied with water as long as there is any water to feed.

Catalog will be sent on request.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.
Manufacturers of the Fulton Pump Governor

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Dunlop Tire & Rubber Co., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
Victor Balata & Textile Belting Co., Boston, Mass.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. S. Sexton Boiler Setting Co., Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

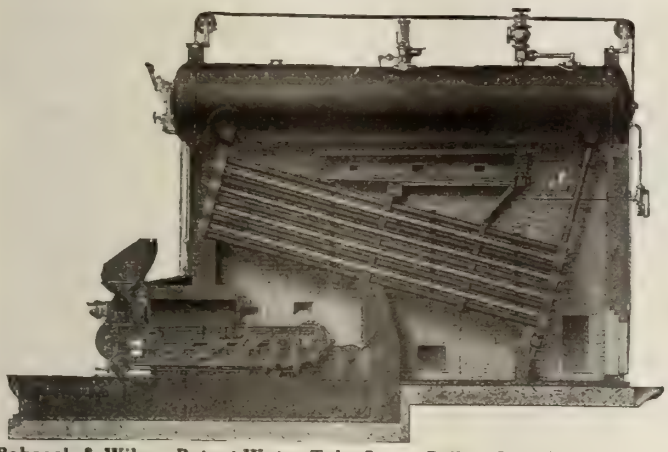
CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Beveridge Paper Co., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

A. C. UNITS

3 Phase, 60 Cycle, 550 Volts

Generator K.W.	Make	R.P.M.	Engine Cyl. Dimensions	Make
100	General Electric	257	150 H.P.	Ide.
100	Westinghouse	300	12" x 30"	Westinghouse.
400	Can. Gen. Electric	150		Robb-Armstrong.
400KVA	Westinghtouse	260	4 cylinder	Bruce McBeth.
450KVA	Wheeler	250	4 cylinder	Bruce McBeth.
500	Can. Gen. Electric	150	21" x 32"	Robb-Armstrong.
800	General Electric	100	24" x 48"	McIntosh & Seymour.

3 Phase, 60 Cycle, 2200 Volts

18½	Emberg Electric	360	7" x 8"	Emberg.
30KVA	Westinghouse	1200	12" x 16"	Muncie.
40	Ridgway		2 cylinder	Bruce McBeth.
50KVA	Westinghouse	300	10" x 12"	Skinner.
50	Bullock	1200	11" x 12"	Skinner.
50	Ft. Wayne	300	12" x 13"	Rathburn.
50	Bullock	1200	11" x 12"	Skinner.
50KVA	Westinghouse	1200	10" x 32"	Sioux City Corliss.
59	Western Electric	276	9" x 14"	Robb-Armstrong
60KVA	Fairbanks Morse	1200	11" x	Fairbanks-Morse
100KVA	Western Electric	180	10" x 18" x 24"	Buckeye.
100	Crocker Wheeler	277	14" x 14"	Harrisburg-Fleming.
100	General Electric	257	14" x 14"	Lycoming.
110	Warren	720	13" x 18"	Erie City.
120	General Electric	225	16" x 18"	Erie Ball.
120	General Electric	225	16" x 18"	Erie Ball.
100	Westinghouse	300	15" x 14"	Skinner.
150	General Electric	600		Chandler Taylor.
150	Ft. Wayne	225	16" x 18"	Ball.

Generator K.W.	Make	R.P.M.	Engine Cyl. Dimensions	Make
165KVA	Westinghouse	225	20" x 18"	Fleming Harrisburg
170KVA	Bergman		4 cylinder	Crossley Gas.
175KVA	Western Electric	225	21¾" x 22"	Sheffield.
185	General Electric	225	17" x 21"	Erie City.
200	Westinghouse	600	20" x 42"	Corliss.
200	General Electric	200		MacIntosh & Seymour.
240	General Electric	240	14" x 30" x 18"	Harrisburg.
250	General Electric	225		Bruce McBeth.
250	General Electric	200	15" x 29" x 22"	Harrisburg.
325	Can. Gen. Electric	150	18" x 36" x 24"	
360	General Electric	150	15" x 28" x 30"	Harris Corliss.
375KVA	General Electric	150	18" x 30" x 32"	McEwen.
400	General Electric	120	20" x 40" x 42"	McIntosh & Seymour.
400	Westinghouse	107	18" x 32" x 42"	Eice & Sergeant
450	General Electric	100	22" x 42" x 48"	E. P. Allis.
450	General Electric	100	22" x 42" x 48"	E. P. Allis.
600	General Electric	120	24" x 48" x 42"	McIntosh & Seymour.
600	General Electric	100		Corliss.
600	General Electric	150	20" x 38" x 24"	Laurie & Lamb.
675	General Electric	100	20" x 38" x 42"	McIntosh & Seymour.
600	A. C. Bergman		23" x 40" x 30"	Goldie & McCulloch.
800	General Electric	100		Corliss.
750	General Electric	164	25" x 42" x 30"	Lentz.
750	General Electric	164	25" x 42" x 30"	Lentz.
1000	General Electric	120	26" x 54" x 48"	McIntosh & Seymour.

MacGOVERN & COMPANY, Inc.

Offices: New York, Pittsburg, 285 Beaver Hall Hill, Montreal Plants: Lincoln, N.Y., and Linden, N.J.
BUYERS AND SELLERS OF NEW AND USED MACHINERY A CONTINENT-WIDE SERVICE

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd. Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co, Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES

Messrs. of Manchester, London, England.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Messrs. of Manchester, London, England.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Montreal General Tool Co., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton. Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd. Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd. Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto,, Ont.
Coventry Chain Co., Coventry, Eng.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co.,Ltd.,Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Can Allis-Chalmers, Ltd, Toronto, Ont
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

ENGINEERING BOOKS

MacLean Publishing Co., Toronto.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS

Ministry of Munitions, London, England.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk, Con.

Handling Costs Reduced

from $65 Daily to One Man's Wages by Installing Jeffrey Coal Conveying Equipment

Showing interior view of head end of 20-in. Belt Conveyer over bunkers operated over a self-propelling belt tripper.

The new generating plant of the Mansfield Electric Light & Power Company, located at Melco, Ohio, 13 miles southeast of Mansfield, offers a striking example of the economies that can be effected by the substitution of modern equipment for old-time methods. All equipment used is the last word in efficiency.

The coal for this plant is unloaded from railroad cars into a steel hopper, or dumped into a submerged storage into a 2000-ton concrete bin, which now stands where the coal pile is shown in top illustration.

From track hopper, a 30-in. Reciprocating Plate Feeder regulates the flow of coal to a Jeffrey 30-in. x 30-in. Single Roll Crusher, as shown in lower illustration, and a Jeffrey 20-in. Belt Conveyer carries the crushed coal to boiler house and distributes to bunkers.

The Conveyer proper consists of 736 ft. of 20-in., five-ply rubber belting. It is driven at a speed of 258 feet per minute and is supported by 80 standard 20-in., three-pulley troughing idlers, 36-20-in. return idlers and sufficient guide idlers.

The Jeffrey Equipment has a rated capacity of 50 tons of coal per hour, although the engineers in charge of this installation state that it is many times called upon to handle up to 70 tons per hour.

20-in. Belt Conveyer in the inclined portion from Crusher to boiler house.

Showing Reciprocating Plate Feeder under Track Hopper and 30-in. x 30-in. Single Roll Crusher which discharges the coal on foot end of belt conveyer.

Write for Jeffrey Catalog No. 175-4, featuring this and numerous other Belt Conveyer installations.

THE JEFFREY MFG. CO.

Canadian Branch and Warerooms

MONTREAL

Handle it Mechanically

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal. Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubrciator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton. Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

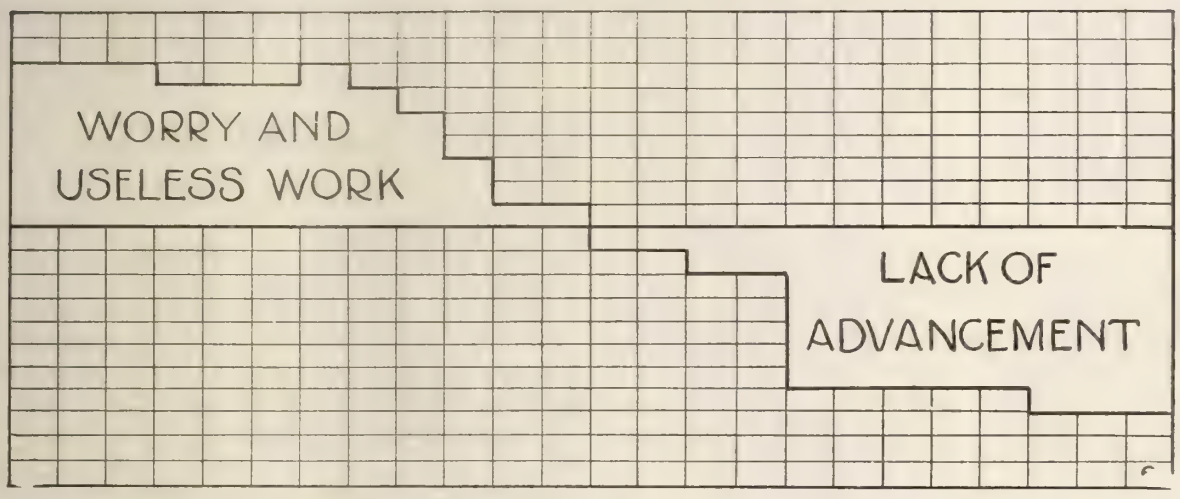
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the *C.A.S.E.* Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

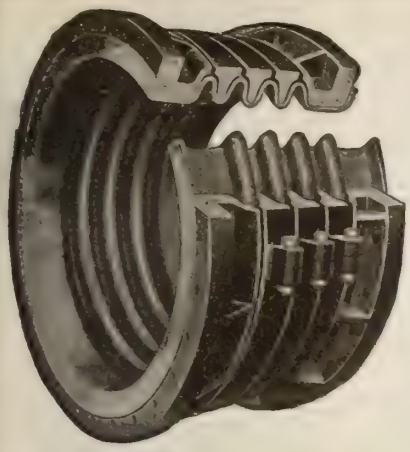
Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.
Beveridge Paper Co., Ltd., Montreal.
MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, AIR
E. J. Philip & Sons, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.
METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
METERS, GAS
E. J. Philip & Sons, Toronto, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.
METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
MIXING VALVES
Crane's Limited, Montreal.
MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.
OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.
ORSAT APPARATUS
Defender Automatic Regulator Co., St Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Williams Machinery Co., A. R., Toronto
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.
PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.
PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.
PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.
PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.
PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Beveridge Paper Co., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



Three reasons why *you should install* BADGER SELF-EQUALIZING EXPANSION JOINTS

They will prevent leakage. They will not allow looseness. They will insure you against fractures in all pipe lines.

Write for our new book today

E. B. BADGER & SONS CO.

101 Park Avenue, NEW YORK CITY
81 Pitts Street, BOSTON, MASS.
616 South Michigan Avenue, CHICAGO, ILL.

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

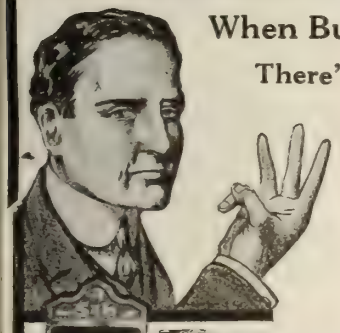
BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.



When Buying Thermometers
There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.
Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

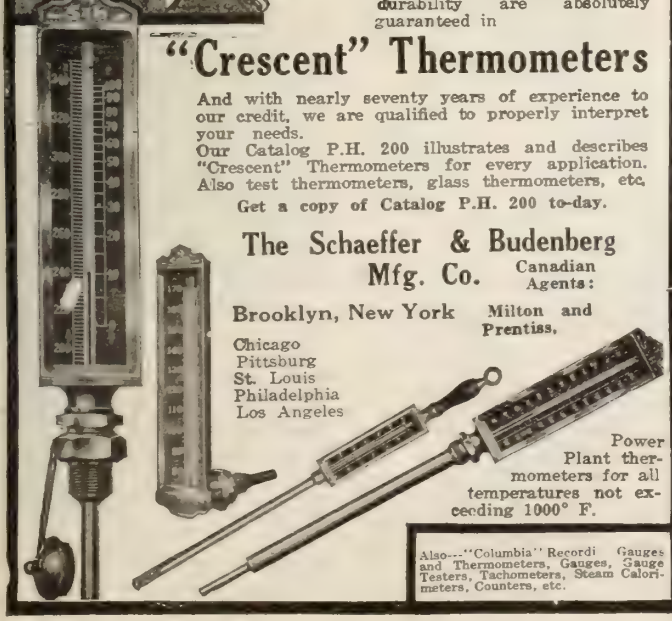
Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss.



Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

In Bulk

SAFETY PLASTIC METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
B. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
Defender Automatic Reg. Co., St. Louis.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.
W. S. Sexton Boiler Setting Co. Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co, Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

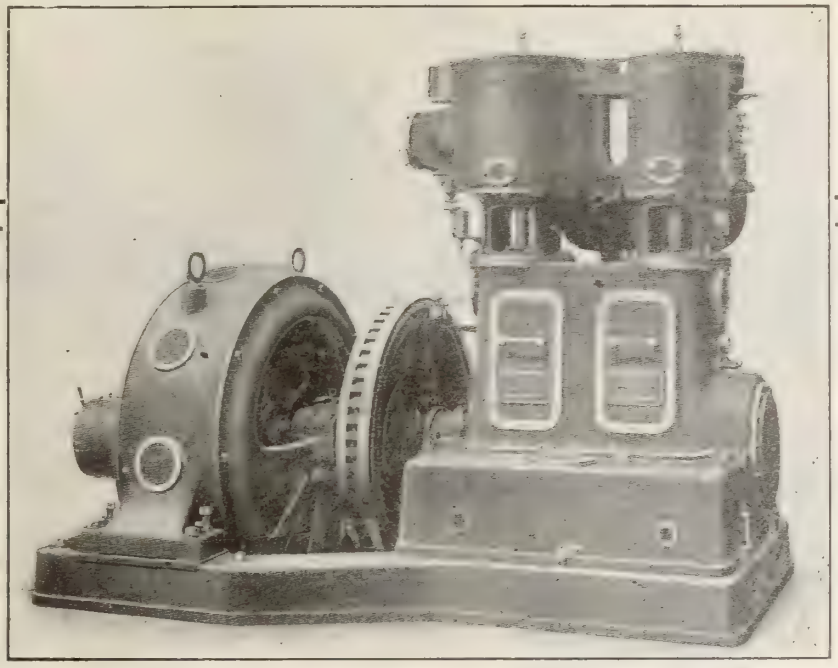
UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

BELLISS & MORCOM
LIMITED

ENGINES AND AIR COMPRESSORS



Belliss & Morcom Motor-Driven Air Compressor.

HIGH-GRADE POWER EQUIPMENT

We are prepared to supply and install Steam, Gas, Diesel Oil Engines, Steam and Exhaust Turbines—on short notice. We have Engine Generator Sets ready to ship.

Send Us Your Enquiries For

Steam Engines	Condensing Plants	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

We specialize in power plant design and erection. Put your problems up to our engineers, their services are at your disposal without obligation.

LAURIE & LAMB

ENGINEERS

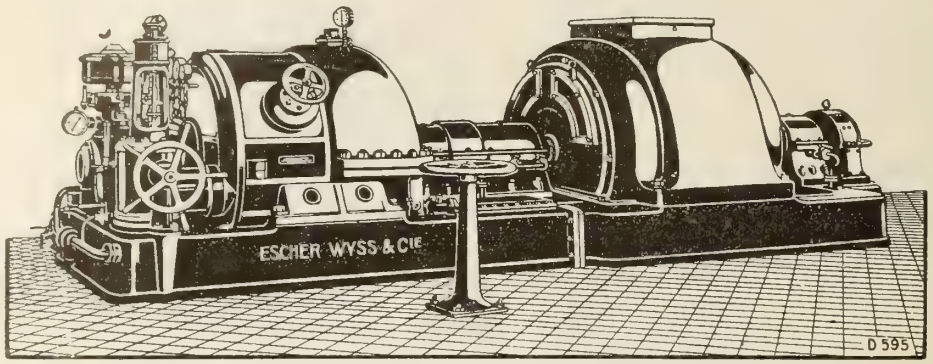
211 Board of Trade Building, MONTREAL

We handle only quality equipment. It is selected and approved by our engineers and backed by years of service. When you are in the market you will do well to investigate our lines.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford. Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.
Can. Allis-Chalmers, Ltd., Toronto.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville.

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

Plibrico Jointless Fire Brick can be molded to fit any place in the furnace or setting.

PLIBRICO
Better Than Fire Brick
Jointless Furnace Lining for Industrial Boilers

It can be used for front door arches, side walls, bridge walls and rear arches and wherever fire brick can be used. It is also unexcelled for baffle construction and repairs. Made for hard service and fuel economy.

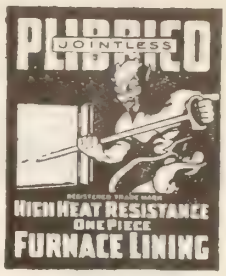
Easy to Install

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery

Write for book on furnace building

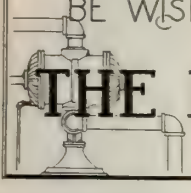
JOINTLESS FIRE BRICK CO.
Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.



Trade Mark
Reg. U.S. Pat Office

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co
27 COTE ST MONTRAL, CAN.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

MASON
Reducing Valves
Pump Regulator
Balanced Valves
Damper Regulators

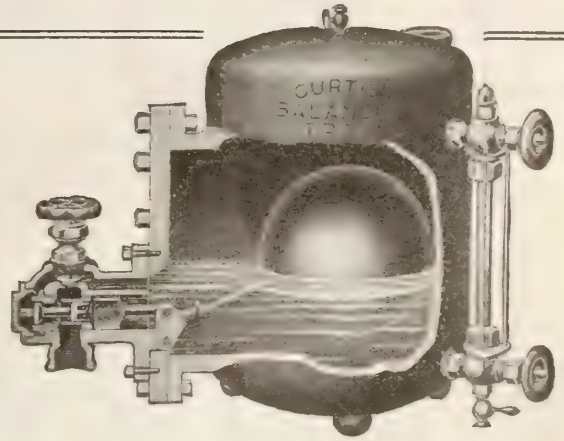
If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

INDEX TO ADVERTISERS

A

All-Way Oiler Co..... 7
Anderson Co., V. D..... 54
American Steam Gauge and Valve Manufacturing Co.... 75
American Steam Pump 63
Armstrong Cork and Insulation Co. 10

B

Babbitt Steam Specialty Co... 6
Babcock & Wilcox 77
Badger & Sons, E. B..... 83
Betson Plastic Fire Brick Co. 62
Boving Hydraulic Eng. Co.... 74
Bowser & Co., S. F..... 4
Branch, G. Joseph 8
[illegible] Engine Co. 83

C

Can. Assn. Stationary Engrs. 81
Can. Consolidated Rubber Co. 61
Can. Fairbanks-Morse Co..... 67
Can. Farnsworth Co., The.... 41
Can. Link Belt Co..... 50
Can. Johns-Manville Co..... 13
Can. Mead-Morrison, Ltd..... 59
Can. Steam Boiler Equiment. 70
Chaplin-Fulton Mfg. Co..... 75
[illegible] 84
Coppus Engr. and Equip. Co. 43
Carling Turbine Blower Co... 55
[illegible] 75
Cole, Geo. W., Ltd..... 63

D

Darling Bros. 87
Dart Union Co. 62
[illegible] 87
Department of Labor 75
Diamond Specialty Co. 6
Direct Separator Co. 68
Dominion Coal Co. 74
Dunham & Co., C. A..... 52
Durabla Manufacturing Co... 68

E

Electric Welding Co. 54
Economy Fuse Co. of Can., Limited 58
Empire Manufacturing Co. .. 3
Escher, Wyss & Co..... 86
Engr. and Mach. Works of Canada 47

F

Foyle, W. & G..... 44
Frick Co. 11

G

Garlock Packing Co..... 51
Goodyear Tire and Rubber Co. 64 and 65
Goldie & McCulloch Co..... 16
Greene, Tweed & Co..... 69
Green's Economizer, Ltd..... 49
Gutta Percha and Rubber Co. 73

H

Hamilton Co., William 59
Hays Corporation, Jos. W... 60
Holden Company, Ltd., The... 3
Holmes Metallic Packing Co.. 74
Homestead Valve Mfg. Co.... 71

I

Inglis Co., John. Inside back cover

J

Jeffrey Manufacturing Co..... 79
Jefferson Union Co..... 56
Jenkins Bros.....Front cover
Johns-Pratt Co., The..... 57
Jointless Fire Brick Co..... 87
Jamison Cold Storage Door Co. 12

K

Kellogg & Co., E. H..... 44
Kerr Engine Co. 88

L

La Clede Christy Clay Products Co.....8 and 9
Laurie & Lamb.....74 and 85
Leitch Co., The Arthur S.... 55
Leonard & Sons, Ltd., E..... 53
Linde Can. Refrig. Co..... 10
Lincoln Electric Co..... 55
Lunkenheimer Co. 15
Long, J. T. 44

M

MacGovern & Co. 77
Magnolia Metal Co. 4
Manny Co., E. S.....54 and 87
Mason Regulator Co. 87
Mason Regulator and Eng. Co. 72
McAvity & Sons, T. A..... 47
Metlskin Co., Inc..... 70
Ministry of Munitions 45
Morrison Brass Mfg. Co., Jas. Outside back cover
Morse Chain Co. 46
Murphy Iron Works 7
Mueller Mfg. Co., H..... 53

N

Norwalk Iron Works Co..... 2

P

Penberthy Injector Co..... 5
Philip & Sons, E. J..... 71
Pilley Packing and Flue Brush Mfg. Co..... 74
Page-Hersey Iron and Lead Co., Ltd.....Inside front cover
Pratt & Cady Co., Inc..... 71

R

Robb Engineering Co..... 52

S

Sanford Riley Stoker Co..... 7
Scaife & Sons Co., Wm. B.... 87
Schaeffer & Budenberg Mfg. Co. 83
School of Engineering..... 48
Sturtevant & Co., B. F..... 66
Steel Mill Packing Co..... 83

T

Trimont Instrument Co. 6

U

Uehling Instrument Co. 7

V

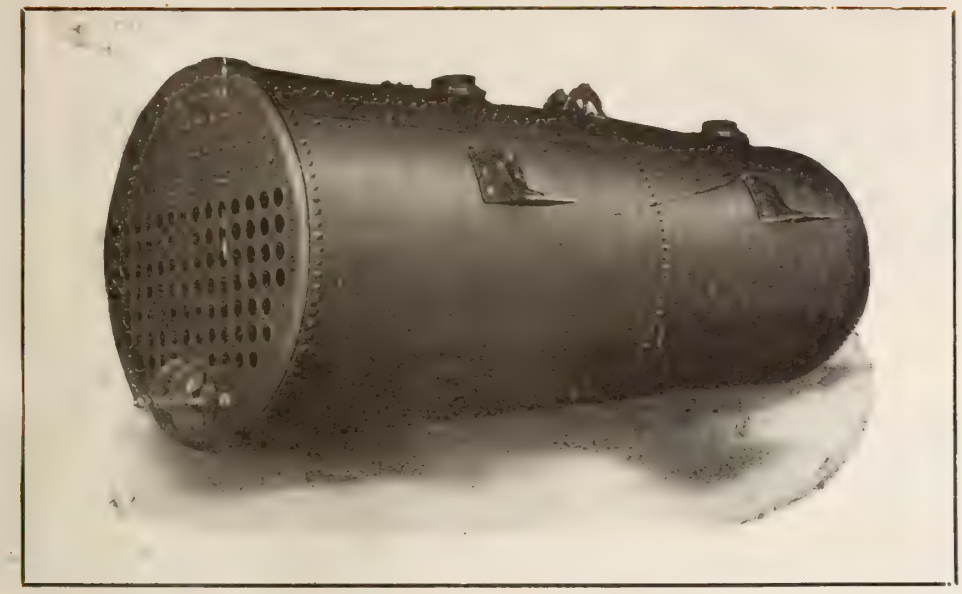
Victoria Foundry Co..... 75
Vilter Manufacturing Co..... 10
Voorhees Rubber Co., Ltd..... 68

W

Wall, W. J. 44
Waterous Engine Works Co... 1
Watson & McDaniel Co..... 74
Williams & Co., J. H:..... 2
Wilson Mfg. Co., J. C..... 75
Worthing Pump and Machine Corp. 14

Y

Yarnall-Waring Co. 58
York Manufacturing Co..... 11



INGLIS BOILERS

TANKS AND ENGINES

Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and service in Canada for over a half-a-century. Always reliable!

Write us for prices and specifications.

The John Inglis Company

LIMITED

ENGINEERS AND BOILER MAKERS

14 Strachan Avenue — **Toronto, Canada**

Representatives in Eastern Canada:
JAMES W. PYKE & CO., LIMITED
232 St. James St., Montreal

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

THE JAS. MORRISON BRASS MFG. CO. LIMITED TORONTO, ONT.

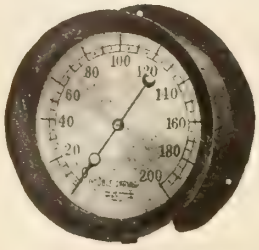
TRADE MARK J.M.T

Morrison's Steam Specialties

THE material used in Morrison's line of steam goods and specialties is carefully selected; their construction throughout represents skill and knowledge of the highest order drawn from forty years of varied experience.

Their unvarying quality assures safety and durability and every article is thoroughly factory-tested.

Approved by the Provincial Boiler Inspection Departments.



Pressure Gauge

A FEW OF OUR LINES

Stop Valves,	Inspirators,
Check Valves,	Jet Pumps,
Gate Valves,	Steam Gauges,
Safety Valves,	Pipe, Tools, Etc.,
Relief Valves,	Vacuum Gauges,
Reducing Valves,	Ammonia Gauges,
Steam Traps,	Gauge Board Outfits,
General Boiler,	Lubricators,
Mountings,	Pipe Fittings,
Injectors,	Steam Whistles,
Ejectors,	Engine Indicators

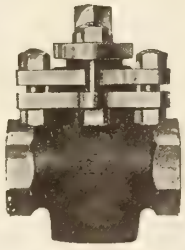
Morrison Automatic Drainer, operates on water pressure.

JAMES MORRISON BRASS MFG. COMPANY

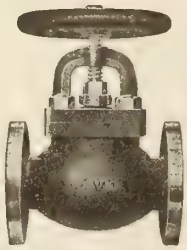
93-97 Adelaide Street West

TORONTO - ONTARIO

J. M. T. Globe Valve, Renewable Disc



Asbestos Packed Cock



"Beaver" Globe Valve

J. M. T. "Y" Valve

MORRISON

POWER HOUSE

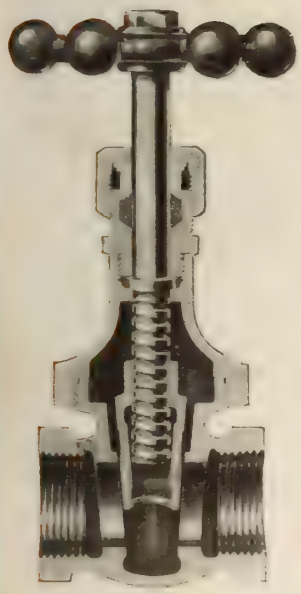
A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 8. Publication Office, Toronto—April 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE PENBERTHY MARK.



Sectional View
Penberthy Gate Valve

BRASS GATE VALVES

THERE ARE SPECIAL FEATURES
IN THE CONSTRUCTION OF THIS GATE VALVE
THAT APPEAL TO EVERY GOOD ENGINEER

NAMELY:

THE OUTSIDE BONNET CONSTRUCTION
THE SOLID WEDGE DISC
STUFFING BOX WITH PACKING GLAND AND FOLLOWER
SPECIAL QUALITY OF BEST STEAM METAL
CAREFUL WORKMANSHIP AND FINISH

Registered and Approved (Ont. Pub. Wks. Dept.) for 150 lbs. Steam Pressure

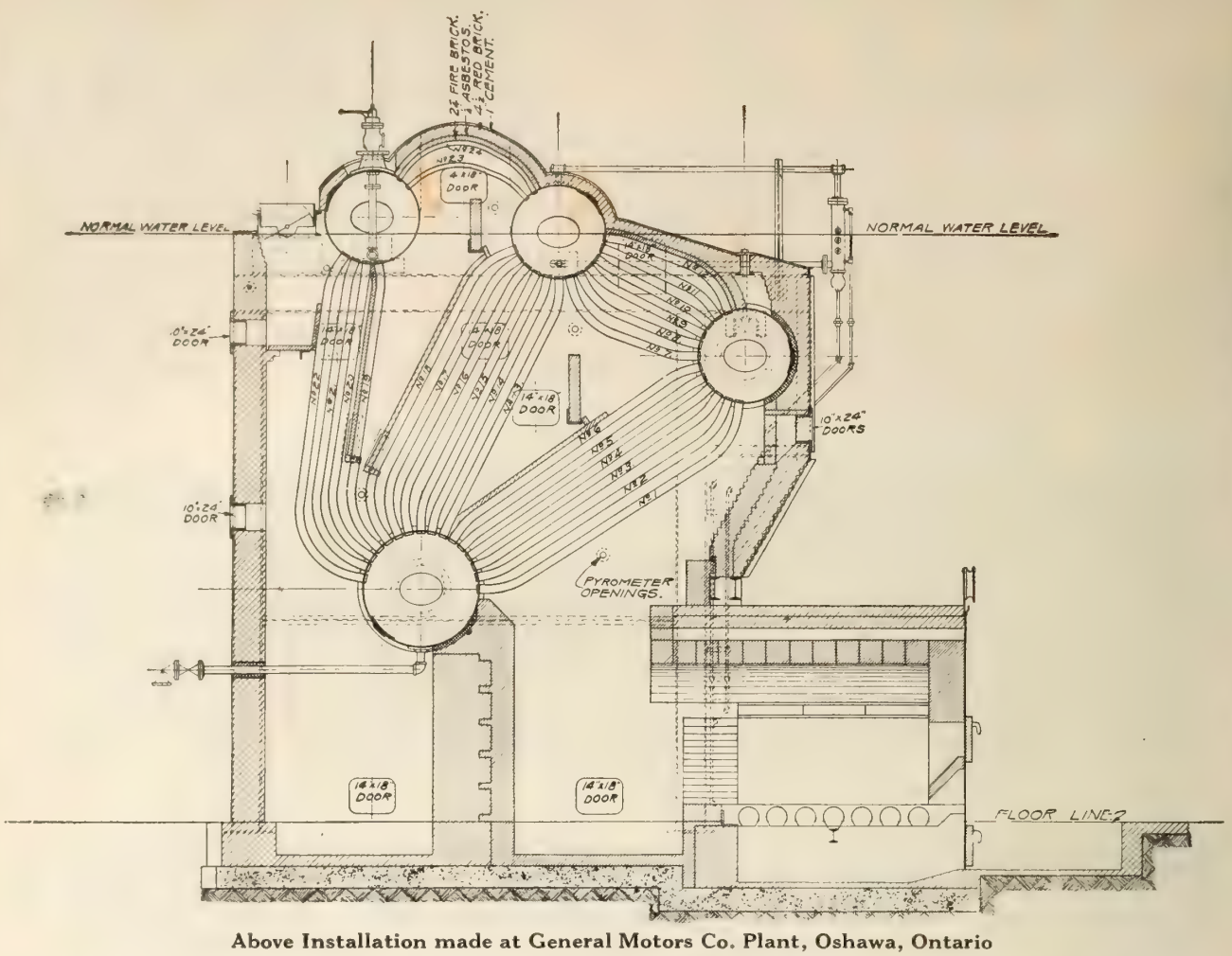
USED BY THE BEST ENGINEERS
THROUGHOUT CANADA

BE SURE THIS NAME
IS ON THE VALVE YOU BUY

MANUFACTURED BY

PENBERTHY INJECTOR CO., LIMITED - WINDSOR, ONTARIO

ANNUAL REFRIGERATION NUMBER



Above Installation made at General Motors Co. Plant, Oshawa, Ontario

Connelly (Patented U.S. & Canada) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of circulation and deliver steam superheated to from 5 to 10 degrees Fahrenheit.

Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally.

Can be built in units from 200 H.P. up to 4000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. LEONARD & SONS, LIMITED

Head Office and Works : LONDON, Canada

Branches:

1790 St. James St., Montreal, Que. 62 Water Street, St. John, N. B.

Agents:

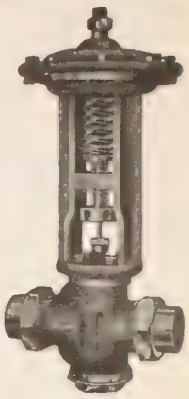
E. J. Phillips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B. C.
Thos. A. Pippy, Waldegrave St., St. John's, Nfld.

ESTABLISHED 1834

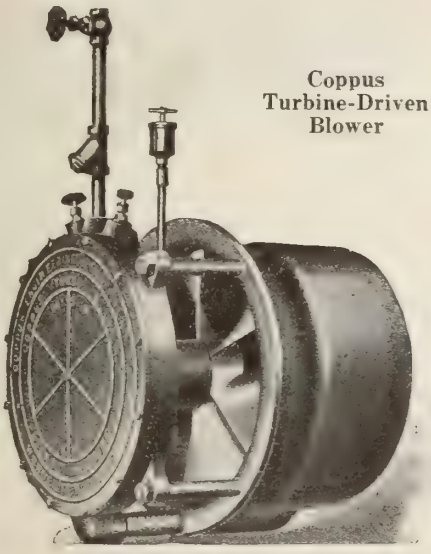
LEONARD

MASON SPECIALTIES

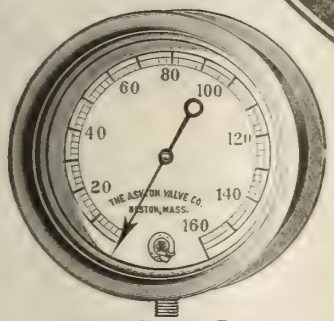
Mason Standard Bronze Reducing Valve



Mason No. 55 Pump Pressure Regulator

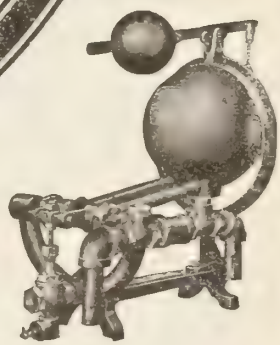


Coppus Turbine-Driven Blower



Ashton Steam Gauge

You can't go wrong on Mason Equipment



New Bundy Return Trap

We maintain an experienced engineering staff to advise you from an unprejudiced point of view on the selection of your equipment. Our salesmen are trained as practical engineers, thoroughly conversant with the latest practice of power plant equipment installation and operation.

The result is that in dealing with Mason you eliminate all possibility of purchasing equipment not suitable for your needs. If you order Mason equipment you will get absolute satisfaction.

This we guarantee you. **You can't go wrong on Mason equipment.**

Our complete catalogue tells you why we guarantee absolute satisfaction. Let us mail you a copy.

The Mason Regulator & Engineering Co., Limited

Successors to H. L. PEILER & COMPANY

MONTREAL, Office and Factory, 135-153 DAGENAIS ST.

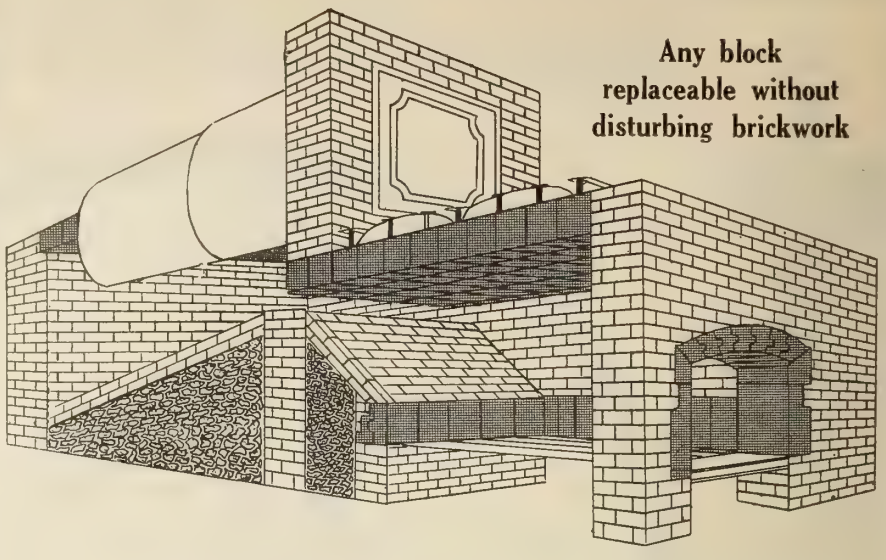
TORONTO REPRESENTATIVE: S. Balmfirth, 145 Wellington St. West, Room 5

Permanent Satisfaction

Costly air leaks and rapid formation of clinkers materially increase the cost of making steam.

Gates Patent Furnace Linings

Close fitting, tongued and grooved joints prevent air leaks. Then the lack of projections eliminate the possible formation of clinkers. The material used is very hard and refractory; the softening point is 1700° centigrade.



Any block replaceable without disturbing brickwork

We specialize in all kinds of power plant brickwork. Our engineers are at your service. Call on them at any time for information—without obligation.

Gates Refractories, Limited

St. James Chambers
Church & Adelaide Sts. Toronto

Head Office
382 St. James St. Montreal

HOYT'S BABBITT METALS

they are always dependable quality

You can always depend upon HOYT BABBITTS to take care of high speeds and heavy loads. They are scientifically compounded—exactly suited for their purpose. This is why Hoyt's Metals have been adopted by many of the most exacting power plants the world over.

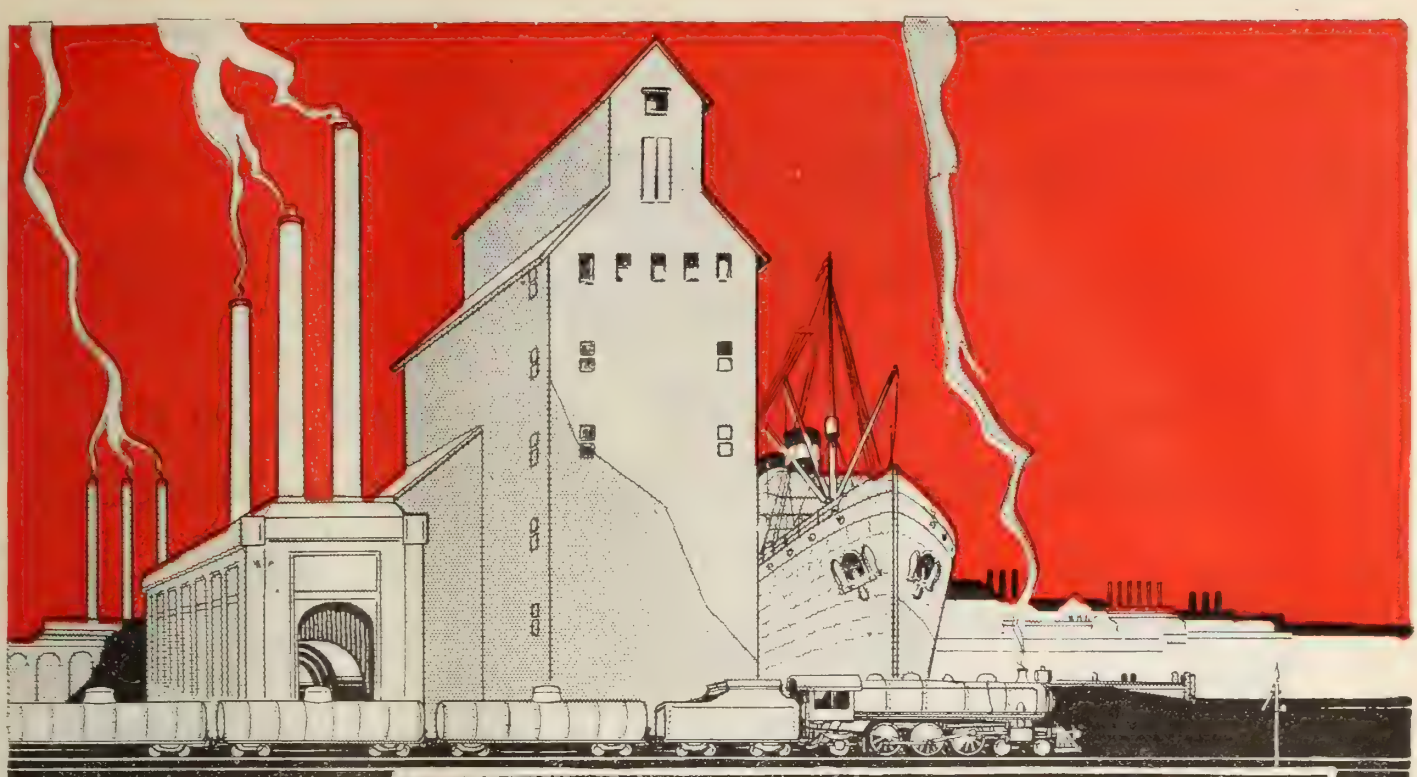
Hoyt's Frost King is the ideal, all-round babbitt. **Give it a trial!**

Hoyt's Nickel Genuine is as perfect an alloy as can be made. It is especially designed for Gas Engines, Marine Engines, Automobiles or wherever high speed is essential.

HEAD OFFICE:
Eastern Avenue and Lewis St.
TORONTO

BRANCH OFFICES:
Montreal
and
Winnipeg

Largest Makers of White Metals in the World



IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Arlo Compressor Oil

Reduce Your Overhead

THE proper use of selected lubricants is a sure means of reducing overhead expenses and of eliminating unnecessary operating costs. *Perfectly-lubricated machinery gets less wear and lasts longer.* Repair bills are smaller and fewer; depreciation is kept at the lowest possible figure when lubricants are chosen with an eye to mechanical needs and service conditions.

Imperial Lubricants are designed to meet definite needs and conditions. Made from the best crudes they are formulated and designed for real service. They are Canadian-made and readily obtainable everywhere in Canada through our extensive distribution system.

There is a "just right" grade of lubricant for each type of machinery and for each moving part—railroad, marine, power plant, factory and mill. The right use of Imperial Lubricants will reduce your overhead.

Imperial Lubrication Engineers are at your service for consultation. Their co-operation and recommendation for better lubrication are part of Imperial Oil Service.

Write us at 56 Church Street, Toronto, or at any of our branches, for an appointment or for further information.

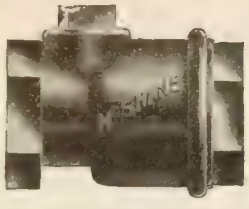
IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

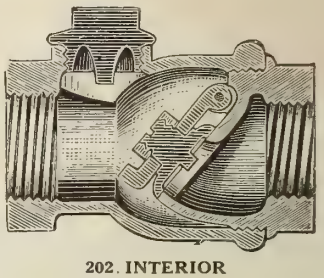
BRANCHES IN ALL CITIES

McAvity
BRASS AND IRON PRODUCTS

THE GENUINE McSHANE
STRAIGHTWAY SWINGING CHECK VALVE


202. EXTERIOR

For use Upright or Horizontally.
Especially adapted to Pumps, Boilers and Injectors.
Simple and Strong.
Can be repaired by simply removing cap.
200 LBS. WORKING PRESSURE.
To avoid imitations and get the GENUINE McSOANE, see that the name T. McAVITY & SONS, LTD., is on every VALVE.


202. INTERIOR

T. McAVITY & SONS, LIMITED

Wholesale and Retail Hardware. Brass and Iron Founders
ST. JOHN, N. B.

MONTREAL, T. McA. Stewart, 157 St. James St. CALGARY TORONTO WINNIPEG VANCOUVER LONDON, Eng. DURBAN, S. Africa EDMONTON
Established 1834

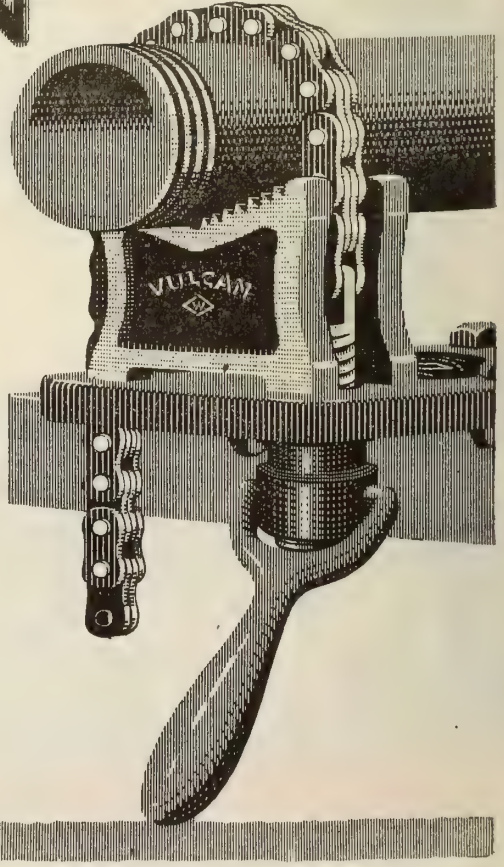
WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE

In general, you know there's no comparison between a cast and a wrought tool.

The same principle applies to pipe vises.

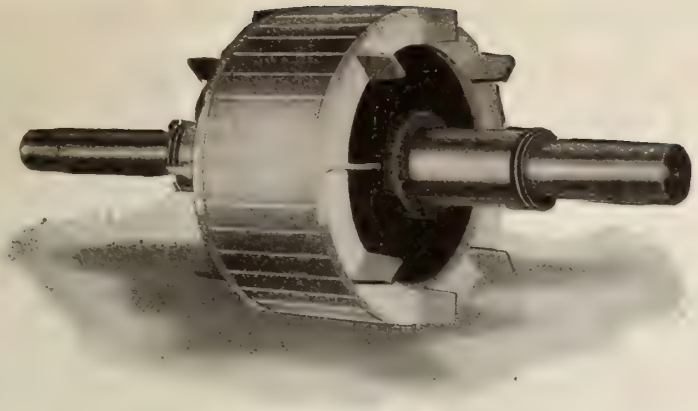
Williams' "Vulcan" No. 4, for ¾ to 8-inch pipe is stronger, quicker in action and cheaper.

3 Sizes for ⅛ to 8-inch pipe—at your dealer's



J. H. WILLIAMS & CO.
"The Drop-Forging People"

78 So. Clinton Street, Chicago, Ill.
78 Vulcan Street, Buffalo, N.Y.
78 Richards Street, Brooklyn, N.Y.



No Soldered Joints or Bolted Connections in—

Canadian Crocker-Wheeler Rotors

¶ The greatest improvement in modern induction motor design—no soldered joints to melt and cause arcing or open circuit and no bolted connections to work loose.

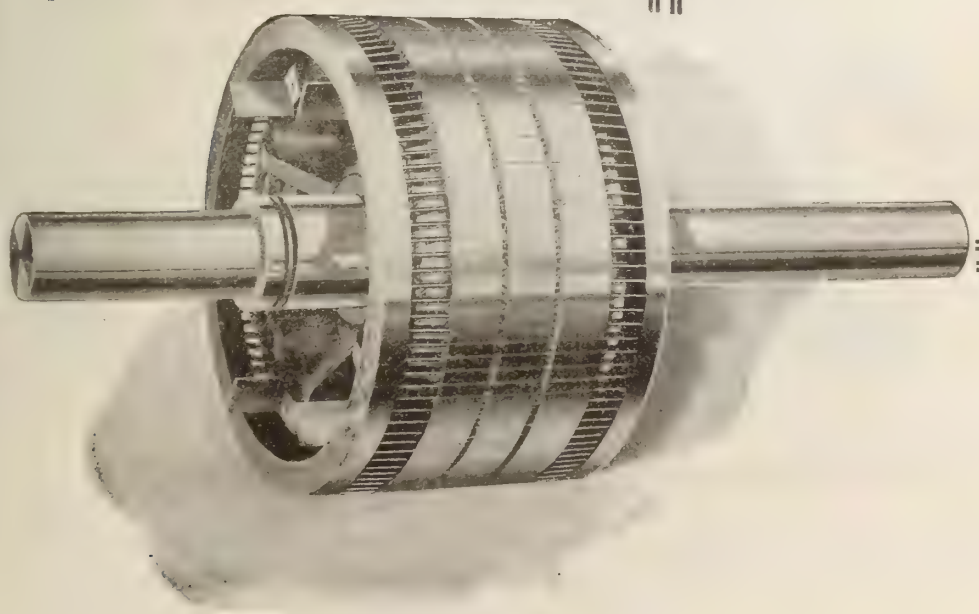
¶ The entire Rotor Winding of small squirrel-cage induction motors is cast of aluminum alloy—in one operation. Thus, the complete winding is one integral structure.

¶ The medium and large size Rotors have liberal section copper bars and the end rings are cast-welded, making perfect contact.

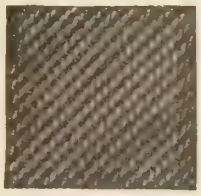
Northern Electric Company
LIMITED

MONTREAL		REGINA
HALIFAX	TORONTO	CALGARY
QUEBEC	LONDON	EDMONTON
OTTAWA	WINNIPEG	VANCOUVER

In Stock at our Branch Houses

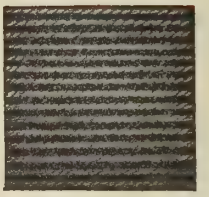


"SPANDO"



CROSS SECTION "SPANDO" PACKING

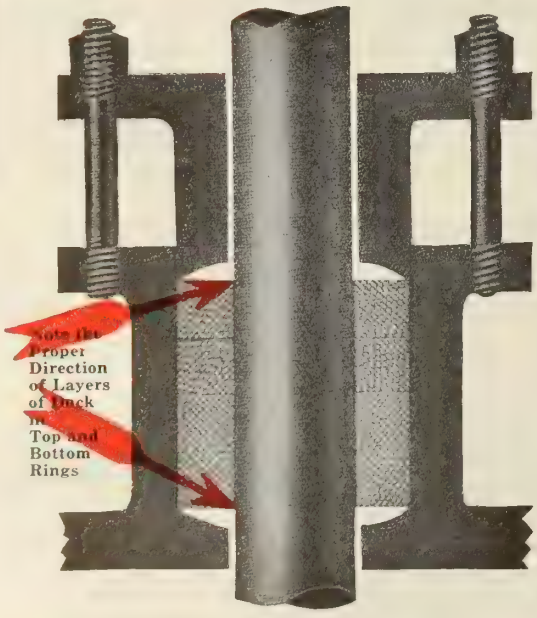
THIS is the Registered Trade Mark which guarantees the Original and Genuine SPANDO Cross Expansion Piston Packing. It is *your* protection as well as *ours*. Insist on having SPANDO. Do not accept any of the numerous substitutes which are put forth as *"Just as good as Spando."*



CROSS SECTION REGULAR PACKING

Regular square packing in general use under pressure as illustrated will expand but little.

"SPANDO" PACKING IN SERVICE



"SPANDO" SQUARE PACKING

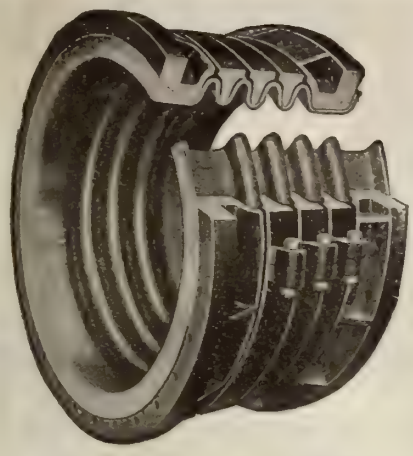
Under pressure as illustrated will expand 100 per cent.

These test pieces of packing were square before pressure was applied.

Send for samples and make this test yourself in a vise.

Valve Engineering Company

160 King St. West, Toronto, Ont.



The BADGER SELF-EQUALIZING EXPANSION JOINT

is a one-piece joint, thus eliminating the necessity of frequent renewal of packing; it is properly designed, and manufactured from material with sufficient elasticity to stand the repeated changes in shape, and it absolutely controls the expansion and equally distributes it on all corrugations.

Write for our new book to-day

E. B. BADGER & SONS CO.
75 PITT ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

For forty years the accuracy of machine shop work has been measured by

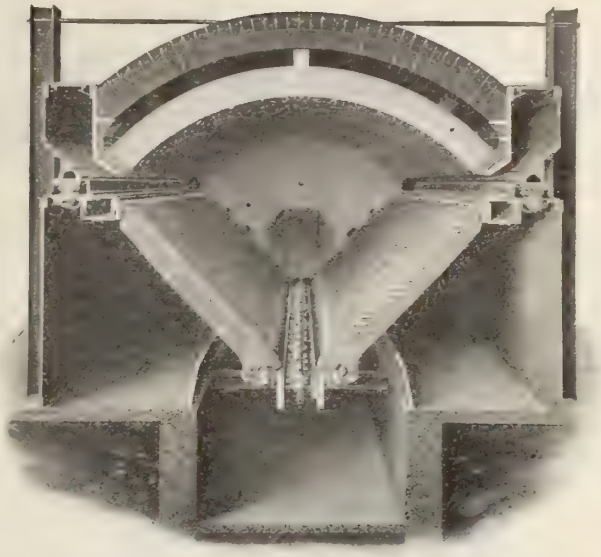
Starrett Tools

Catalog No. 21 "CD" sent on request

The L. S. Starrett Co.
THE WORLD'S GREATEST TOOL MAKERS
MANUFACTURERS of HACK SAWS UNEXCELLED
Athol, Mass. U.S.A.

Starrett Tools

MURPHY AUTOMATIC FURNACES



For Any Boiler
50 h.p. and Up

Any boiler from 50 h.p. and up, can be equipped with the MURPHY FURNACE, The ***smaller plant*** can therefore enjoy all the economical advantages of fuel and labor savings ***without resorting*** to forced draft.

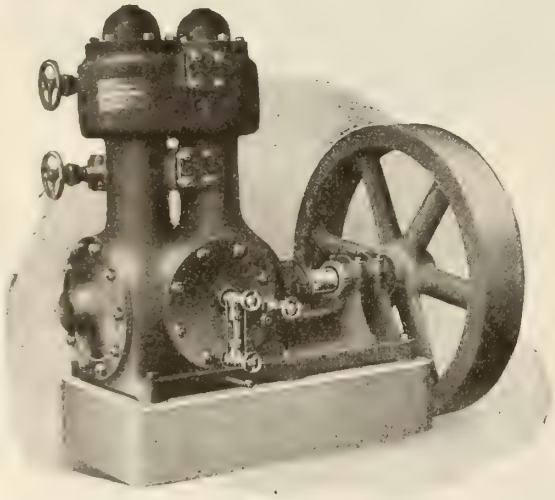
To-day over ***6000 boilers*** are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry from hospital to industrial and central station service. MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

Our Catalogue "HM-4" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

For information on RILEY UNDER-FEED STOKERS for large boilers see June 5th advertisement or send for RILEY STOKER Catalogue "HR-4."

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to your business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

Let Us Solve Your Water Problems

We have an up-to-date organization which will efficiently take care of your water problems—whether industrial, municipal or residential. Prompt service.

We can make prompt deliveries of the following lines :

Controllers for Temperature, Pressure or Time.

Meters for measuring Steam, Water, Air or Gas.

CO_2 Gas Analysers—Hand Type.

Water Filters—Pressure and Gravity.

Thermometers for every use.

Gauges—Vacuum, Pressure and Compound.

Furnace Efficiency Indicators.

Hydrometers.

Steam Traps — Tank Type.

Separators — Steam or Oil.

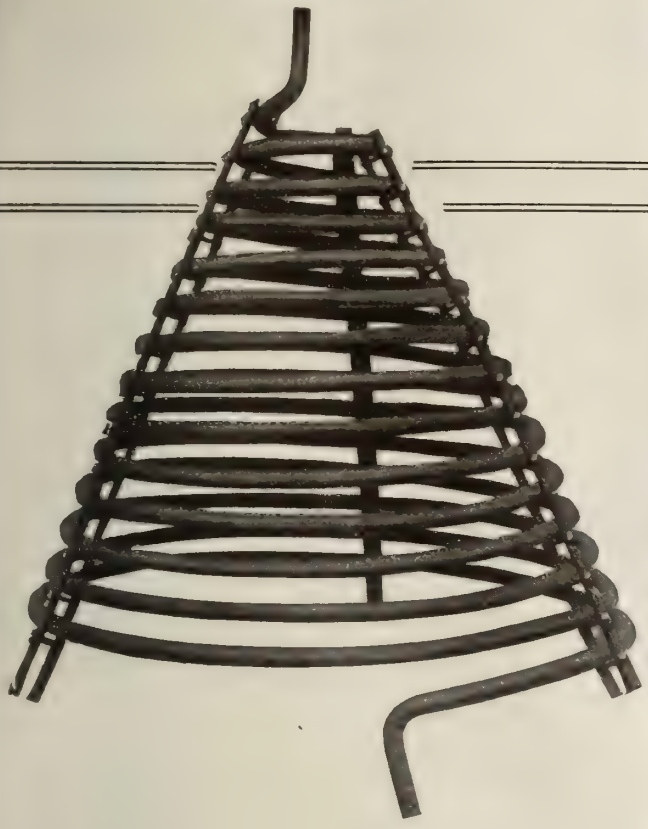
Oil Filters.

Steel Tanks - Stacks - Plate Work
Return Tubular Boilers
Connelly Water Tube Boilers
Manufactured by E. Leonard & Sons, London, Ont.

E. J. PHILIP & SONS

57 Queen Street West : TORONTO

PITTSBURGH COILS



OUR plant is splendidly equipped to fulfill your requirements in coils. Where work is of an exacting character and where plans call for coils out of the ordinary, our facilities will completely meet your needs.

Before leaving our plant, each individual coil is tested under air pressure, while completely submerged in water—an inspection that insures absolute dependability.

Send us blue prints or specifications for quotations.

COILS

of all shapes, descriptions and sizes, made from Wrought Iron or Steel Pipe, Copper or Brass Tubing, for use in
Brine and Ammonia Circulating Systems.
Ice Rinks.
Blast Furnaces.
Chemical Plants.
Soap Factories.

Welded Ammonia Receivers.
Welded Headers.
Accumulators.

Pittsburgh Pipe Coil & Bending Company
PITTSBURGH, PA., U.S.A.

Special Thermometers for Ice and Refrigeration

The Ice and Refrigeration Industry calls for thermometers especially fitted to many different needs, and accurate beyond doubt in every application.

TAG Thermometers are backed by 150 years of experience in making thermometers, and a close study of refrigeration and ice manufacture since the beginning of the industry.

On brine tanks, on ammonia lines, on condensers, in any connection, TAG Thermometers give the exact facts, facts that are essential to intelligent and economical plant operation.

Bulletin PP-370 illustrates many forms of Ice and Refrigeration Thermometers.

The following guarantee covers all TAG Thermometers.

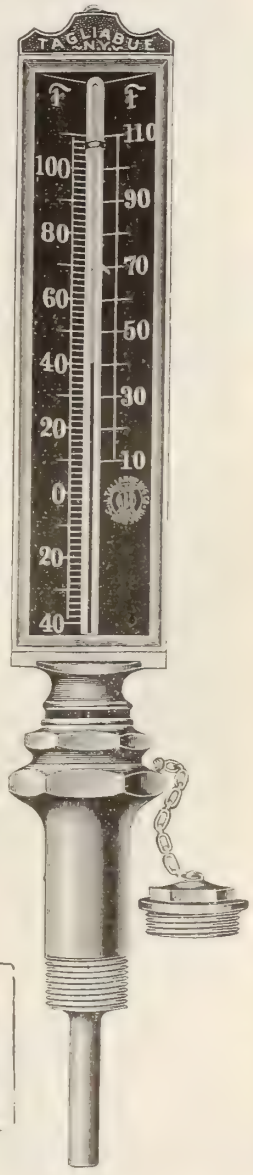
Accuracy — Absolute and Constant.

Construction — Highest Grade Workmanship.

Material—Most Durable for the Particular Application.

Insurance — Against Loss by Breakage in Transit.

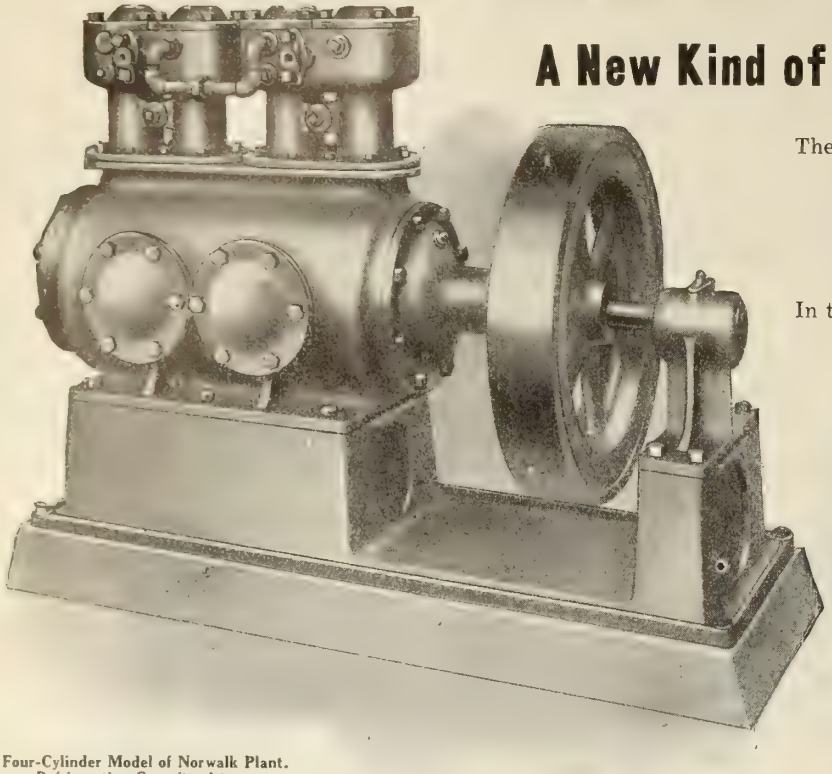
The insurance clause means that we shall assume the burden of obtaining redress from the Transportation Company, if the customer will notify us of damage immediately upon receipt of goods, and co-operate with us in securing the necessary evidence.



C.J. TAG LIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark
Reg. U.S. Pat. Off.

NORWALK
REFRIGERATING PLANT



Four-Cylinder Model of Norwalk Plant.
Refrigerating Capacity, 4 tons.

A New Kind of Refrigerating Service

The Norwalk Refrigerating Plant, now ready for the market, has been perfected to meet a wide demand for increased simplicity, reliability, economy and flexibility of service. Supplied in capacities from one-quarter ton up.

In the Norwalk the Compressors are greatly simplified in construction, and the multi-cylinder design permits of high speed and smaller-sized units. The machine is ruggedly built throughout. Can be direct-connected to a gasoline engine or chain-driven from a motor. All features have demonstrated their value in severe tests.

We provide attachments to adapt the Norwalk to any form of refrigerating or ice-making service. Write for details.

The Norwalk Iron Works Co.
Pioneer Builders of High-Quality Air and Gas Compressors
South Norwalk, Conn.

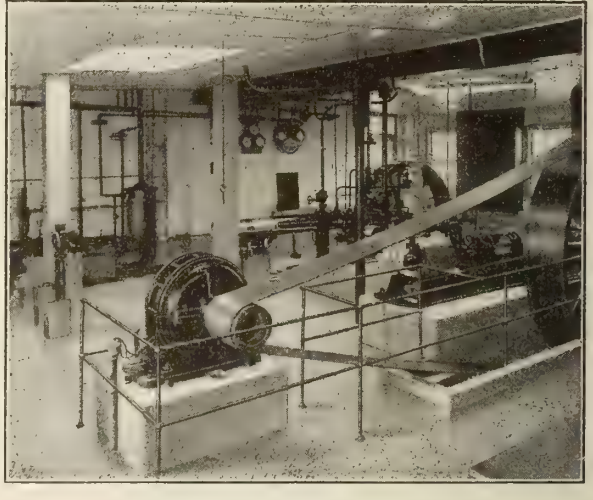
LINDE
Ice Making Machinery
Used by Large Firms

Many of the most prominent firms, corporations and institutions in Canada use Linde Refrigerating Machinery. Some of them include:

The Manitoba Cold Storage Co., Limited, Winnipeg; City Dairy Company, Ltd., Toronto; Civic Abattoir, Toronto; Wm. Davies Co., Toronto; Dominion Fish and Fruit Co., Quebec; General Hospital, Montreal.

These and many other users of Linde equipment have testified to its high efficiency and economy.

Machines made for plants big or small. Our new Vertical Enclosed Type machines are suited for plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our horizontal type is guaranteed to give better service than any other refrigerating equipment on the market.



Linde Equipment Installed in Civic Abattoir, Toronto

Adopt Linde equipment in the place of old and unsanitary methods. We keep a permanent staff of engineers in Montreal, Toronto, Winnipeg and Vancouver, both for erection work and emergency calls that may arise.

The Linde Canadian Refrigeration Co., Limited
37 St. Peter Street, MONTREAL

TORONTO **WINNIPEG** **VANCOUVER**

REGISTERED
COPPUS
U.S.PAT.OFFICE

To the Refrigerating Industry &

COPPUS TURBO BLOWERS EFFECT STEADY SAVINGS

In the modern plant of the New York Ice Company, New York City, this 22" COPPUS Turbo Blower has been saving time, money and labor ever since installation in April, 1917. It has made possible the use of cheap fuel, and made sure the maintenance of constant steam pressure. So satisfactory has been the service of this COPPUS Blower that two more blowers have since been purchased for other plants of the New York Ice Company.

COPPUS Turbo Blowers are cutting down fuel costs and keeping up steam pressures in cold storage and artificial ice plants all over the country. Automatically regulated, self-oiling, quiet-running—COPPUS Turbo Blowers are by far the most efficient means of securing mechanical draft.

Let our engineers tell you just what COPPUS Blowers can save you in your boiler room. Write for Blower Catalog.

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
W. J. Yeo & Co., 413 McLean Block,
Calgary, Alberta

COPPUS TURBO BLOWER

FOR REFRIGERATING EQUIPMENT

USE

P⊕H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KINDS AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

PAGE-HERSEY IRON, TUBE & LEAD CO. LIMITED

Head Office:
100 Church Street, TORONTO, Ont.

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of
Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

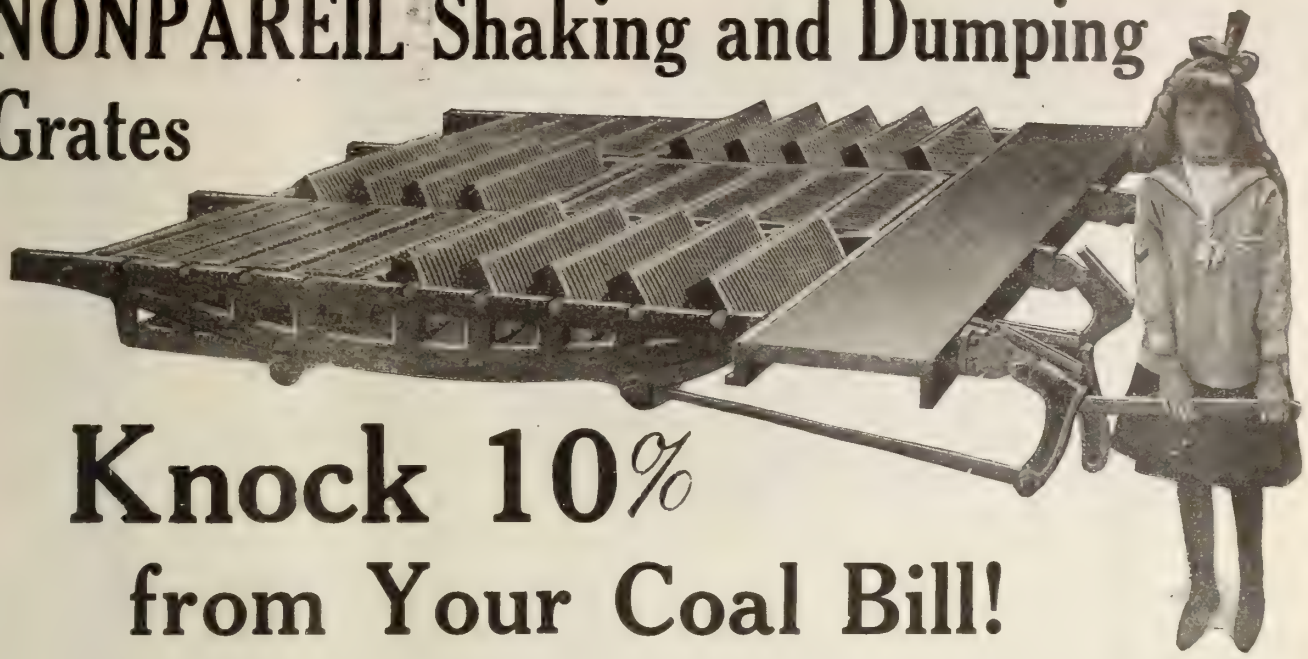
One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

NONPAREIL Shaking and Dumping Grates



Knock 10% from Your Coal Bill!

Even a girl can operate it

This is no idle statement: We *guarantee* that Nonpareil Shaking and Dumping Grates will give complete satisfaction. Test them for a period of thirty days under any kind of boiler—should they not prove satisfactory in every respect, they may be removed and shipped back to us—we will pay the freight.

Nonpareil Shaking and Dumping Grates give complete combustion of every pound of coal. They will help you secure maximum results from low-grade fuel. 'Phone, write or wire for details.

Grate Bars and Repairs

For grate bars and repairs to all shaking grates, and boilers of all sizes — See Sexton.

For FIREBRICK WORK

See SEXTON

When "Safety First" Sexton tackles your firebrick work you are assured of lasting satisfaction. Sexton has a reputation for doing his work thoroughly and well. His work lasts longer and gives a higher degree of satisfaction. That this is so many of the larger firms throughout Canada are ready to confirm.

THE W. R. SEXTON BOILER SETTING COMPANY

670 Shaw St. or 127 D'Arcy St.
TORONTO

Established 1900 Phone, College 682

Turning a Loss Into a Saving

Before Detroit "V" Type Stokers were installed

Higher coal prices made hand firing too expensive for the Mercer County Light, Heat and Power Company, Greenville, Pa.

To obtain more heat from the coal with the same natural draft their engineers installed four **Detroit "V" Type Stokers.**

The result is best told by Chief Engineer, R. L. Morsman, in the following statement:

"We compute that we are obtaining a saving of from 10 to 12 per cent of coal over previous hand fired method.

"We are obtaining a b.h.p. on approximately 3½ lb. of coal of 13,000 to 13,500 b.t.u. This is equivalent to a little better than 72% efficiency, which we consider very good for everyday conditions.

"The stokers are giving excellent satisfaction and we would be very glad to recommend them to your prospective purchasers."

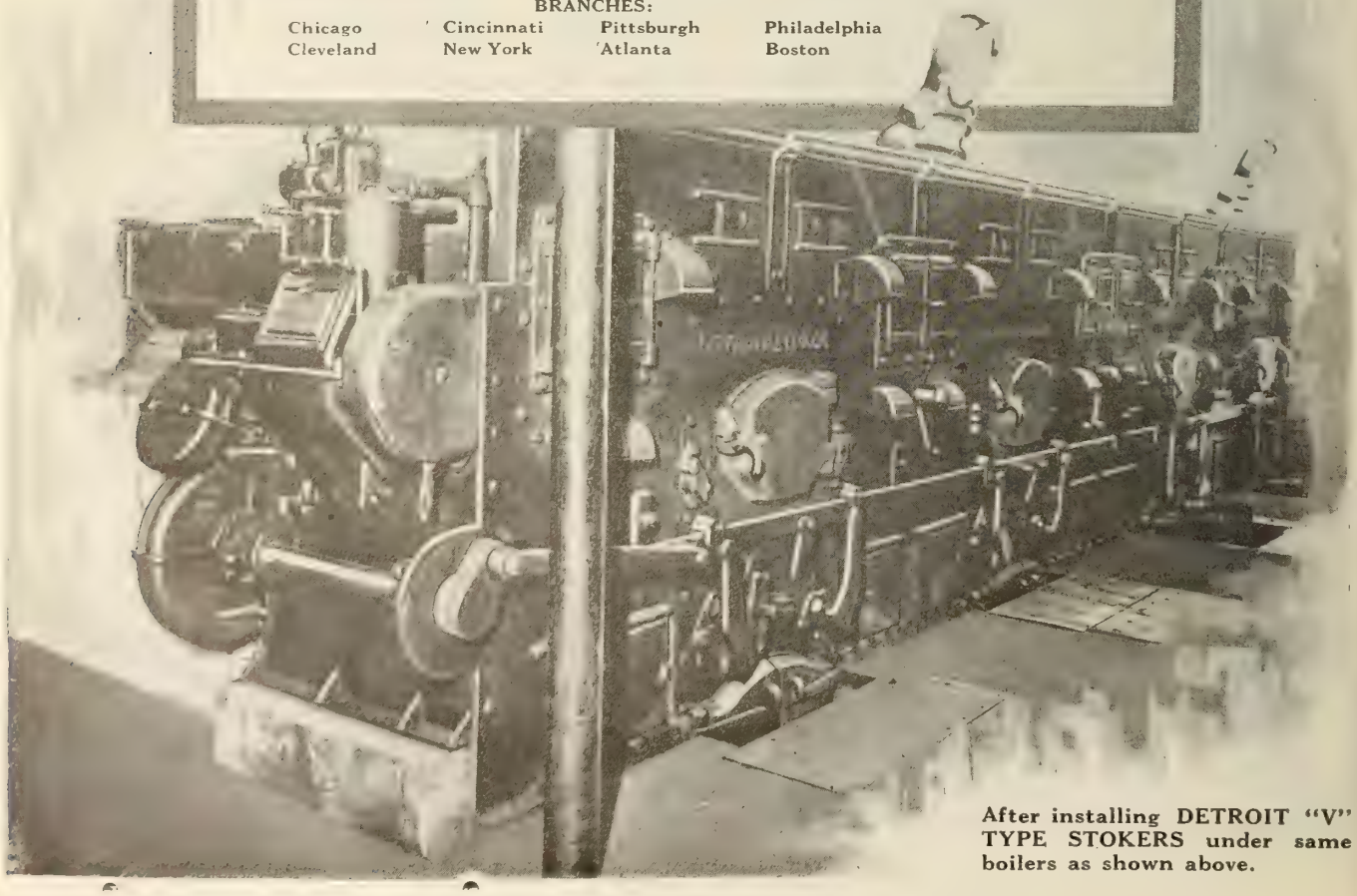
Let us tell you what Stokers can do for you. Write for Catalog "P."

Detroit Stoker Company, Detroit, Mich.

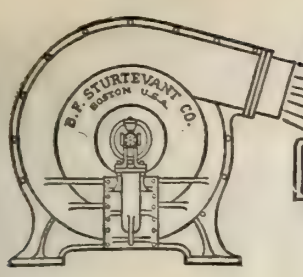
BRANCHES:

Chicago	Cincinnati	Pittsburgh	Philadelphia
Cleveland	New York	Atlanta	Boston

Detroit Stokers Save Coal



After installing DETROIT "V" TYPE STOKERS under same boilers as shown above.



Sturtevant

REG. U.S. PAT. OFF.

PUTS AIR TO WORK

THE NEW A-7 TURBINE-TRANSMISSION

A BRAND-NEW DRIVE FOR STOKERS—FANS—PUMPS

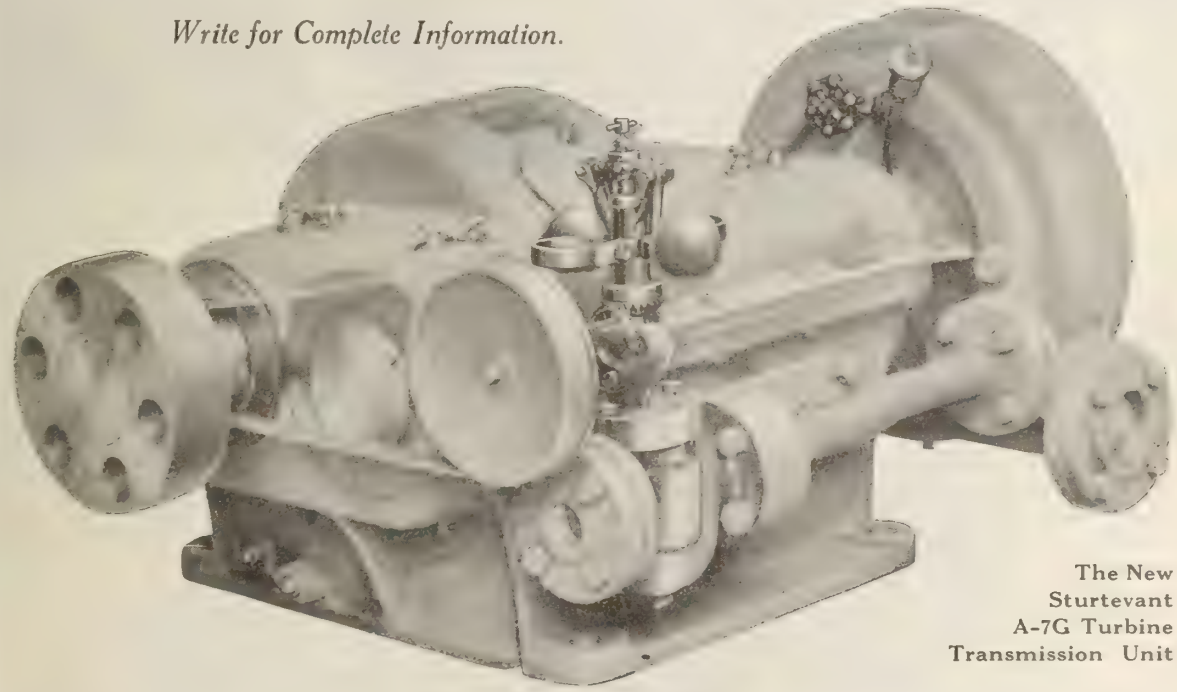
The cumulative experience of 60 years is expressed in the design and construction of this new unit. The unique features allow highest turbine efficiency while the stokers, fans and pumps are working at their most economical speeds.

The turbine is supported directly from the transmission casing—flexible couplings are eliminated—no sub-base is necessary—alignment trouble is impossible—and lubrication is automatic.

Much time has been spent in carefully designing this unit. Thorough tests were made in our shops long before anyone outside of our organization was asked to prove its merits under actual working conditions. For over a year a number have been in use, by several of our customers, with remarkable satisfaction.

It is with confidence and readiness that we ask you to acquaint yourself with the possibilities of this practically tested driver. You will find our Turbine Department always prepared to co-operate with you.

Write for Complete Information.

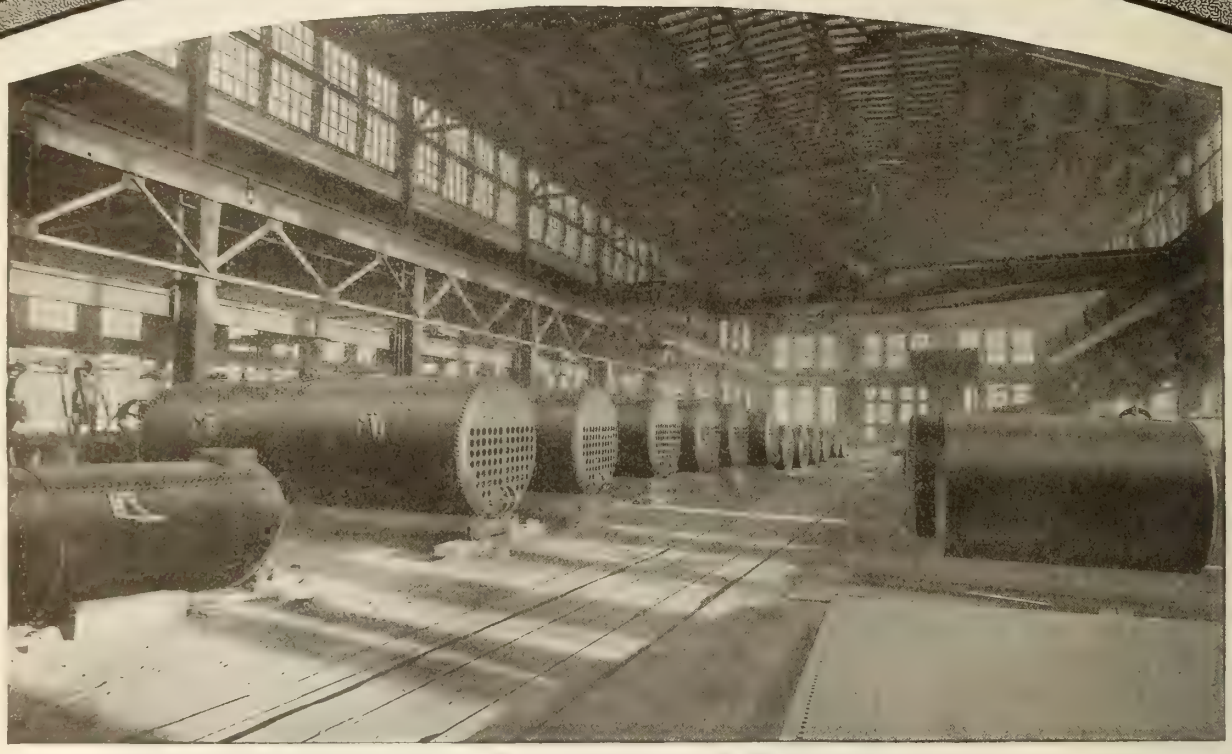


The New
Sturtevant
A-7G Turbine
Transmission Unit

B. F. STURTEVANT COMPANY OF CANADA, LTD.

HEAD OFFICE AND WORKS: GALT, ONT.
SALES OFFICE: TORONTO AND MONTREAL

DEPENDABLE POWER EQUIPMENT



A small corner of our Boiler Shop, showing 12 Boilers under construction on one order.

GOLDIE & McCULLOCH

Horizontal Return Tubular Boilers

WE ARE EQUIPPED FOR QUICK DELIVERY

An immense plant, with modern manufacturing facilities enables us to turn out G. & McC. Co. Boilers on short notice. Whether ordered for prompt delivery or not, the G. & McC. Co. quality in material and skill in workmanship is always maintained.

Tube holes are all drilled never punched. Flanging, riveting, caulking and staying is all done by the most modern methods, and the best material for the purpose is constantly used.

G. & McC. Co. Boilers are designed to conform to various provincial regulations and are thoroughly dependable.

WE BUILD :—Steam Engines, Steam Turbines, Return Tubular & Water-Tube Boilers, Heaters, Tanks, Stacks, Pumps and Condensers. Catalogues sent on request

The Goldie & McCulloch Co., Limited

Head Office & Works. GALT, Ontario, Canada

Toronto Office
Suite 1101-2 Bank of Hamilton Bldg.

Quebec Agents
Ross & Greig,
400 St. James St., Montreal.

Western Branch
248 McDermott Ave.,
Winnipeg.

British Columbia Agents
Robt. Hamilton & Co.,
Bank of Ottawa Bldg.,
Vancouver.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Plant Equipment of a Montreal Dairy

The Modern Dairy Finds Extensive Use for Power Plant Equipment for Steam Supply and Refrigeration—This Article Deals With That Installed in the Dairy of J. J. Joubert, Montreal

By J. H. RODGERS

WHEN the bottle of milk is taken from the doorstep in the morning how many stop to consider the process through which the contents have passed from the time it leaves the farm? Few of us, it might be said, give the matter a second thought, content that the milk is fresh and cool.

The plant of J. J. Joubert Ltd., of Montreal, while not an exceptionally large one, illustrates remarkably well the development that has taken place during the past decade, in the systematic distribution of milk to the rapidly growing urban populations. The original factory was established a little over fifteen years ago, and the operation of the plant at that time was amply provided for by a 2½ H.P. steam engine. The demands of the "milk trade," however, necessitated continued expansion, so that the initial equipment has been augmented from time to time, and the present requirements call for steam heating capacity of 200 H.P. and the electric motors, for the operation of the machinery, aggregate 250 H.P. The first refrigerating unit was installed about ten years ago, it being a Linde Canadian machine of 25 ton capacity and operated on the direct expansion system, the reservoir and the piping having a capacity of 1,500 gallons. The second installation was made about six years ago and consisted of a 65-ton Canadian ice machine, operated on the direct expansion system, provided with two reservoirs, which with the piping, had a capacity of 3,125 gallons, the chambers supplied being maintained at a temperature ranging from 26 to 38 degrees F., with a separate room for ice cream kept at a temperature of 10 degrees above zero. This 65-ton machine likewise provides for the making of 13 tons of artificial ice per day. The heavy demand for ice cream made it necessary to add still further to the refrigerating equipment and the latest installation, made a couple of years ago, consists of a 50-ton Linde Canadian machine, which is exclusively devoted to the making of ice cream, the other two units being used for general refrigeration and pasteurizing purposes.

A Drysdale centrifugal pump is used for forcing the water through the condenser to the brine tank located on the roof of the building, 90 feet above the level of the pump. Rochester force feed lubricators are fitted to all of the ammonia and air compressors.

Owing to the varied sources of supply the modern city dairy requires to exercise the greatest care when accepting milk at the factory. Both the cans and the contents are subjected to the most rigid inspection as soon as they are placed on the platform. The cans in particular are closely examined by the inspector and suspicious containers are handed over to the chemist, who makes a thorough analysis of the contents, and if the milk is polluted in any way, the can and the contents are confiscated and the shipper immediately notified of such milk.

After the milk has passed inspection it is filtered through a fine mesh strainer before being pumped to the storage tanks, which are specially equipped for prompt cooling. From here on the modern pasteurizing of the milk takes place.

Dairy engineers have solved the problem as to how large quantities of milk may be pasteurized. It is a difficult thing to raise thousands of gallons of milk up to the required temperature, maintaining it at that heat for a specified time, and again cooling it to the temperature of cold water. Before commencing the actual pasteurizing process, the milk, as it comes from the storage tanks, passes through a DeLaval power separator for clarifying purposes and separating the different elements, the cream and the milk being divided and drawn from the chamber through separate outlets. All solid particles and sediment are retained in the machine so that the milk is left clear and clean. This installation is shown in Fig. 2.

It will be seen that the separator is elevated on a concrete base so that the milk, after clarifying, flows directly into the top of the pre-heater in which it is raised to a temperature of about 125 degrees F., the milk being in motion at all times. Steam coils are used for heating the milk and regulators are provided for keeping the temperature of the milk constant. From the pre-heater the milk passes to the pasteurizing vats, shown in Fig. 3, where the temperature is raised to 145 degrees F., the flow of the milk being such that its duration in these vats will be about twenty minutes.

For correct and effective pasteurization it is essential that closed vats be adopted and the milk kept constantly agitated during the process so as to prevent the formation of scum or "scalded layer"—a condition that serves as a

FIG. 1—LINDE CANADIAN 50-TON REFRIGERATING MACHINE, MOTOR DRIVEN.

good protection to tubercle bacilli and enables them to resist a higher temperature than otherwise would be fatal to them. At a temperature slightly above 150 degrees F., milk begins to acquire a cooked flavor which is often objectionable, so that the J. J. Joubert Company have adopted a maximum temperature for pasteurization of 145 degrees F., for a period ranging from fifteen to twenty minutes and under constant agitation. This latter is accomplished by means of a helical pipe coil passing through the centre of the vats, and through which coil the steam for heating the milk is passed. Individual motors of 5 H.P. are provided for agitating the milk. Thermometers and indicators are fitted to each vat to register the temperature and the level of the milk.

To complete the pasteurization it is necessary to lower the temperature of the milk to about 45 degrees as quickly as possible. This is accomplished by means of refrigeration and the method employed at this plant is that of the double-pipe condenser, shown to the rear of the pre-heater in Fig. 2. The milk is drawn from the pasteurizing vats and by means of the small pump shown at the left of Fig. 2, is forced through the inner pipes of the condenser, the liquid ammonia

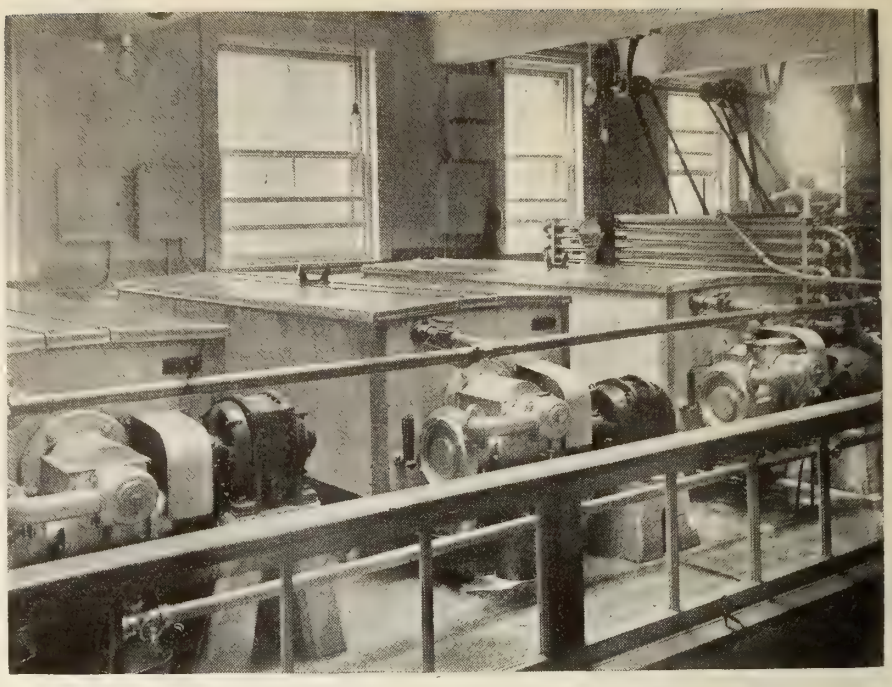


FIG. 3—PASTEURIZING VATS FOR MILK, WHERE IT IS KEPT AT A CONSTANT TEMPERATURE OF APPROXIMATELY 145° FAH.

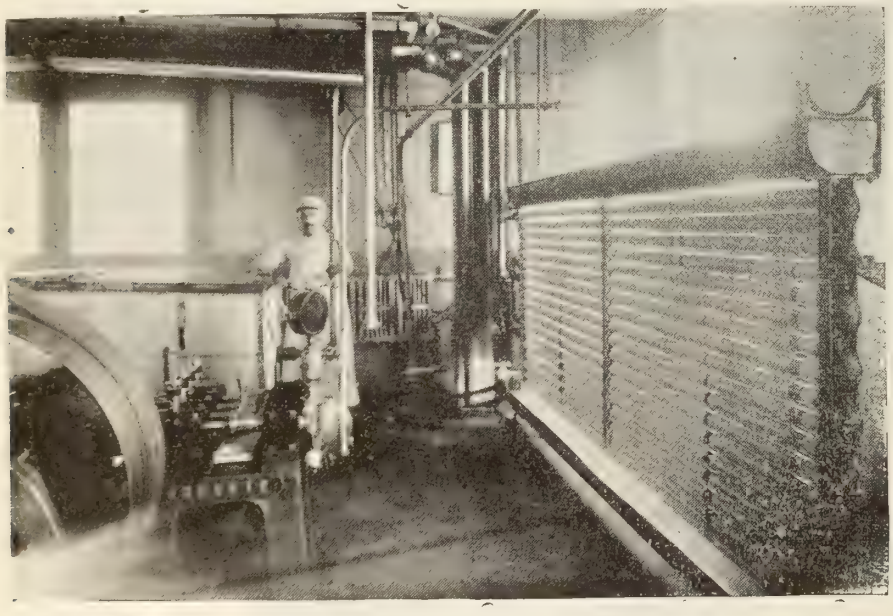


FIG. 4—PASTEURIZING VAT, CIRCULATING PUMP AND COOLING COILS FOR CREAM

in the outer or surrounding pipes absorbing the heat from the milk, so that the latter passes from the refrigerator coils at a temperature of 45 degrees F.

WHEN MERCURY FREEZES TO STONE AND RUBBER GROWS BRITTLE

By F. H. Sweet, in "Tycos"

Among the marvels of science which go to prove the saying that truth is stranger than fiction, none can be more curious, interesting and instructive than the phenomena of liquefied gases and, more specially, liquid air. For although scientists had predicted the possibility of its existence before the liquefaction of air or any other gases had much more than been thought of, it was only after a struggle of many years on the part of physicists that the first drop of liquid air was born, and this was but a mist appearing in a glass tube for the fraction of a second. It is a Frenchman to whom belongs the honor of first producing liquid air, which he succeeded in doing December 2, 1877, by accidentally opening a wrong valve on his apparatus. The infinite amount of patience, toil and ingenuity represented in the subsequent research and following up of those few drops of transient mist is seldom thought of now, since liquid air has become one of the commonplaces of this ultra-scientific age.

Liquid air, as it is now known, is manufactured by a process of alternate compression and expansion, the latter producing the enormous cold necessary to liquefy air. Powerful machines first compress the air to several thousand pounds per square inch; this air is then allowed to expand through a jet, and since even the cold thus produced is vastly insufficient to cause it to liquefy, the

FIG. 2—SEPARATOR, PREHEATER COOLING COILS AND CIRCULATING PUMP.

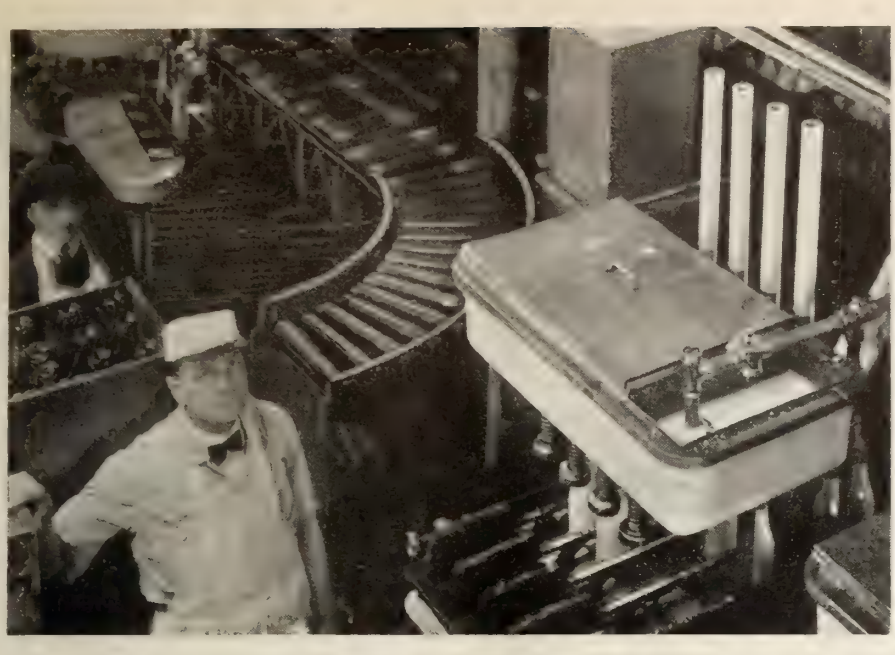


FIG. 5—BOTTLE FILLING AND CAPPING MACHINE.

air is ingeniously made to cool itself by passing through a tube, just before it reaches the expansion nozzle which is surrounded with another tube through which the expanded and therefore cooled air from the nozzle is caused to pass. This, of course, cools the incoming air, so that when it expands it becomes still colder and cools the entering air still more, which goes on until the air liquefies. The apparatus with various elaborations and embellishments, constitutes the basis of all the commercial processes for liquefying air, which is manufactured rather extensively to secure oxygen and nitrogen from the atmosphere. The most recent achievement in liquefying gases is the success with helium, the most refractory gas to liquefy known, and by its aid reached a temperature within three degrees of absolute zero.

Liquid air, then, is nothing but air cooled by expansion until it condenses to a liquid, the same as steam cooled below 212 degrees F. will condense to liquid water, and it contains the same constituents as atmospheric air; oxygen and nitrogen. But it is intensely cold,—193 degrees C., or about 320 degrees below zero, Fahrenheit, and therefore, is in a veritable furnace all the time, but just as water will not rise above 212 degrees, no matter how hot its surroundings are heated, liquid air remains at its boiling point of—193 C., although evaporating rapidly, as water would do under the same circumstances. To prevent this evaporation, special containers must be used—flasks with two walls and a vacuum between them to prevent the conduction of heat to the liquid air, and silvered to prevent radiation of heat as much as possible, in reality, a thermos bottle. Such a flask, called after its inventor a Dewar flask, is used with satisfactory success.

We have spoken of the evaporating of liquid air, and given its boiling point as —193 C. Now the two components of liquid air mentioned above have not the same boiling point; nitrogen is harder to liquefy of the two, that is, the more volatile, and therefore it evaporates first, when liquid air vaporizes. Liquid air is therefore always becoming richer in oxygen until it becomes pure liquid oxygen, deep blue, and boiling at—182C. This means that liquid air is practically always richer in oxygen than normal air, and it is to this fact that many of its peculiar effects are due.

These facts are taken advantage of in the processes for making pure oxygen and nitrogen from air, which forms by far the most important commercial application of liquid air, for an elaborate apparatus for rectifying the liquid as it evaporates provides an unbelievably cheap way of separating air into pure oxygen and nitrogen, due to the difference in boiling points of the liquids. This fractional evaporation is shown by this pretty experiment. Liquid air is poured into a glass of water, and, as by curious coincidence the density is almost exactly that of water, the nitrogen slightly lighter, the oxygen heavier, the globule will first float upon the surface, then, as the nitrogen evaporates, it will gradually dip below and finally sink when it has become pure oxygen.

Strange as it may seem, the water will not be frozen during this experiment. For while it is very cold in degree, liquid air contains no large quantity of cold; it is only another paradox of these extreme temperatures that a pound of ice should furnish nearly twice as much cold in melting as a pound of liquid air does in evaporating, for while the cooling by liquid air is performed at a much lower temperature, it is significantly less in quantity, and entirely insufficient to overcome the high specific heat of water and freeze a quantity of this liquid larger than its own volume, fiction writers to the contrary.

This brings us to the subject undoubtedly more interesting to the layman, though fortunately not the only achievement to the credit of liquid air, that is, the effects of its remarkably low temperature. Nearly all liquids and even in liquid air are frozen to a block which can be used to drive nails. Alcohol, or better still, wine, is frozen to a solid which may be eaten with a spoon while in the pasty stage. While this list could be extended indefinitely, we must consider in our limited space the modifications of solids, which are none the less interesting, in liquid air.

A flower assumes the consistency of porcelain after a moment's dip, and is broken by a slight tap, a piece of rubber tubing becomes as hard as a rock, and easily broken into pieces, and a tender beefsteak is capable of breaking plates, or, stranger still, of driving a nail made of mercury. Naturally liquid air has the same effect upon our flesh. The sensation is that of a burn, and a few seconds converts a finger into a very brittle yellowish stick, very easy to knock off.

If we use in our experiments liquid air which has partly evaporated, and, therefore, consists largely or entirely of liquid oxygen, new possibilities present themselves. The great vigor of combustion in oxygen is well known, and combustibles burn with unaccustomed brilliancy in the gases vaporizing from liquid oxygen. It might be assumed, however, that combustion in so cold a medium as the liquid itself would be impossible, but the combustion of, say a match, is greatly accelerated by plunging it into the liquid, and the highest and lowest temperatures can coexist without the least difficulty. An arc carbon heated red-hot and plunged into liquid oxygen burns tranquilly, giving off an intense glow of light and heat. Other combustions of this nature are less docile. Cotton waste dipped in oxygen deflagrates in the manner of guncotton in the open air, and if confined, explodes with equal violence. Cartridges made of charcoal and similar combustible materials, and impregnated just before use with liquid oxygen have been used with fair success in the place of dynamite, so fierce and rapid is the combustion of the carbon with this liberal supply of oxygen, although supplied at such a low temperature. Magnesium, phosphorus and petroleum are other combustibles which burn so rapidly in liquid oxygen as practically to constitute an explosion. Of course it should be understood that liquid oxygen alone is entirely devoid of explosive properties; it is only the combustions provoked with its aid that partake of this nature.

The industrial applications of oxygen in these connections are many and numerous, the oxy-acetylene cutting and welding torch being the most familiar, and as mentioned above, the gases secured by evaporating liquids rich in oxygen are compressed in steel cylinders for distribution to the trade.

Liquid air cannot be preserved in closed vessels, since it is the small evaporation always taking place which keeps it cold, and if not free to communicate with the atmosphere, it rapidly vaporizes, until entirely evaporated.

Explosions in Ammonia Refrigeration Plants

Explosions in Refrigerating Plants Are Somewhat of a Rarity, But the Engineer Should be Well Aware of Their Possibility— The Writer Points Out Their Possible Origin

By W. C. KLOTZ

THE possibility of explosive accidents, while fortunately of infrequent occurrence, is nevertheless ever present in a refrigeration plant. They may occur at any time through unforseen and apparently remote causes, so that too much care cannot be exercised in the handling and running of all apparatus connected therewith. The collection of data and study of explosions that have occurred, has shown how divergent these causes may be, and has at the same time, in many instances, pointed out the way of avoiding such conditions in future.

Ammonia gas by itself is neither inflammable or explosive in air, nor are mixtures of air and ammonia explosive, but the gases of a refrigeration system, consisting as they do of ammonia gas with varying amounts of oil vapor, hydrogen, etc., can be decidedly so. Explosions have been noted to occur, not from the sudden release of gas due to a breakage, but from the subsequent ignition of the mixture of gas and air in contact with an open flame. An example of this is shown in the case of a large compressor in which a cylinder head was forced out, due to the breaking of the follower plate of the piston. The gases escaped into the room, and coming in contact with an open light, ignited. The resulting explosion wrecked the machinery, and was followed by a fire which finished the work of destruction. Another similar accident was one in which the bypass valves of a large compressor gave way, allowing the escape into the room of a quantity of gas. In this case, the explosion did not occur for several minutes after the escape of the gas, and was apparently caused by ignition from an electric arc light hanging near. A different condition was that of an oil-cooled compressor in which the sight glass of the oil reservoir broke, letting oil and ammonia gas be blown out. No subsequent explosion was recorded, but when the fumes were dispersed, and the room entered, evidences were found that a slight fire had taken place, as the paint on the walls was found blistered, and some loose papers on a desk were burned.

But that an explosion can take place in a compression system itself without the presence of ammonia is shown by an accident that occurred while testing out with air pressure. The compressor had been undergoing repairs and was being air tested, when at 250 pounds the oil separator exploded with great violence. The explanation advanced was that the superheated air, forced from the compressor into the oil separator, which apparently was not clean, formed an explosive mixture with the oil vapor, which automatically ignited with disruptive force, severely injuring several persons.

Explosive accidents to absorption systems that have been noted, have been largely due simply to overpressure, resulting in the violent fracture of the generator or other parts, and have been traced generally to defective parts, or negligence. Such an accident occurred some years ago resulting in the death of five persons. It was found subsequently that the safety valve had been removed and not yet replaced. There is, however, an amount of hydrogen formed, apparently by decomposition of ammonia at high temperature in the generator, or else by hydrolysis, which finds its way to the top of the condenser. The gases from the purge line may be ignited at almost any time, burning with a yellowish flame. Formerly this inflammability was attributed to a supposedly impure ammonia, but the condition is found to exist irrespective of the kind or quality of ammonia used. A sudden release of this gas in quantity under the proper conditions is quite able to produce explosion when ignited, and in fact experiments have been made with certain proportions of such gases with air which have been made to explode at will.

The theory that lubricating oil in a compressor can be sufficiently vaporized to produce a source of danger is a reasonable one when the conditions are taken into consideration. Ammonia compressor oil, having a low cold test, generally has a flash point of 300 deg. fahr. or under. At such temperatures ignitable volatile vapors are given off by the oil, and the rapid passing back and forth of the compressor piston releases, and mixes the oil vapor with ammonia gas, the mixture passing out of the compressor. When mixed with the proper proportions of air, it can quite readily form a highly explosive gas.

The conclusions to be drawn from the study of ammonia plant explosive accidents and their causes are that, except for overpressure, an explosion within the system is very unlikely under running conditions, and the explosive result of a sudden discharge of the working gases into the atmosphere without contact with open lights or fire, is not probable. On the contrary, the contact of fire with such gases in the atmosphere, in a restricted space, can and has produced most disastrous results. This makes it imperative to allow no open flame of any nature within range of a working plant. Further, costly experience has shown that, before testing out a plant with air pressure, it is necessary to be absolutely certain that the tested parts are clear of oil, so that no combination of superheated air and oil vapor can have a chance to accumulate.

That explosive accidents are so few is due, not so much to the care with which plants are operated, as to the fact that fortunately all the necessary conditions are only infrequently at hand, for if every "blow-out" meant a corresponding explosion, the history of ammonia refrigeration would be vastly different from what it now is. Finally, it is most essential that strict watch is kept on the whole system from end to end in all details, as the failure of even an apparently unimportant part has been found sufficient to cause general havoc, and even fatality.

When a liquid is heated in the vessel which contains it, there is an apparent expansion which varies with the nature of the vessel, so that, in order to determine the absolute expansion, a double measurement must be made, the apparent expansion of the fluid being modified by the previous measurement of expansion of the container.

The "Revue de Chimie Industrielle" gives the following report of a much more direct process evolved by M. Jean Escard, which requires only one operation.

He makes use of an apparatus composed of two concentric cylindrical containers, the inner one of copper and the outer of glass. The inner container has a volume which is exactly half that of the outer one. But it is a known fact that the co-efficient of expansion of copper is 0.000,0172, while that of glass is only 0.000,0086, i.e., exactly half. Consequently, when the two containers are heated at the same time there is no change in the volume of the space between them, since the inner one has an expansion which is double that of the outer vessel having a double volume. Thanks to this ingenious compensation, a single reading enables us to calculate the co-efficient of expansion of any liquid whatever occupying the space comprised between the two vessels.

The combination is placed in a water-bath, which is heated from the outside. This has a ring-shaped cover containing two holes, in one of which is inserted a thermometer which fits tightly and which indicates the temperature attained by the liquid being tested. In the other hole is placed a graduated tube welded to the glass and having a very narrow channel so as to make it extremely sensitive. The liquid expands into this, and its expansion is measured directly and without significant error

The Absorption System of Refrigeration

The Following Article is Descriptive of the Functioning of the Absorption System of Ammonia Compression—The Absorption System is Apt to Appear Complicated to the Engineer at First

By JAMES F. PATTON

MODERN cold storage practice demands refrigerating machinery capable of producing and continuously maintaining, with high economy both of fuel and water; very low temperatures as compared with those of a few years ago—and this is true whether ammonia or brine be used as the medium of circulation. The latter is now generally used on account of the ease of regulation of the temperature and because of its safety. Brine temperatures of 15 to 25 degrees below zero are common, and by the use of calcium chloride or special coolers this point may be greatly exceeded. The absorption system of refrigeration is particularly adapted to cold storage work, but its operation is a mystery to many of those who are thoroughly familiar with the operating principle of the compression system. In these latter days when the cost of fuel and labor is advancing continually and the cry of "Profiteer" is heard in the land, economical operation is important; but of even greater importance is the selection of the system to be used for any given work. Ice-makers have found out that there are but two practical methods of manufacturing artificial ice—the compression and absorption. Each system has its advocates and its advantages and it is not the object of this article to enter into any discussion or to advocate the selection of either type for any given work. But as a large percentage of the plants now in operation are run on the compression principle, and as most of the articles which appear in the magazines from time to time relate to that system, a discussion of the absorption system may be of value. This system operates on well-known laws and when once these laws are understood the absence of the massive, complicated and highly polished engine used in the compression system is easily explained. The cycle is as follows : 1st.—The liberation of an-hydrous gas from aqua ammonia in the generator by means of heat. 2nd.—The liquefaction of this gas in the condenser by removing the heat with the condensing water. 3rd. — The expansion of this liquid through the freezing tank coils—thereby absorbing heat from the brine in the tank. 4th.—The reforming of the original solution of aqua ammonia in the absorber and the return of this solution to the generator. The fact that water and ammonia have a great affinity for each other is the foundation on which the entire system is based. At 50 degrees one volume of water will absorb 900 volumes of ammonia gas, while at 100 degrees it will take up over 450. When a liquid can be vaporized readily and the resulting gas can be readily absorbed by another liquid, we have the conditions for the successfud operation of an absorption system. Fig. I. shows a modern absorption plant. Steam being turned into the generator will gradually heat the ammonia to the boiling point and the ammonia gas which is generated passes to the analyzer or rectifier (E) which is directedly over the generator. This consists of a series of deflecting pans or plates over which the hot gas must pass for the purpose of separating any water which may have been carried over with the ammonia gas. The water thus distilled is drained back into the generator. From the rectifier the gas passes to the condenser (F) which consists of a series of pipes over which water flows, cooling the dry gas, which liquifies under the generator pressure. The liquid ammonia flows to the receiver (G) under pressure and is expanded into the freezing coils through an expansion valve (H) circulating through the coils and absorbing heat from the brine. It is then passed to a coil in the tank which contains the water for the cans and as this water is materially reduced in temperature, the efficiency of the plant is raised to a considerable extent. From the distilled water tank the gas passes on to the absorber (D) which performs a reverse operation to that performed in the generator. Heat supplied in the generator separates the ammonia from the solution, leaving what is called "poor liquor"; in the absorber the weak aqua ammonia entering through a spray pipe at the top absorbs the gas which comes from the distilled water tank. The pressure produced by the formation of gas in the generator forces the poor liquor out through a coil in the exchange and

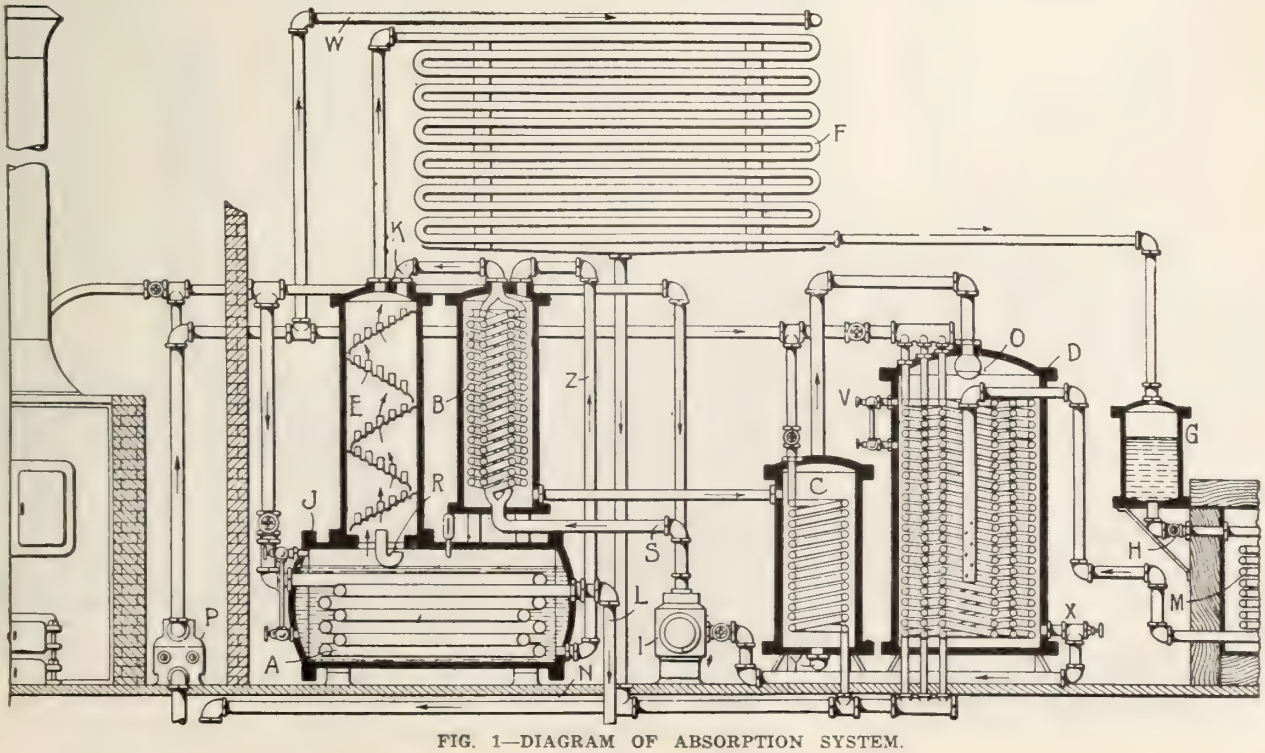


FIG. 1—DIAGRAM OF ABSORPTION SYSTEM.

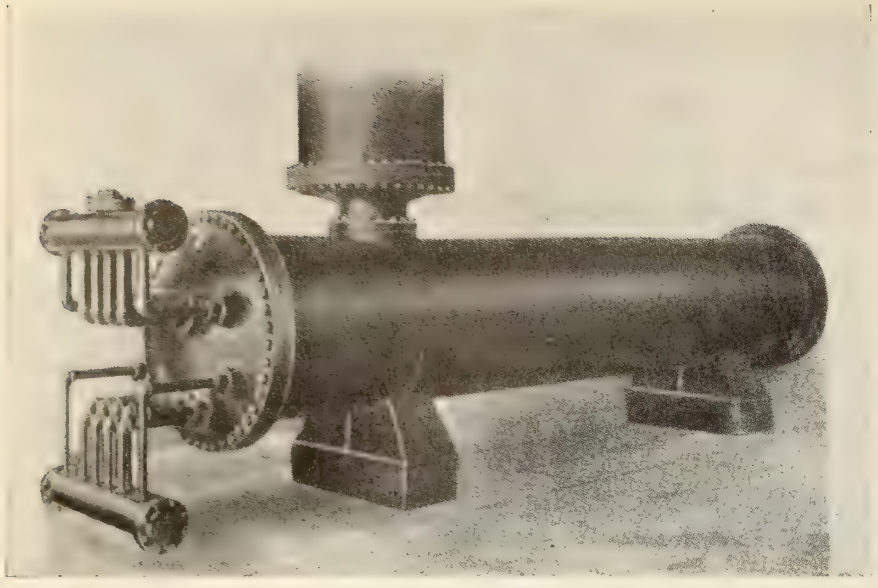


FIG. 2.

on to the absorber from which it goes back to the generator, through the pump. The absorption of gas is rapid and continuous, the rich liquor being drawn off from the bottom of the absorber by an ammonia pump (I) and forced through the exchanger (B). This consists of a drum in which are several coils of pipe through which the liquid from the pump is forced. The coils are surrounded by the hot weak liquor which comes from the generator. This hot liquor, therefore, is made to give up heat to the rich liquor in the coils. The higher the temperature—the less the moisture removed by the liquor in the analyzer, and as dry gas governs the economy of the system more than any other factor, the horizontal generator has an advantage over the vertical as it allows much more exchange surface. Generators are constructed in various forms, both horizontal, as shown in Fig. 2 and vertical as shown at (X) in Fig. 3. The horizontal is the more expensive, but has the advantage of supplying dryer gas. In the vertical type the evaporating surface is small and the boiling rapid, therefore, it is hard to keep the steam coils covered with liquid. The coils when uncovered become pitted by the action of the gas and ammonia liquor and the vertical type will boil over if forced. Also as shown in Fig. 3 the height of the apparatus is excessive when it is combined with a rectifier. However, in many installations the rectifier is now being omitted as some engineers claim that the benefits resulting from its use are not sufficient to pay for its installation. So the last objection to the vertical type generator has little weight. The atmospheric or surface type condenser, shown in Fig. 4, consists of a series of wrought iron pipe coils through which the ammonia passes being cooled by water which flows from the sprinkler troughs shown. This is a simple and efficient form, but in some cases the building construction will not permit its use while in other cases the splash from the condensing water may be objectionable. In the double pipe condenser, shown in Fig. 5, the gaseous ammonia enters the space between the inner and outer pipes, the water flowing through the inner pipe. In the shell and coil type the water flows through the coils while the ammonia circulates at the top of the shell—is cooled and condensed and leaves from the bottom. This construction reduces the vapor friction to the lowest possible point, thereby, keeping the pressure close to that theoretically desired. The selection of the proper type is largely a matter to be governed by local conditions. When the condensing water is of a hard scale forming nature the efficiency of a double pipe system will be greatly reduced, while the efficiency of an atmospheric type will be greatly increased if it is used in an excessively dry climate as there is considerable evaporating effect due to the water flowing over the pipes. There are many types of absorber, but in general they may be classed as "full" or "empty" —according to their method of operation. In the first type the liquid and gas are admitted at the bottom and the gas must pass through the entire body of liquid in the shell—which of course gives almost perfect absorption, but there is a loss of pressure equal to the head of liquid between the top level of the liquor and the gas inlet. In the "empty" type as already mentioned—the gas enters at the bottom and meets the poor liquor which is sprayed in at the top. As successful operation depends to a great extent on the strength of the rich liquor supplied to the generator, it is desirable that this be as contant as possible. This regulation is easily obtained in the "full" type systems, but when the empty form is used, satisfactory results can be obtained only through the use of special regulators which keep the density between 16 degrees to 18 degrees Baume. The power required for an absorption machine may be calculated as follows: First determine the heat required in the generator. This is equal to the heat lost in the condensing coils minus the heat gained by the ammonia pump. The heat lost in the condenser is equal to the temperature of the gas which enters it minus the temperature of the liquid ammonia plus the latent heat of ammonia. This latent heat is difficult to find, but it may be calculated approximately by the rule:

555,5 — (.613 × temp.) — (.000219 × sq. of temperature).

The loss in the absorber is the sum of that produced by the absorption of 1 lb. of ammonia by the weak liquor and that which has been brought into the absorber

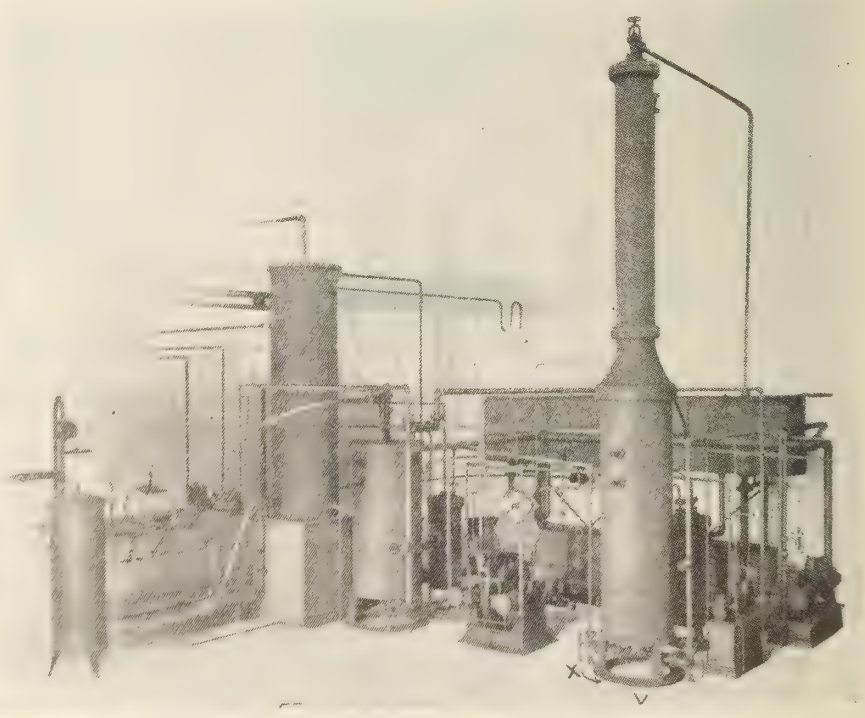


FIG. 3—GENERAL ARRANGEMENT OF ABSORPTION PLANT.

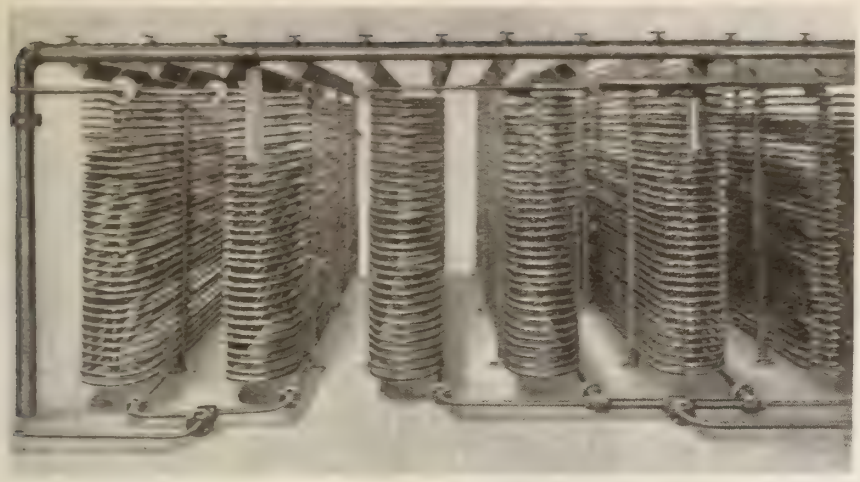


FIG. 4.

by the poor liquor, plus the negative heat produced by one pound of gas from the cooling coils. This latter is equal to the difference in temperature between the rich liquor going out and the gas in the coils, multiplied by .5. The heat which is brought into the absorber is equal to the number of pounds of rich liquor for each pound of active ammonia minus one times the difference in temperature between the incoming poor liquor and the outgoing rich liquor. The heat absorbed by one pound of the refrigerant in the cooling coils equals the latent heat of ammonia plus the difference in temperature of the ammonia liquid and the refrigerator, multiplied by the specific heat of ammonia. The heat produced by the pump is ordinarily disregarded but may be found by the rule.—Heat produced is equal to weight of rich liquor pumped multiplied by the difference between the height in feet of a column of water 1 sq. in. in area which will give the pressure of the absorber. This result is to be divided by the specific gravity of the rich liquor multiplied by 778. The weight in pounds of rich liquor circulated in an hour is equal to the pump cylinder area is square inches multiplied by length of strokes in inches multiplied by number of strokes per hour divided by 27.7 multiplied by the specific gravity of the liquid. This gives the B T U required per hour in the generator which is divided by the latent heat of steam corresponding to the generator pressure in order to find the number of pounds of steam required.

The steam consumption for the auxiliaries is found as follows: Multiply together the square of the cylinder diameter in inches, the length of stroke, the number of strokes per minute and the weight of one cubic foot of steam at the initial pressure. The result is the steam consumption per cylinder. Add to this the weight of steam required to distill the ammonia, and divide the result by 13.8 and the number of square feet of heating surface in the boiler is obtained.

Preliminary to charging and putting a plant in operation, it must be tested under pressure for leaks. This is done by connecting the suction of the ammonia pump to a water supply and pumping water into the system until full, and a pressure of 150 pounds is had. Inspection is then made for leaks and, if everything proves tight, the pressure is increased gradually to 300 pounds of something more. This pressure is maintained for at least half an hour while careful inspection of all joints is made. While the pressure is on, the valves on the gauge piping connections are closed and the gauges disconnected and cleaned by blowing out. Drains are then opened and the water allowed to flow out of all parts of the system except from the generator, which is left half full.

Steam pressure of 50 pounds is then turned on the generator coil, which results in a pressure of 30 pounds in the generator as soon as the water is heated and sufficient steam made to fill the high pressure side. At this stage the valves on the weak liquor pipe to the absorber are opened and the pressure forces the water from the generator to the absorber. The suction of the ammonia pump is now connected to the absorber, and the water and steam circulated through the system, while the vent cocks are left open so that all parts are thoroughly cleaned and blown out. After this has gone on for an hour or so, the pump is stopped, the steam shut off the generator coil, and the system allowed to cool. As soon as steam stops coming from vent cocks, they are closed, and the stop valves separating the various parts of the system are closed so that, on vacuum if formed in different parts by condensing steam, a leak in one part could not affect the rest of the plant.

With the system under a vacuum, as after steaming out, aqua ammonia may be forced into the generator and absorber by atmospheric pressure. Otherwise, the ammonia pump must be used to fill the two parts of the system—one after the other. An auxiliary suction makes connection to the pump, and the end of the suction pipe is inserted in the 1½ inch bung-hole of an aqua ammonia drum to within 1 inch of the bottom. All valves on the discharge side of the pump are opened and the ammonia is pumped into the system, care being taken to keep the drum as cool as possible. The generator is filled to the working level, as shown by the gauge cocks, and the absorber is filled to the top of the gauge glass. The ammonia pump is now connected with its suction to the absorber; all valves are adjusted for regular working conditions with steam admitted to the generator coils; the ammonia gas generated is allowed to pass over to the condenser, over which cooling water is circulated. When the pressure is about 120 pounds on the high side, the ammonia pump is started slowly, and the liquor level in the absorber is gradually reduced to the normal about mid-height of the gauge glass. With cooling water circulating through the absorber coils and the weak liquor cooler, the plant is in full operation.

When in operation with a normal charge the gauge glasses should indicated the following conditions:

The generator should have from one to two inches of liquid covering the coils. The amount in the absorber depends on the type used. In the tubular the level of the liquid should be at least one inch above the top of top row of tubes. In the atmospheric or double pipe type there should be about 12 inches of liquid in the receiver above the pump suction connection. In the shell type which runs empty the glass should show the liquid

(Continued on page 197)

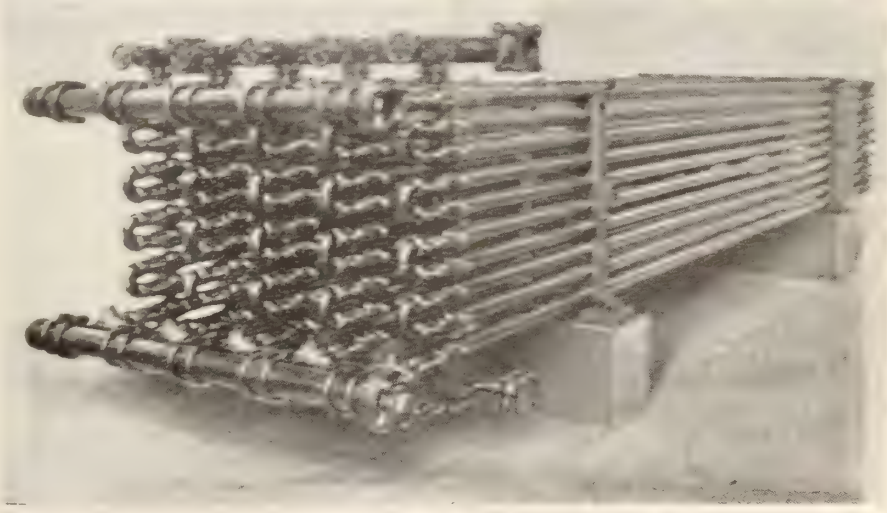


FIG. 5.

The Indication of the Ammonia Compressor

A Good-Looking Indicator Card is Not Always a Sure Sign of an Efficiently Working Compressor—The Writer Shows How to Determine the Isothermal and Adiabatic Lines and From Them to Judge of Operating Characteristics

By F. F. McNEIL

NO matter what book you pick up that deals with refrigeration and ammonia compressors, they always state, for capacity keep the back or suction pressure as high as possible. I have always found that for every temperature in the evaporating coils we have a corresponding pressure, and in the dry gas compressor we do not wish to run with the discharge pipe cold no more than we wish to run with it too hot, but we do wish to keep as much ammonia as possible in the evaporating coils. If you desire to run the compressor at a constant temperature on the discharge side, you will have a constant suction pressure and any variation from this pressure will mean a variation in the temperature on the discharge side of compressor, this means for a constant temperature of brine or room, but also applies to all brine and room temperatures, each temperature having a corresponding pressure.

Again they tell us it is bad practice to run a plant when short of ammonia. I fail to see how it is possible to run an ammonia compression plant when short of ammonia; the only plant that I ever saw run with any success when short of ammonia was one in which a shell type cooler was used, the shortage could then be detected by the amount of opening of the expansion valve as well as the gage glass on the receiver.

One of the best indications of lack of ammonia in the system is a constant variation of pressure and consequently temperatures; this is most noted by the constant variation of the temperature on the discharge side of the compressor which will vary up and down with the same brine or room temperature, and with the same opening of expansion valves.

Many engineers figure out the mean pressure of the indicator card and if it looks good they believe their compressors are o.k. and let it go at that. If you would get the best from the compression you should apply both the Isothermal and Adiabatic compression curves.

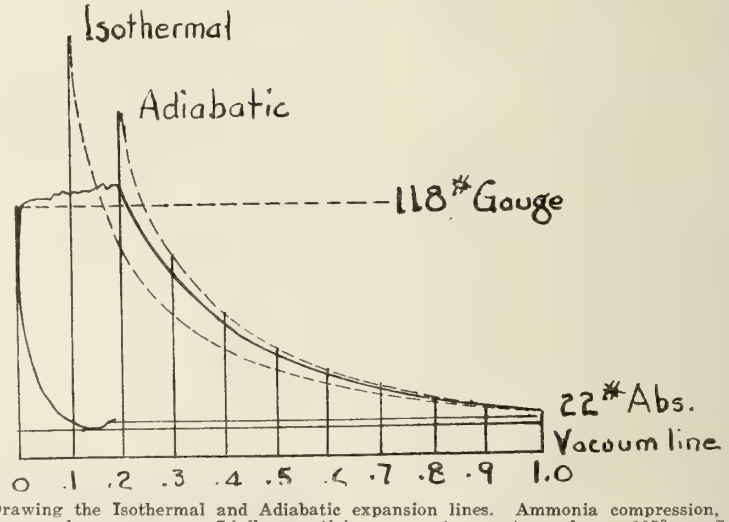
The curve the indicator pencil will trace should compression take place without heat is known as the isothermal curve but no means have this far been provided to remove the heat of compression as fast as it appears, therefore it is seen that if the compressor is in proper working condition the curve traced by the indicator pencil will be above this isothermal curve.

On the other hand, the adiabatic curve is the curve the indicator pencil would trace if there was no loss of heat due to compression, this is also impossible in the ammonia compressor and in order to use the least power possible per ton of refrigeration every means is used to keep this temperature down, it is now seen that the curve traced by the indicator is not adiabatic but must fall below it. The actual curve as traced by the indicator pencil from a compressor in good working condition will fall somewhere between these two curves, and that it will be somewhat closer to the adiabatic than the isothermal curve.

From the first laws of gases known as Boyles laws, we have (P. V. = a constant), in which P = absolute pressure and V. = volume.

That is, the product of the absolute pressure multiplied by the volume for any point of the stroke must be the same, the temperature, of course, remaining constant.

For example, below is an indicator "diagram" from one end of the cylinder of a 18½ in. x 30 in. ammonia compressor to which I have added these curves:



Drawing the Isothermal and Adiabatic expansion lines. Ammonia compression, 118 lbs., condenser pressure, 7.' lbs., suctioi pressure temperature of gas, 105° c. Scale of spring, 100 lb. = 1 in. Cyl. 18½" x 30" x 72 revo. per min. Area of card, 1.32 sq. in. M.E.P., 49 lbs.

In this case, the cylinder is filled with gas at a suction pressure of 22 lbs. absolute, the diagram is divided into ten equal spaces. Remember to use absolute pressures we have P. V. = a constant where P = 22, V = 1. 22 × 22, which is constant. Now for .9 of the volume we have 22 ÷ .9 = 24.4 lbs., likewise for .8 and, etc., to the .1. These results as found are measured off with a rule that is scaled to correspond with the indicator spring used, and laying the different pressures off on the diagram in their respective plans, we have a series of points through which the isothermal curve is drawn.

Computing the points through which the adiabatic curve is drawn, involves the use of logarithms, which are not understood by all engineers. The following table of adiabatic multipliers will make the operation very simple, and the results, although not absolutely correct, will be quite reliable.

Adiabatic Multiplier

Volumes in one-tenths parts.	Absolute pressure pounds per sq. inch.
1.00	1.
.90	1.147
.80	1.337
.70	1.590
.60	1.943
.50	2.462
.40	3.291
.30	4.783
.20	4.103
.10	19.953

The formula used for computing the adiabatic curve is $PV^{1.3}$ = a constant that is the product of the absolute pressure × the volume to the 1.3 power equals a constant, the 1.3 is the ratio of the specific heat of ammonia gas at constant pressure to that at constant voleum; specific heat of NH^4 gas at constant pressure is .3913 and at constant volume .508, therefore .508 ÷ 3913 = 1.3 approx.

The formula used in finding the higher pressure due to decrease volume is: $P_2 = P_1(V_1/V_2)^{1.3}$; $P_3 = P_1(V_1/V_3)^{1.3}$ and etc. This equation is solved by logarithms thus:

Log. P_2 = Log. P_1 + [(Log. V_1 — Log. V_2) × 1.3]; and so on for the other pressures.

For convenience use the above table, which, although not absolutely correct, is all that is necessary for accurate results.

These curves are aso used for air compressor cards only the constant is 1.41 for air.

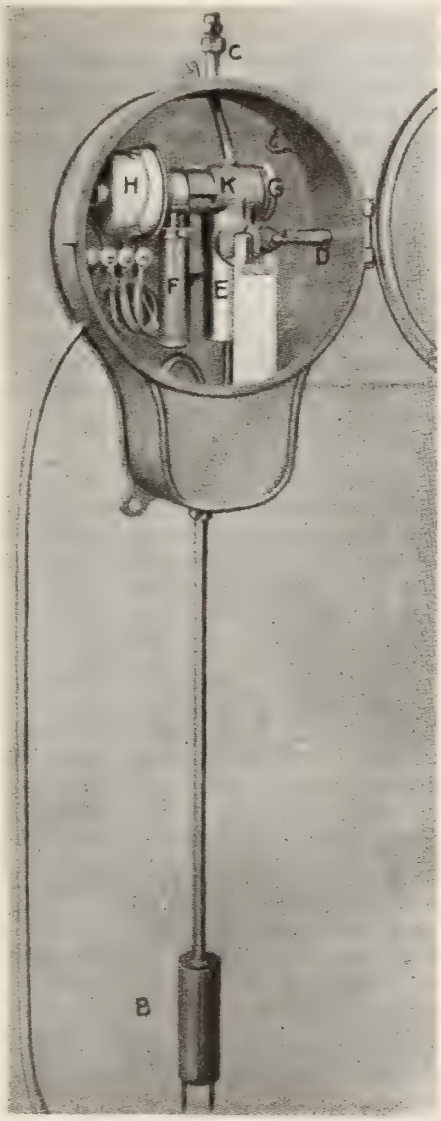
An example will explain the use of the above table, using the same diagram, we have 22 lbs. abs. pressure. Consulting the table we have volume one (1) has a multiplier of 1, thus $22 \times 1 = 22$ lbs. At a volume of .9 the multipier is 1.147 and $22 \times 1.147 = 25.234$ lbs. Likewise using the other volumes with their multipliers as .8, .7, .6, and so on, then by using the same scale and taking a measurement from the vacuum line as in the isothermal curve we have a series of points through which the true adiabatic curve is drawn.

The drawing of these curves is just the same for any suction pressure, the only difference is in using the new suction pressure and making sure it is absolute, that is, by adding 14.7 lbs. to the gage pressure.

How should the actual curve lie above the adiabatic curve? It would indicate that the pressure was too high due to gas leaking back through the discharge valves from the condensor. On the other hand, should the actual curve lie closer to the isothermal curve it would indicate not enough pressure due to leaky suction valves or a leaky piston. In closing, I wish to say that it does not pay to form an opinion too quickly as to whether a good looking card is the indication of a perfect compressor, apply the above rules and be sure.

A NOVEL CO_2 RECORDER

A novel electrical CO_2 recorder, which enables the percentage of CO_2 in flue gases to be determined by an electrical method, not involving the use of any chemical absorbent was exhibited by the Cambridge and Paul Instrument Co., Ltd., at the recent exhibition of the Physical and Optical Societies, states the "Engineer." The instrument has been tested under actual working conditions, and it is claimed it is both accurate and sensitive. It possesses the advantage that, while the portion of the instrument through which the gases actually pass can be placed in close proximity to the flue, the recorder may be some considerable distance away. If desired an indicator may be used instead of the recorder. The method employed for measuring the percentage of CO_2 is one devised by Dr. G. A. Shakespear, of the University of Birmingham, for testing the purity of gases. The composition of the flue gas is compared with that of air by means of an instrument known as a katharometer, which consists of two identical spirals of platinum wire contained in two cells drilled in a copper block, each of the spirals being connected to form one arm of a Wheatstone bridge circuit. If a fairly large current is allowed to flow in this circuit, the two spirals will become heated and will lose heat to the walls of the cells. The rate of cooling will depend on the thermal conductivities of the gases in the cells, so that if the two cells contain gases of different conductivities the two spirals will cool at different rates, and one will therefore be maintained at a lower temperature than the other. The difference in temperature of the two wires will cause a deflection of the galvanometer, the extent of deflection depending on the difference in conductivity of the two gases. If, therefore, one cell of the katharometer contains a pure gas and the other the same gas mixed with some other constituent, the extent of the deflection will be an indication of the amount of the second gas present, and



NEW CO RECORDER

the galvanometer can be calibrated to show directly the percentage composition of the mixture. The difference in conductivity between air and carbon-dioxide enables the method to be employed to determine the percentage of CO_2 in flue gases.

The engraving—Fig. 3—shows the katharometer and water aspirator, which are enclosed in a metal case with glass door. The katharometer H is screwed into the chamber K. The open cell of the katharometer communicates with this chamber, through which the flue gases are drawn by the water aspirator E. The other cell of the katharometer, which is filled with air, is connected to the tube F, which contains water, so that the air in the katharometer cell is kept saturated. The object of this arrangement is to prevent the water vapor in the flue gases from vitiating the readings, as it would do if the flue gases were compared with dry air. When the gas in both cells is saturated with water vapor the effect of the water vapor is the same on both sides and the readings are not influenced. Owing to the nearly equal conductivities of air and carbon-monoxide, the presence of the latter gas does not affect the readings. A filter box of glass wool for cleaning the gas which passes into the katharometer is attached to the screwed plug G. The water inlet to the aspirator is shown at D, and the pipe carrying the gas from the flue is connected to the tube C. A soot filter should be inserted between the flue and the tube C, and at the lowest point of the pipe a T piece with its end dipping under water should be provided as a drain for condensed steam. The U tube on the front of the aspirator is half filled with water, and when the aspirator is not working the water level in this tube will be quite steady and will indicate the chimney draught. The position of the water in the U tube also indicates the presence of any obstruction in the gas supply pipe, as this causes the water to be unusually high on the aspirator side. The water flow regulator B is designed to give maximum efficiency in the working of the aspirator. The flow is adjusted until water runs freely out of the fine tube at the bottom and only trickles out of the wider tube, which is an overflow pipe. The water consumption is about 5 gallons per hour.

The records are obtained by means of the company's thread recorder. This consists essentially of a suspended coil galvanometer in which the pointer is depressed by means of clockwork mechanism every minute or half-minute on to a thread impregnated with ink, which passes above the surface of a revolving drum carrying a chart. Between the times of marking the pointer is allowed to swing freely and take up its new position so that the succession of dots forms a record of the varying positions of the pointer. The charts are calibrated to read directly the percentage of CO_2. A 2-volt 40-ampere-hour battery is used to operate the instrument. Provision is made for testing at intervals the current flowing through the katharometer coils, and rheostats are provided to enable this current to be kept constant in spite of variations in the voltage of the battery.

A board of supervising engineers, composed of City Engineer Doucet, and Messrs. R. S. Lea and Walter J. Francis, consulting engineers of Montreal, has been appointed to prepare plans and supervise the work of completing the construction of the aqueduct that will eventually provide water supply for the city.

A High Pressure Rotary Compressor

A New Type of Compressor Recently Described in a Paper Before the American Society of Mechanical Engineers. High Volumetric Efficiency and High Ratio of Compression Are Obtained

By CHESTER B. LORD

ANY one familiar with the various lines of mechanical endeavor must realize that no vital change has been made in compressors in the last thirty years or more. While steam-engine practice has profited greatly by the development of the turbine, and generators and motors have been vastly improved, refrigerating machinery, at least as far as the compressors are concerned, has not been developed.

2. The same cumbersome reciprocating machines that were in use thirty years ago are being used to-day, with perhaps the difference that they are more cumbersome. There have been improvements in the way of better valves, a little higher speed and minor matters, of this kind, but none of them has changed the principle of the machine or resulted in any great economy either in weight, operating space required, or cost of installation. Any reciprocating machine, because of the very principle of reciprocation, must be built exceedingly heavy per unit of capacity and is confined to comparatively low speeds in operation. Because of this and its slow speed of operation, the power unit for driving such machines is of necessity also exceedingly heavy and cumbersome. High-speed machines such as electric motors and steam turbines are very rarely used because of the impracticability of connecting them directly to a large refrigerating machine.

3. Moreover, these machines require a great deal of attention, and necessary repairs are expensive because in almost every case the machines must be partly taken down in order to get at the parts to be repaired. Incidentally the repair parts, by reason of their size and expensive design, are very costly.

4. It may also be well to mention the many bearings that must be taken care

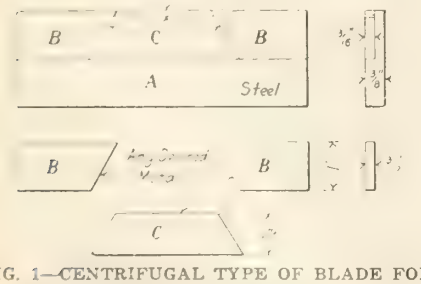


FIG. 1—CENTRIFUGAL TYPE OF BLADE FOR USE IN ROTARY COMPRESSOR WITH ECCENTRIC ROTOR.

of, the difficulty of lubricating them, and the delicate manner in which the valves must be adjusted in order to give best efficiency. All of these things combine to make the reciprocating machine very high in cost of installation, cost of operation and cost of maintenance, and hence in the mechanical world we are continually striving to get on a unidirection basis. We are replacing the reciprocating planer with a unidirection miller. In the place of the reciprocating engine we are introducing the uniflow principle. The automotive world is searching for the unidirection gasoline unit; and wherever possible reciprocating pumps and compressors are being replaced by the rotary type. The Patent Office records are full of rotary valves, rotary engines and rotary pumps. So much time and effort has been spent on them and to so little purpose that the rotary engine and compressor have almost been placed in the same category with the perpetual-motion machine.

5. From time to time the mechanical world has been startled or interested by claims of a perfected rotary engine, or its complement, a rotary compressor, and while all these attempts have been in the direction of perfecting the rotary principle as applied to compressors, the disadvantages which developed have more than offset any advantages gained.

6. The rotary principle, however, is so valuable that, in spite of their deficiencies three general types of rotary compressors have been retained, namely, the centrifugal blower, the gear-type compressor, and the eccentric rotor with a telescopic blade. The centrifugal blower depends more upon the velocity of the air than upon compression and requires several stages to secure any considerable degree of compression. The gear-type compressor, in which there are two moving members, which, roughly speaking, compress air between two gears with their teeth in mesh, taking it in at one side of the teeth and delivering it at the other, has a very low efficiency, but is able to compress to a higher degree, single-stage, than either of the other types. None of them, however, compresses to over 8 or 10 lb. single-stage. There are many modifications and variations of these three types, but they represent the vast majority of rotary compressors.

7. Once again the mechanical world is about to be startled, perhaps, with a story of a perfected rotary compressor, or at least, it is hoped, interested. Since the writer is not the inventor and has a reputation to consider, it may be assumed that when he makes unqualified statement that it is possible with a rotary compressor to get commercially 92 per cent. volumetric efficiency at seven compressions, or 100 lb. per sq. in., that the compressor will, without adjustment or alteration, handle gas or a liquid, or a gas and liquid at the same time, close investigation has been made and the statement is based upon something more than paper facts. Until explained it will raise still further doubt when it is stated that the perfected high-pressure rotary compressor is built on the eccentric-rotor-and-telescopic-blade principle, this being the least efficient of the three types above referred to and the only one

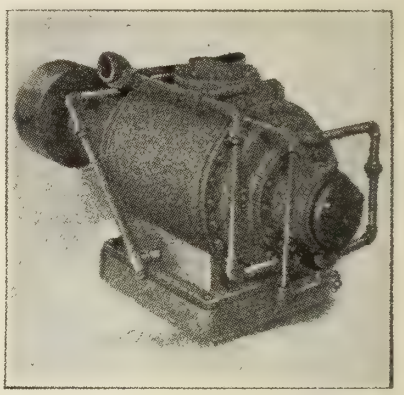


FIG. 2—TWENTY-TON ROTARY REFRIGERATING MACHINE.

that has had no commercial applications except in small water and oil pumps.

8 Before proceeding with the description of the perfected compressor let us analyze the troubles which have been experienced with this type of machine. The first and greatest was that it was necessary to maintain a seal at one point between the rotor and the cylinder. This was a source of large friction losses and the seal was soon broken by wear. Second, the blade pressure against the end plates and the inner surface of the cylinder created great friction loss and still further wore the cylinder at the contact point between the rotor and the cylinder wall. Third, the pressure being all on one side of the blade created such friction that the blade did not work in and out freely. Next, it was found impossible to devise a method of packing square corners, and hence the only commercial application of this type was in the pumping of oil or water at a comparatively high velocity, which service produced the least friction and no important losses.

9. The compressor about to be described was perfected by W. G. E. Rolaff, of the Research Engineering Company, St. Louis. It is not an invention but the result of long, patient research and the ingenious application of obvious principles. As stated, it is of the eccentric-rotor-and-telescopic-blade type, such as just described, except that the faults mentioned have been eliminated and the mentioned have been eliminated.

10. Taking the three difficulties enumerated in their order, the first men-

tioned, that of maintaining a seal at one point between the rotor and the cylinder, is fundamental. Some years ago a Mr. Hermansen developed an engine in which the cylinder revolved at the same peripheral speed as the rotor and was in fact carried by the rotor. Having both moving parts travelling at the same peripheral speed, not at the same angular speed, means that there is no slip between the two, and consequently little or no friction. It also reduces to a minimum the blade friction against the outside of the cylinder because the movement of the blade on the wall of the cylinder per compressive revolution is only that represented by the difference between the circumferences of the outside of the rotor and the inside of the cylinder. In other words, in a 100-cu.-ft. size, with a cylinder 10⅝ in. in diameter and a rotor 10 in. in diameter, the blade travel per compressive revolution is only the difference between 31.41 in. and 33.38 in., or less than 2 in., so that it requires approximately 17 revolutions of the rotor for one revolution of the blade upon the cylinder wall. In order that this may be brought out clearly the writer will state that there are no valve openings in the cylinder and that as it travels always in the same plane it makes no difference whether the cylinder is revolving with the rotor, standing still, or reversing itself, as far as compression is concerned. Hermansen's principle, however, solves but one of the many difficulties and by itself is valueless. Mr. Rolaff was unaware of this patent when he started his research work, and even after he had evolved the principle he did not think it patentable, due to its similarity to a roller-bearing detail. Hermansen had had no difficulty in doing so, however, and Mr. Rolaff was obliged to acquire the Hermansen patent.

11. The second difficulty, that of excessive end pressure, was overcome by floating plates at the ends of the cylinder held in intimate contact with it and the rotor by pressure generated by the machine itself. The pressure upon the outer surface of the plates is greater than upon the inner surface by reason of the difference in the area exposed to this pressure. This supplemental pressure is always in direct proportion to the pressure generated by the machine, hence the additional friction is only what is necessary to keep the cylinder heads in close contact with the rotor and cylinder ends; and it is obvious that where the pressure is even slightly greater on the outside than on the inside there can be no leakage.

12. It will be seen that any motion imparted to the rotor shaft will immediately be communicated to the cylinder by reason of the metal-to-metal contact between the two. In other words, if the rotor is revolved the cylinder will revolve with it and the cylinder plates will float with the cylinder or piston or between the two as the case may be. The friction developed is merely the friction of the wiping contact between the rotor ends and the cylinder plates, since there is very little or no friction in the rolling contact between the rotor and the cylinder.

13. There still remained the question of packing square corners and of friction between the ends of the blades and the end plates. When the rotor is revolved the piston blades which fit loosely in the slot fly out by centrifugal force and remain in contact with the cylinder wall and the cylinder heads, since centrifugal force acting on a wedge keeps them in such contact.

14. It has already been stated that the cylinder revolves with the rotor. Since the piston blades also revolve with the rotor and at approximately the same speed as the cylinder, it follows that the piston blades create very little or no friction on the inner wall of the cylinder. This is also true of the cylinder heads, hence the friction at this point is negligible. At each revolution of the rotor the piston blades travel in the slot to the extreme limit of the crescent-shaped displacement space and back, and in such travel they rub back and forth against the cylinder heads. This is the principal point of friction. But calculating this friction on basis of speed in feet per minute, we find, for instance, that on a machine capable of compressing 100 cu. ft. of free air per min. the piston-blade travel is approximately ⅝ in., and since a machine of this type would run at about 900 r.p.m., we have the following calculation: ⅝ in. × 2 × 900, which gives 93 ft., and since the surface in contact with the cylinder heads is very small, the total amount of friction generated by this reciprocating action of the piston blade is proportionately small:

15. These blades as developed are of two types, centrifugal and pressure. At present the centrifugal type shown in Fig. 1 is used commercially. This blade consists of four parts, one of which, A, might be termed a blade in itself. Part of this is cut away as shown, and on it are imposed three thin blades, B and C, of any desired metal. It will be noted that the two outside pieces B are beveled and that the centre piece C fits between these, forming a wedge, and that the top of C is cut away to allow of movement vertically. Revolving at speed the centre piece C is thrown out by centrifugal action, the force exerted on each piece B being in the direction of the arrow. This presses the B pieces against the sides and ends of the cylinder. These blades are self-aligning and self-adjusting, also self-compensating. The force with which these blades B strike against the corners is regulated

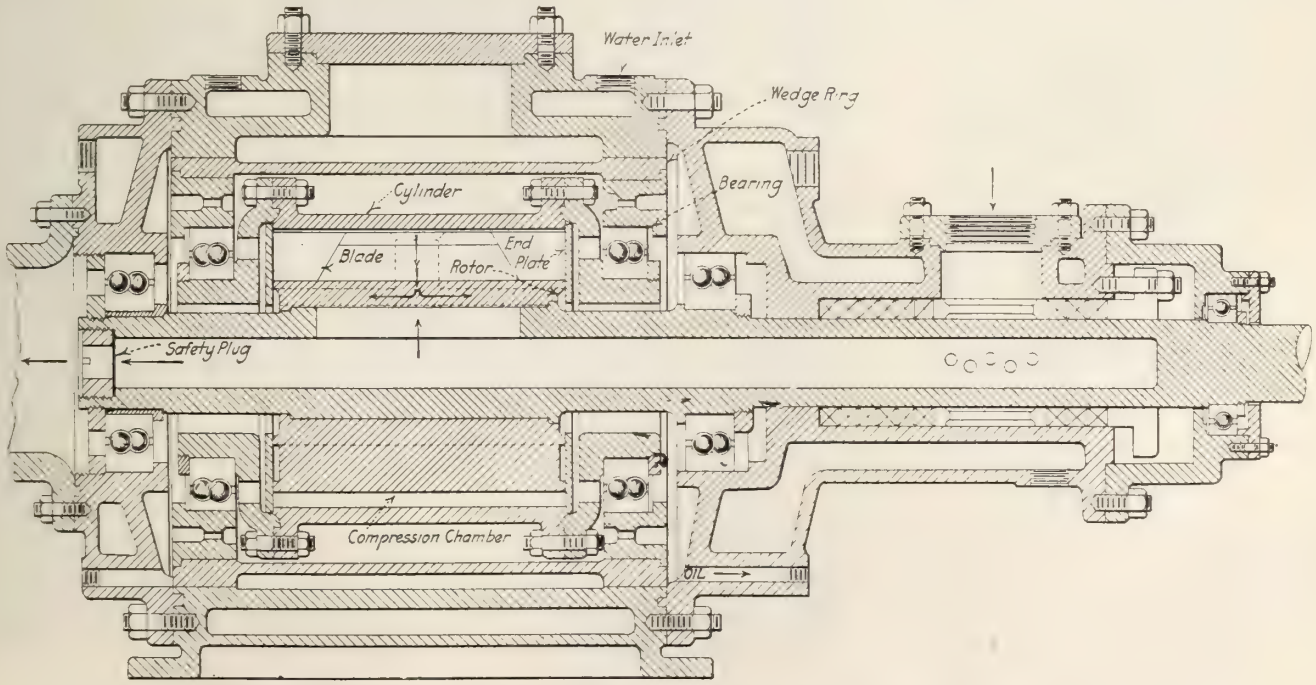


FIG. 3—CROSS-SECTION ASSEMBLY OF 20-TON REFRIGERATION MACHINE SHOWN IN FIG. 2.

by the angle of their inner sides and the weight of the centre piece. There are no springs whatever and the blade is balanced for back pressure by having both sides exposed to chamber pressure with a seat at the top of the slot in back, and as oil from the cylinder wall is scraped off by the blade into the slot, an effective seal is maintained. The blade A is about 1-32 in. short on each end and makes contact with the cylinder wall except at the extreme corner and side. The discharge valve is immediately in front of this blade. Fig. 2 is reproduced from a photograph of a 20-ton rotary refrigerating machine of the type under consideration, a cross-section assembly of which is shown in Fig. 3.

16. One of the greatest advantages of the compressor is that it may be direct-connected. It can be run at any speed at which a prime mover can be run safely. A 100-ton refrigerating machine is run at 600 r.p.m., a 1-ton or 5-cu.-ft. size at 1800 r.p.m. The first thought of a mechanical engineer at this statement is that the piston speed is entirely toto high for efficiency. Let us take from a catalogue the data on a reciprocating compressor of 14 in. stroke and having 100 cu. ft. capacity at 200 r.p.m. The piston speed would be 466 ft. per min., or over 200 per cent. in excess of a rotary compressor of the same capacity run at 900 r.p.m., with a relative speed of 150 ft. per min. between the rotor and cylinder. The next advantage is in its space requirements. A 100-ton rotary compressor on its base with its prime mover requires only 60 sq. ft. of floor space, whereas a horizontal reciprocating unit of the same capacity requires approximately 1200 sq. ft. plus a building, plus a boiler room, and weighs 100 lb. per ton capacity as against approximately 8 lb. for the rotary. It is usually possible to replace any pump or compressor with a machine weighing less than the flywheel of the displaced unit. With engineers the prime consideration is always efficiency. With the high-pressure rotary compressor, as before stated, the volumetric efficiency at 100 lb. pressure is 90 to 92 per cent., depending on size, as against 65 to 85 per cent. with the reciprocating machine. A number of engineers who tested one of these machines were nonplussed by finding that at no discharge pressure it had a volumetric efficiency of 107 per cent. Never having encountered this phenomenon before they were at a loss to know whether the capacity as given by the company, the instruments furnished by it, or their own instruments or arithmetic was wrong, and for seevral days they did not give out any conclusions. The manufacturer was of course familiar with it and suspected what their troubles were as such action is not uncommon in uniflow machines, but the best information obtainable is to the effect that the greatest volumetric efficiency found is usually about 102 or 103 per cent.

17. It has been stated that these compressors without adjustment or alteration would pump gas, air or liquid, or all three. Those who have had experience with refrigerating machines know that when ammonia condenses in the refrigerating coils and a "slug," as it is called, happens to get into the compressor, usually a valve or a cylinder head is blown off. One of the tests of the rotary compressor, for the benefit of visitors, is the pouring of a 5-gal. tank of oil into a compressor running at full speed under load, as fast as the inlet pipe will take it. The secret of its ability to take care of this is simple. Since the end plates are held to the cylinder only by differential pressure, if when the oil enters the cylinder and cannot be discharged fast enough by the valves, the end plates open up, allow the oil to pass out and then close. It is obvious that when pumping fluid continuously the pressures inside and out would again be different and be relatively maintained, so that no leakage would occur. In other words, the loose end plates act as safety valves without effort, as any necessary area of exit is secured and the oil leaves the cylinder at just sufficient pressure to raise the end plates. This feature is valuable in pumping hot water, or gas and oil.

18. Another feature of this construction which as yet has not been dealt with is the possibility of making the compressor double-acting by placing two blades 180 deg. apart, which would add from 60 to 70 per cent to the capacity of the machine. Until recently, however, no effort has been made to do this as it requires an intake valve, which is troublesome. In the simple type no intake valve is used, the seal between the rotor and cylinder acting as such. The major trouble with all air compressors, reciprocating or otherwise, lies in the valves, and the same trouble was found initially in the rotary compressor. It was aggravated somewhat in the rotary by the fact that cracking or splitting of the valve in its cage was not immediately perceptible, and it was possible for a valve to gradually break up into fine pieces and get into the cylinder. Experiments were undertaken to find a suitable material, and this has been done for cases where the temperatures do not exceed 200 deg. Fahr. In the 100-ton size the discharge valve is about 24 in. long by ½ in. wide, so it will be seen that the problem differs from that of the reciprocating machine.

19. The next and most important things to consider are the commercial uses of the rotary compressor. Broadly speaking, it may be said that these embrace every one possible to a compressor of the reciprocating type and some that are not. It is possible to get 500 lb. pressure single-stage; to get 1,,000 lb. pressure in three stages with the three units on the same shaft; to make it a low-pressure machine, giving it any desired capacity by making the rotor relatively small, and to give even more than 1,000 lb. pressure single-stage by reducing the displacement. As a vacuum pump it will pull 28½ in. against a pressure of 180 lb., but to do this continuously with a compressor it is necessary to shut off the oil pipe, and for commercial practice it would be necessary to have a self-contained oiling system. These high single-stage pressures and vacua are of course interesting only as illustrating the possibilities of the rotary compressor as compared with the reciprocating type. It is of course not desirable to compress to 500 lb. without intercooling unless we wish to use the compressor as a Diesel engine, and to pump 28½ in. vacuum against 180 lb. pressure is unnecessary and merely demonstrates the excellence of the machine.

20. The firm handling the rotary compressor in question has already been asked to consider the making of blowing engines for blast furnaces, as compressors of the rotary type do not take up more than 5 per cent. of the room now necessary. These rotary compressors are in use at the present time as boosters on refrigerating units for both high and low pressures. One of the large packers has four. The small household refrigerating business has not grown because it has been found impossible to secure a dependable compressor. One manufacturer is at present building units using this rotary compressor. It is a 0.5-cu.-ft. size, runs at 1760 r.p.m., is direct-connected, and is perceptibly noiseless (practically noiseless means nothing, absolutely noiseless means too much, so "perceptibly" is used advisedly), as are all other sizes of this compressor. The rotor in this size is 1⅞ in. in diameter and 1 in. long. Another manufacturer is making the 3-ton refrigerating size. Still another has a contract on which is guaranteed a minimum of 10,000 cu. ft. per year for street car compressors. Its use for this purpose should be extensive, as no satisfactory reciprocating pump has ever been designed. Another use is as a small individual unit for refrigerating cars, run either from the axle direct or with a motor from a turbine in the engine. Upon arrival at terminals, instead of the expense and waste of icing, it will only be necessary to plug in. Dining cars are still another use to which, among a multitude of others, it may be put. Imagine a cooled Pullman compartment on a hot, dusty day!

21. Used as an air compressor the rotary compressor is ideal, as the air is taken off at the centre and the oil thrown out centrifugally to the periphery.

22. No rotary pump is at present made that will prime itself, but this is not true of the compressor when used as a pump. Further, so far as the writer is aware, no reciprocating pump manufactured handles CO_2 successfully for any length of time. Those that do so at all are usually packed with leather, which wears rapidly. Because of the high efficiency and the character of its cylinder construction there would seem to be little doubt of the rotary's ability to handle CO_2 continuously without repairs. This, however, is in the future, which also applies to hydraulic applications.

23. The compressor may be built either vertical or horizontal and in the small sizes up to 5 cu. ft. it is air-cooled. Between this and the 15-cu.-ft. size it is partly water-cooled. In the 20-cu.-ft. size and above it is completely jacketed.

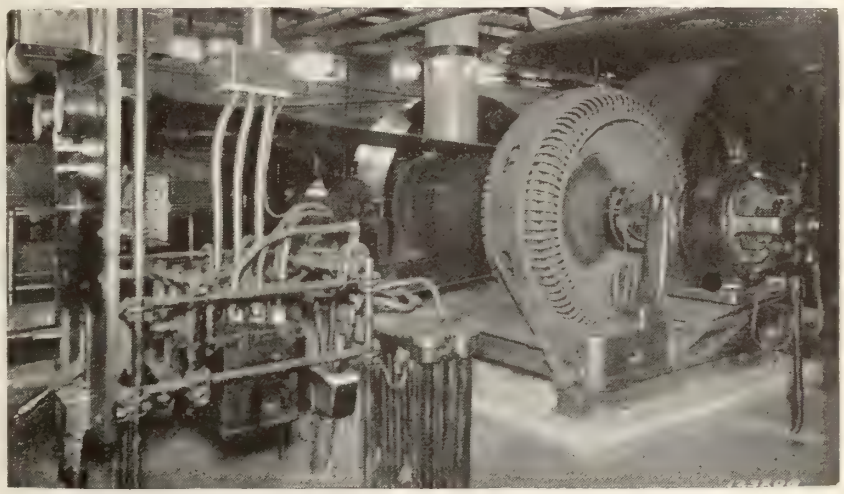
The Synchronous Motor and Refrigeration

Despite the Apparent Advantages of the Induction Motor for Many Uses the Synchronous Machine is Rapidly Ousting Its Rival in Many Fields—Its Use in the Refrigeration Plant is Here Described

By WILLIAM H. EASTON

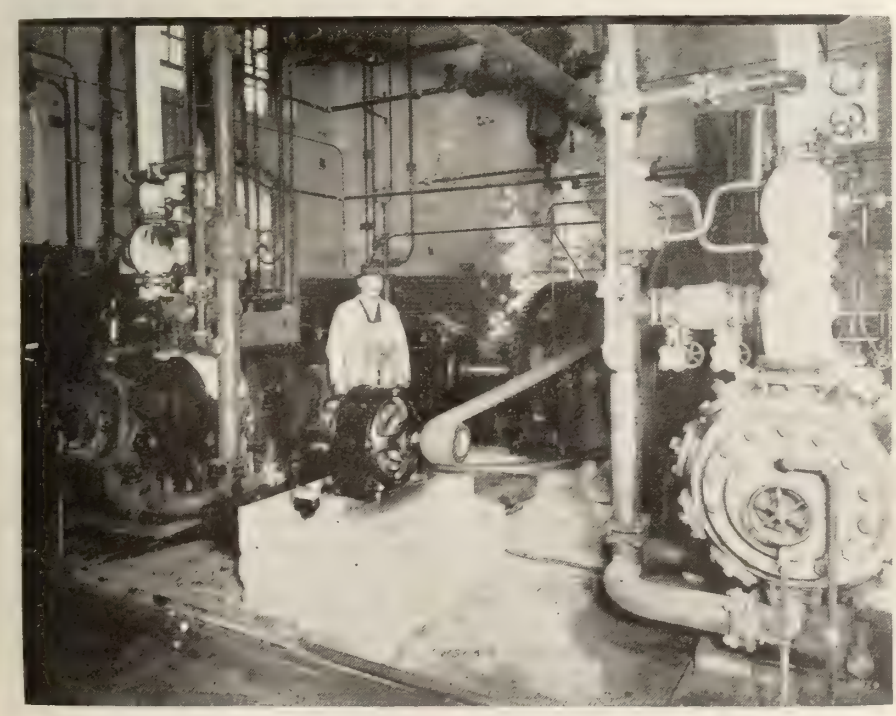
It is difficult to discuss the subject of power factor in a few words, but briefly, low power factor means a loss of power. When the power factor of a circuit is 80 per cent., only about 80 per cent. of the current flowing through it is available for producing power; the remainder circulates idly, requiring coal to produce it and copper to carry it, but unable to do useful work. Hence with an 80 per cent. power factor, the generator, transmission lines, transformers, and other apparatus must be 25 per cent. larger than would be necessary to handle the same amount of power at a power factor of 100 per cent. Other disadvantages, such as poorer voltage regulation, are also caused by low power factor. H. P. Under the best of circumstances the power factor of an induction motor is not much over 90 per cent., while for very low speed machines, such as would be necessary for direct connection to refrigerating compressors, the power factor is even lower. The synchronous motor, however, not only operates at 100 per cent. power factor itself, but also can be arranged so as to connect the lowering of the power factor by induction motors operating on the same circuit.

The use of the synchronous motor by an industrial plant is therefore advantageous because it provides current of the most desirable characteristics and permits the use of smaller transformers and other apparatus. To the central station the maintenance of high power everywhere on its lines is of great importance, because the idle currents that appear with low power factor are a source of expense but create no revenue. Hence central stations encourage the use of synchronous motors wherever they can be properly used.



500 H.P. SYNCHRONOUS MOTOR, 440 VOLT, 60 CYCLE, 350 REV. PER MIN., BELTED TO REFRIGERATING EQUIPMENT.

On account of its limitations of more complex construction, higher first cost, low starting torque, and unchangeable speed, the synchronous motor can not be used for a large variety of applications, but compressor drive is work that is well suited to it. Starting under full load is avoided by by-passing the compressor until full speed is attained and then throwing on the load. Reduced capacity in cold weather is obtained by driving two compressors by each motor, as in the installation illustrated, and using both in summer and only one in winter, instead of reducing the speed of the outfit. The more complicated construction of the synchronous motor is not an actual drawback, since the modern synchronous motor is quite as reliable, as easily operated and as readily repaired as the induction motor. Though its first cost is somewhat higher than that of an induction motor of the same capacity, the synchronous motor is somewhat more efficient and will save the difference in price in a short time by lowering the power bills.



Two 15 x 15 Vilta Compressors driven by a 350 H.P. direct connected synchronous motor: belted 13 1-2 k.w., 125 volt exciter.

Hence the synchronous motor is in every respect as satisfactory as the induction motor for driving refrigerating compressors. while its ability to maintain a 100 per cent. power factor makes it superior. So generally has this fact become recognized, that as a matter of fact, electrical manufacturers do not supply induction motors in the proper sizes and speeds for direct connection to refrigerating machines but offer synchronous motors only.

The Switchboard

The switchboard for controlling the equipment shown in Fig. No. 1 is simple, each of the three left hand panels controls a single motor-driven unit and carries the following equipment; a power factor meter and an ammeter; a motor field-switch; a motor-field rheostat and at the bottom, a starting switch for the motor which is so arranged that the motor can not be started

Continued on page 197

Boiler-Feed Water and the Formation of Scale

The Following Article, Reprinted Through the Courtesy of "Ice and Refrigeration," Was Delivered in the Form of an Address Before the Annual Convention of the National Association of Practical Refrigerating Engineers in Kansas City, Mo.

By W. A. CONVERSE

THE subject of boiler feed water is not as simple as the name might imply. Water itself, as obtained from its natural sources, is much more complicated in its character and action than many persons realize, more particularly those who have not had an opportunity of noting its action, both from a technical and a practical point of view. To thoroughly consider and understand any particular subject, it is necessary to have a general idea of the fundamentals underlying it; hence, if we are to consider the subject, "Boiler Feed Water," we must have at least some knowledge of what water really is, where it obtains its impurities, what they consist of, and in a general way, their influence as a part of the impurities contained in the water itself.

Water, to the technical man, is water in an absolutely pure state, devoid of all foreign substances, either gaseous, liquid or solid. Chemically, water is made up of two gases: Hydrogen and oxygen.

Hydrogen gas when pure is odorless, colorless, tasteless and non-poisonous. It has, however, the property of inflammability. If we should pass hydrogen gas through an ordinary gas jet and light it, it would burn in the same manner as does illuminating gas.

Oxygen gas has the identical properties of hydrogen, with one exception, i.e., it is entirely devoid of the property of inflammability. It will not burn, but it is absolutely essential to all processes of combustion. If it were not for this fact and the fact that a large part of the atmosphere which you allow to pass into the furnaces under your boilers, is made up of oxygen, you would not be able to obtain any efficiency therefrom, because there would be absolutely no combustion of the fuel.

If we should mix two quarts of hydrogen gas and one quart of oxygen gas, we would have a mechanical mixture of the two, in the proper relative amounts necessary to form water, if chemically combined. Thus far we have but a mechanical mixture and not a chemical combination of the two gases. Now, if we should produce an electric spark in the mixture, the gases would immediately enter into chemical combination and we would have formed a few drops of water.

Surface Water

For our purpose at this time we may assume that water has its origin at the surfaces of the seas, rivers, lakes, and last, but not least, from the surface of the earth itself. The action of the sun's rays upon these surfaces causes the evaporation of more or less of the water, which rises in an invisible form known to us all as humidity. Eventually it assumes the form of clouds, in which condition it becomes visible. The water composing the clouds may be considered as being in a pure condition because of the fact that it has passed through a natural process of distillation. The water exists in clouds in a very finely divided condition, i.e., divided into very minute particles which are so small that they remain suspended in the air. Due to atmospheric temperature changes, electrolytic disturbances, or both, these extremely minute particles combine, one with another, and form larger particles which readily fall to the surface of the earth. Water falls to the earth in several different forms, as rain, snow, frost, dew, etc. However, we shall consider it only as falling in the form of rain.

Immediately following the beginning of the fall of water from the clouds in the form of rain, contamination begins. Air is a mixture of gaseous elements present small amounts of carbonic acid, element retaining its own characteristic properties. Aside from the two principal gases composing the atmosphere, viz., oxygen and nitrogen, there are also presetn small amounts of carbonic acid, nitric acid, and ammonia; and, in localities where bituminous coal is the chief fuel, and particularly where this fuel is heavily impregnated with sulphur, the sulphur, in the process of combustion, is converted into sulphur gases which impregnate the air and, along with other constituent gases, are taken up by the water—the sulphur gases eventually becoming converted into sulphuric acid.

Earth Substances Taken Up

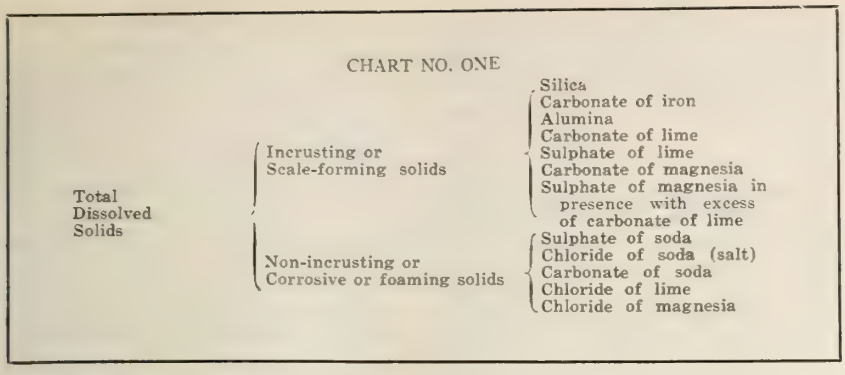
Assuming, now that the water has passed down through the atmosphere and has reached the immediate surface of the earth, it has taken up some carbon dioxide (CO.), some ammonia undoubtedly, some sulphur gases, and probably some oxygen (since the air is made up, to the extent of twenty per cent. of this gas)—all of these gases being in solution in the water itself.

What happens at the immediate surface of the earth? That depends upon the litter or refuse which covers the surface of the earth upon which the water falls. If the surface is strewn with decaying or rotting vegetable matter, such as timber, leaves, twigs, etc., it takes upon another portion of carbon dioxide (CO_2) because the process of rotting of timber for instance, is nothing more or less than a slow process of combustion, identical in character in every chemical respect with that which takes place underneath your boilers; that is, a combining of the oxygen of the atmosphere with the carbon of the fuel which you are burning, or the carbon forming the greater part of the vegetable matter which is in process of decay. The only reason you do not notice heat or light in the case of the decaying of vegetable matter is because the rate at which the oxygen of the atmosphere combines with the carbon of the decaying timber is not sufficiently rapidly. If the combination in the process of decay were going on as rapidly as it is in your furnace, you would perceive temperament and light as well. If the water falls upon a surface strewn with animal matter like we have in the stockyards district in Chicago, where there is more or less animal matter which is converted into ammonia compounds, it takes up more ammonia at this point. Then, again, animal fats like tallow and lard, are made up in part of fatty acids, and these fatty acids are rather soluble in water, and are readily taken up in moderate quantities by water coming in contact with them, and are extremely destructive to metallic surfaces. These are only a few of the substances that are commonly taken up just at the surface of the earth.

And having reached the surface of the earth, the water either permeates the earth itself or travels through channels such as river beds, etc., to the sea. In either case the water coming in contact with the various substances composing the earth dissolves or takes up varying quantities of these substances. In other words, where the strata with which it comes in contact is largely composed of limestone (native carbonate of lime), carbonate of lime will predominate in the water; in case of gypsum (native sulphate of lime), sulphate of lime will predominate; and similar are the results with most all other solid substances contained in natural waters.

I have prepared and here present a chart which shows the substance usually found in natural waters. I am barring from consideration at present, suspended matter and some substances which may be considered later if time will permit. This chart shows all the substances which are found in practically all waters, those containing other substances being by far the exception:

CHART NO. ONE



You will notice that the substances on the chart are divided into two classes; incrusting or scale-forming solids, and non-incrusting or corrosive and foaming solids. This means that all those substances shown under the former classification can and do enter into scale-formation, these substances being the silica, carbonates of lime and magnesia, sulphate of lime, and sulphate of magnesia when present with an excess of carbonate of lime. Those coming under the latter classification, due to their extreme solubility, can not and do not enter into scale-formation; namely, sulphate of soda (Glauber's salts), chloride of soda (common salt), and carbonate of soda (soda ash). On the other hand however, when present in a water in relatively large quantities, they do give rise to foaming, corrosion and many other types of troubles.

Since the carbonate of lime and the carbonate of magnesia (more particularly the former) are readily, largely precipitated or thrown out of solution at a temperature of 212 degrees fahr. or less, you can understand why you have an accumulation of a soft carbonate of lime scale in your heaters, and frequently this extends into the feed lines and pumps, sufficiently, in many cases, to necessitate cleaning or putting in new feed lines, shutting down pumps to clean valves, etc. In no case does such a water enter the boilers sufficiently devoid of these substances to obviate the formation of scale.

Aside from the formation of some scale in the boilers, waters of the type under consideration give rise to the accumulation of much mud due to further precipitation of the carbonates of lime and magnesia in the boilers and the carrying mechanically, with the water, of a part of the substances previously precipitated in the heater. The carbonate composing the mud remain, for some time, in a very light and fine condition, in fact, so much so that much of the precipitated matter floats upon the surface of the water in the boiler while in action. Due to the bursting of the steam bubbles at the surface of the water, the steam space becomes thoroughly permeated with the particles, which are, in turn, carried over, mechanically, with the steam; and, in cases of reciprocating engines, the mud becomes mixed with the cylinder oil on the inner surfaces of the cylinders, which (due to continued rubbing together), assumes the condition of putty. In the case of turbine engines, this results in the formation of a deposit upon the surfaces of the vanes of the turbine, necessitating closing down the turbine for cleaning, which means delay and expense.

Previously, we have been considering the action of a water wherein na part of the scale-forming substances consisted of sulphate of lime. If, now, this same water contained a quantity of sulphate of lime equivalent to 25 per cent. of the total incrusting solids, the results in the boiler would be entirely different. The temperature to which the water is heated in the boiler results in the precipation of the sulphate of lime, which means the accumulation of a greatly increased amount of scale of very much greater hardness and tenacity. The sulphate of lime, following its precipitation by mechanical action, causes the small particles of precipated carbonate of lime to settle rather than to remain on the surface of the water, thereby obviating the troubles heretofore cited in the cylinders of reprocating and turbine engines.

Passing, now, to the consideration of the second or the non-incrusting group as shown by chart: As previously cited, these substances, due to their extreme solubility in both hot or cold water, can not and never do enter into scale-formation, proper. On the other hand, they give rise to trouble in the form of foaming, corrosion, oozing out at and causing leaky joints, leaky gaskets, etc.

Assuming, now, that we have a water wherein the second group of substances constitutes 50 to 60 per cent. of the total solid matter—if the solid matter present amounts to 50 grains per U. S. gallon or more, and the water is being used in boilers worked appreciably beyond their rating, or boilers which are submitted to very uneven load at times, foaming would be the result, which would increase in intensity from hour to hour. In case of a water containing, say, 14 grains of total solids, of which 7 grains consisted of substances of the second group, foaming would not take place before the lapse of a greater length of time following the putting of the boilers back on the line after washing, but would eventually do so, as, in a short time, the water in the boiler would reach a saturation corresponding to that of a water which would foam at the outset. For example: A 500 h.p. boiler, being operated 24 hours per day, would evaporate approximately 45,000 gallons of water. Since 7 grain per gallon is equivalent to one pound per each thousand gallons, there would enter the boiler during each day's operation 45 pounds of these soluble salts. If, then, the boiler is kept on the line for 15 days, there would enter the boiler 675 pounds of said foaming salts—all being in solution in the water in the boiler, which would be more than sufficient to cause much foaming.

Acid Waters

While it is not general, it is not uncommon to find waters containing substances not mentioned on the chart, more particularly those containing free or uncombined acids—sulphuric acid being most commonly encountered. Sulphuric acid is generally found in surface waters in districts where mining or smelting is done on an extensive scale, as you know that, in such districts, there exists varying quantities of ore and waste materials, all of which contain rather large amounts of sulphur. The sulphur, due to action of moisture and atmosphere, becomes converted into sulphuric acid. The district in and about Pittsburgh, Pa., constitutes a very good example. I am informed that, some years since, a certain bureau of the Government estimated (following a careful survey) that there entered the streams of this district, approximately 600 tons of this acid daily. Since most metals, more particularly iron and steel, are soluble in moderately weak solutions of sulphuric acid, you can readily appreciate the rapid destructive effect of water containing it would have upon the interior surfaces of pumps, boilers, etc. The visible effect is that of very rapid corrosion of the surfaces with which it comes in contact. Furthermore, this acid is not volatile; consequently, all that enters the boiler with the feed water remains therein, increasing in quantity in the same manner as the foaming salts previously referred to, so that, even though the feed water contained but a small amount, the water in the boiler would be so heavily impregnated as to constitute a strong solution.

Water Treatment

The treatment of waters, generally, may be conveniently divided into two classes, known as external and internal—the former commonly known as "water softening."

The external class includes all methods of softening of the water before it enters the boilers, and has the effect of reducing only the amount of scale-forming substances, as all other ill effects of a water in a boiler are in no way eliminated or reduced, but, on the other hand, are increased.

The internal class consists of methods of treatment of the water in the boiler while in operation, usually by injection of the treatment into the feed water as it is going to the boiler.

Representative of the external class, the most important method is known as the Porter-Clark, or the lime and soda-ash method. This method was brought forth about 1850, at which time it was a long step forward as compared with what had previously been done. It was rather expected that, by the use of this method all boiler troubles would be solved, but, as a matter of fact, such was not the case, even so far as concerned the elimination of troubles confined to the action of scale-forming substance—while other effects or actions (ofttimes serious) were created.

Any water, even the softest possible to obtain, by the application of lime and soda-ash or caustic soda (per the outside method), still contains and carries into the boiler with it, approximately 4 grains of scale-forming solids per U. S. gallon—said 4 grains per gallon being equivalent to .571 lb. per 1,000 gallons. A 500 h.p. boiler operating 24 hours per day, would evaporate (in round figures) 45,000 gallons, which would result in carrying into the boiler 25.7 pounds of incrusting solids, which, in fifteen days' run between washouts, would amount to better than 385 pounds. It is true that all of these incrusting solids do not enter into formation, but a sufficient amount does, so as to demand further treatment in the boiler if the latter is to be kept free from scale. On the other hand, a considerable part of these incrusting solids are thrown out of solution in the boiler in such a finely divided and light condition that they float upon the surface of the water, and are thrown into the steam space, from where they are carried mechanically with the steam, later on giving rise to deposits of puttylike consistency in cylinders of reciprocating engines, and deposits on the vanes of turbine engines, frequently making it necessary to take the engines out of service, open and clean.

The use of the soda-ash (or other soda salt) in the outside treatment is for the purpose of removing from the water any sulphate of lime contained therein. It does this perfectly, if used in proper quantity and if sufficient time is allowed for the necessary reactions to take place. Since, however (due to these reactions) there is left in the softened water a quantity of sulphate of soda corresponding to the amount of sulphate of lime removed, and the sulphate of soda gives rise to tendency to foaming in any case, and to actual and serious foaming in many cases, the tendencies of carrying over of mud from the boiler are very much increased.

Experience has brought the speaker to the conclusion that, where a water is a sufficiently hard, scale-forming one to justify the purchase and installation of a plant for the application of this method in at least seventy-five per cent. of the cases, other troubles such as foaming, corrosion, oozing out at the joints, destruction of gaskets, etc., are created to such an extent as to make it necessary to further treat the softened water with a suitable preparation to be applied by injection into the boiler with the feed water.

The next in prominence and much more recent method for outside softening of water, is one known as the "Permutit" method. It consists of passing the water through an artificial zeolite to which the name "Permutit" was given by the discoverer, Dr. Gans, of Berlin. Without going into detail as to the chemical composition of Permutit contained in a specially devised apparatus, the hardness of the water is reduced to nil. Since, however, the hardness of water is due exclusively to the scale-forming salts, such a reduction of hardness indicates only the removal of same, but indicates in no way what else has happened. The facts are, that, while the scale-forming salts have been practically eliminated, the softened water, in practically all cases, contains a decidedly increased amount of solid matter. It must then follow, of necessity, that since the scale-forming salts have been removed, they must have been more than replaced with other substances—which is the case.

Usually, the replacement substance is principally carbonate of soda (soda ash); in fact, most waters treated by this method, contain such quantities of carbonate of soda as to prove more objectionable, so far as foaming and similar troubles are concerned, than waters softened by the lime and soda-ash method. Pre-treatment of the water with lime has been resorted to, in some cases, for the prevention of the great accumulation of carbonate of soda in a water after being permuted. Again, however, it seems generally necessary to follow this method of softening with the use of a suitable internal treatment, either to overcome foaming or to prevent corrosion due to the use of too pure water.

Along with the consideration of methods of apparent merit, such persons as have been specializing in certain lines frequently come in contact with proposed methods for accomplishing certain results, which are amusing in the extreme. At this time, one of such methods comes to mind, and I feel that it might prove of interest to you for its peculiarities. The apparatus consisted of sets of corrugated aluminum plates about twelve inches wide and of various lengths, placed at an angle of eighty degrees under a V-shape trough, the latter being perforated at the bottom in such a manner as to cause the water passing from the trough to do so in small streams, each stream falling into the depressed portion of the corrugated plates; then running down over the aluminum plate to storage tank below. No chemicals were to be used, but, in order that the desired results can be obtained, the apparatus must be set so that the plates should face precisely north or south in order that objectionable substances contained in the water would be exposed to the action of galvanic, electric, or some other imaginary currents passing between the north and south poles of the earth.

I feel that it might be interesting for you to know that, despite the mysteriousness of the method, and despite the fact that samples of water of various qualities were taken before passing and after passing through the softened, and were analyzed with absolutely no change being detected—some of our largest water users (most of whom, by the way, were maintaining laboratories in charge of competent chemists) were prevailed upon by smooth-tongued salesmen to install the apparatus. Of course, the matter was not submitted to their chemists for an opinion.

Internal Treatment

As you would naturally infer, the internal method of treatment would consist of the treatment of the water after it enters the boiler, and if satisfactory results are to be expected, the treatment constitutes the use of chemical or chemicals in the form of so-called boiler compounds. It has been shown that waters, even after having been submitted to some outside water-softening method, demand the further use of a suitable compound for the purpose of finishing the job, or, in other words to do what the softening process could not do, i.e., to overcome trouble in the form of foaming, corrosion, etc., due to the new condition of the water itself, brought about due to the method of softening.

This being true, it seems that most waters can be more economically and more successfully treated by the internal method. There are, however, cases where it is advisable to resort to the use of a combination of the two methods, i.e., where a water is so hard a scale-forming one as to make it an impossibility for internal treatment to first remove, at least, the greater part of the scale-forming substances by outside softening, this is to be followed with the use of a suitable preparation to bring about satisfactory conditions. Just at this time, I desire to impress upon you the fact that the outside methods bring about absolutely no improvement in a water other than reduction of the quantities of scale-producing substances, and such improvement is, as previously cited, generally counterbalanced by induced and increased tendencies to foaming, etc.

Since the successful internal treatment of the water is necessarily a chemical one, and different substances are necessary to react chemically the various substances contained in the feed water, it necessarily follows that, in order to insure results, an analysis of the water must be at hand, and from this the selection made of such chemicals as will react with each of the substances contained in the water, and the various amounts necessary to incorporate in the treatment or compound determined, and from these results the treatment built up.

Again, in view of the fact that the deleterious effects of a boiler water are, at least, equally dependent upon the relative amounts of the substances present as to the total quantity, the absolute

necessity of an analysis of the water to be treated becomes apparent.

The speaker has known of many cases where a compound was furnished with a guarantee on the part of the seller, which consisted to the extent of 85 per cent. of the particular substances present in the feed water which was directly responsible for the action which was to be overcome. Such sale and guarantee would, undoubtedly, not have been made if the seller had had an analysis of the water, especially had the seller desired to actually overcome the trouble.

From the foregoing, I feel that you can readily appreciate that an analysis of the feed water to be treated must be the first step to be taken, this accompanied with a thorough knowledge of the conditions governing the boilers in operation, followed with the construction of formula and, finally, the putting together of a correct and suitable, scientific treatment—will insure the best possible and most economic results.

Time is not at hand to permit of entering, to any great extent, into a discussion of this phase of the subject, but the matter of corrosion in steam boilers to-day is demanding more consideration than ever before. I believe that I am fairly correct in saying that 50 per cent. of the demand for treatment, for use more particularly in stationary boilers, is either wholly or in part for the prevention of corrosion.

Three principal theories have been advanced in the past, covering the subject of corrosion, viz., the carbonic theory, the peroxide theory, and the electrolytic theory. Since the advancement of the electrolytic theory, which has been generally accepted as the most rational one, the other two have been cast aside.

No doubt many of you at least have had the opportunity to look over a chemist's report covering a sample of iron or steel; in case you have you must have noticed that he did not state the amount of iron it contained, but he did tell you that it contained carbon, silicon, manganese, sulphur, phosphorous, etc. Each and every one of the substances, as they exist in the metal of the sheets or tubes, are chemically combined with a certain amount of the pure metallic iron or other metals, forming new substances characteristic of themselves, which are very different from the pure or uncombined iron itself. The balance of the metal is made up of uncombined iron commonly known as uniform composition, and knowing that practically no two different substances are soluble to the same extent, we can assume that the compounds of iron which were the most soluble in the water in contact with their surface would first of all dissolve to the greatest extent, which would result in the corrosion showing in the form of pitting rather than taking place to a uniform extent over the entire surface.

Aside from corrosion due to the presence in the feed water of actual corrosive substances, or those which contract the properties necessary to such an effect, due to hydrolization or decomposition thereof, we have another and equally objectionable condition possible—that due to electrolysis or galvanic action.

Science tells us that every substance in existence is either electro-negative or electro-positive to every other substance. We also know that it is not uncommon in boiler practice to have present a noticeable galvanic current, which, if this theory is correct, must result in corrosion. There are three essentials to a galvanic cell, namely an electro-positive, an electro-negative substance, or pole, and an electrolyte or carrier. We frequently have them even in a small area of sheet or flue, the necessary different substances to act as the two poles and the presence of a layer of water over the surface will act as the carrier. Therefore, we have the necessary elements of corrosion. If the water carries more or less common salt, or some other substances, the current-carrying capacity of the water is enhanced and the tendency to corrosion relatively increased.

You must not overlook the fact that practically all steam boilers in service are directly connected with or have attached to them various valves and fittings, and at times other metallic accessories, to say nothing of the difference in the character of many flues or tubes, or the flues or tubes and shell, or both, all of which tends to corrosion in some form.

You may have either wrought iron or steel flues or tubes in your boiler, which are absolutely of as good quality as possible to obtain, but at the same time, sufficiently different in their composition or homogeneity or both, to furnish a possible condition resulting in corrosion.

Since, as previously stated, there are three essentials to an electrolytic action, it stands to reason that if we can eliminate one of these the trouble will be overcome. It is not possible for us to prevent two substances acting in the capacity of the two poles of a battery, under favorable conditions, but it is possible to so change the water being used as a feed supply as to destroy its ability to act as an electrolyte, and thereby prevent corrosion.

In conclusion, I desire to say that, in my opinion, no boiler feed water problem is so small or so unimportant as to not demand an analysis of the water, and a careful study of the conditions governing the operation of the boilers—which should furnish definite information of the actual cause of the trouble. This, followed by a careful study of the various methods of treatment and the final results to be obtained should result in the best possible conditions. Since certain companies are including in their service to customers and prospective customers, the gratuitous analysis of waters, and assume an unbiased position, I feel that there is no excuse for those experiencing trouble in their boiler plant, who do not take advantage of such service. I thank you.

Members manifested a great interest in the paper by Mr. Converse, and there was an extended discussion on various points. Mr. Register raised the question as to how a plant operator is to regulate the treatment of his water when the condition of this water may vary almost from day to day. In reply, Mr. Converse stated that while it is true the actual amount of impurities in the water may vary considerably from time to time, a water supply from a given source will, as a rule, contain the same materials at all times. In the case of dry weather there will be less of these constituents in the water and when a flood comes along, the quantity will be increased. Thus it is merely a question of properly increasing or decreasing the amount of material used in treating the water, so that it will correspond to the impurities contained. Of course, the ideal way is to take samples from time to time, and have them analyzed so as to determine about what the amount of change may be.

A member asked the question as to the benefit to be derived from using graphite in the boilers, and Mr. Converse stated that graphite is the most negative substance, electrolytically speaking, that can be used in a boiler. Zinc is the most positive and carbon the most negative; and as graphite is practically pure carbon, when it is placed in contact with iron there is a great difference of electric potential, so that as soon as there is enough moisture impregnating the material along with other substances, which cause it to act as an electrode, there is a galvanic cell action which sets up a current instead of preventing the electric current. From this it would seem that zinc, which is the most positive material, electrolytically speaking, would be an ideal substance to prevent corrosion in boilers. Theoretically, the speaker stated, this is true, but as a matter of actual practice, there are numerous difficulties in using zinc for this purpose. Among these are the cost of zinc, the difficulty of keeping it in proper position, and a proper distance from the metal parts of the boiler, and the fact that as soon as corrosion begins, the zinc goes to pieces and altogether it is found impractical to maintain the zinc plates in proper condition and position to perform the necessary work. In marine work, especially, and in many parts of the country for stationary practice, zinc plates have been tried, but so far with little practical success, although more has been done in marine practice than elsewhere towards adopting this method of preventing corrosion.

As to the matter of using some material to put a coating on the inside of boilers in order to prevent scale adhering, Mr. Converse thought this impractical, as he felt that it is not possible, either chemically or mechanically, to so prepare the internal surface of a boiler that scale will not adhere.

Index for 1919

The index for Power House Vol. XII, 1919, is now ready and may be had by applying to the publishers, University Ave., Toronto.

The MacLean Publishing Company

LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - President
H. T. HUNTER - - - - - - - President
H. V. TYRRELL - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

W. F. SUTHERLAND, Editor. A. R. KENNEDY, Managing Editor.
Associate Editors: J. H. RODGERS (Montreal). T. H. FENNER
B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

CANADA—
Toronto—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—Roy A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W.
Eastern Representative—G. E. Pearson.
Ontario Representative—S. S. Moore.
Toronto and Hamilton Representative—C. H. Broad.

UNITED STATES—
New York—A. R. Lowe, 1133 Broadway, New York, Telephone 8971 Rector
Chicago—A. H. Byrne, 1401 Lytton Bldg., 14 E. Jackson Street, 'Phone Harrison 9133
Boston—C. L. Morton, Room 734 Old South Bldg., Telephone Main 1024

GREAT BRITAIN—
London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new address.

Office of Publication, 143-153 University Avenue, Toronto, Ontario.

Vol. XIII TORONTO, APRIL 20, 1920 No. 8

PRINCIPAL CONTENTS

Power Plant Equipment of a Modern Dairy 175
Explosions in Ammonia Refrigeration 178
The Absorption System of Refrigeration 179
The Indication of the Ammonia Compressor 182
A High Pressure Rotary Compressor 184
The Synchronous Motor and Refrigeration 187
Boiler Feed Water and the Formation of Scale 188
Editorial 192
New Equipment 194
Operators' Point of View 195
Selected Market Quotations 198

An Accident Hazard

AMMONIA, while deadly enough in itself if let loose in the refrigeration plant, is usually not looked upon as much of an explosive. By itself or mixed with air in varying proportions it is harmless, but when varying amounts of oil vapor, hydrogen, etc., are mixed with it as in a refrigeration system explosions have been known to occur. An article in the present issue points out a number of accident hazards in the refrigeration plant which are not likely to occur to the operating engineer and is well worthy of careful study.

Explosions can also take place in a compression system itself without the presence of ammonia. This was shown in testing out a compressor under 250 lbs. air pressure when the oil separator exploded with great violence. The explanation advanced was that the superheated air, forced from the compressor into the oil separator, found an explosive mixture with the oil vapor.

Explosive accidents to absorption systems are also quite possible, many of those which have occurred having been simply due to overpressure. There is also another cause for explosions in this type of plant; the dissociation of ammonia and the liberation of hydrogen is quite possible and the gases from the purge line being almost highly inflammable probably consist chiefly of this gas.

The author concludes with the statement—"that explosive accidents are so few in number is due not so much to the care with which the plants are operated as to the fact that fortunately all of the necessary conditions are only infrequently at hand. Finally it is most essential that strict watch is kept on the whole system from end to end in all details, as the failure of even an apparently unimportant part has been found sufficient to cause general havoc and even fatality."

Development of Our Water Power

THE utilization of water-power in Canada is advancing even more rapidly than heretofore. During 1919, the installation of plants with a total of 64,400 h.p. was completed in various portions of the Dominion; the developments at present under construction or in process of installation aggregate over 370,000 h.p. Other projects definitely contemplated for the near future will add 750,000 h.p.

Among the more notable developments are the 200,000 Chippawa plant of the Ontario Hydro-Electric Power Commission, now under construction, to utilize the full head of Niagara power, and the impetus given by the Quebec Government to the conservation of water by storage. Much activity is also to be noted in the Maritime Provinces.

This rapid progress, which represents industrial growth of the most valuable character, should be encouraged, yet most carefully guided. In the United States, electrical installations have doubled every five years while, in Canada, the present hydro-electric installation is about ten times that of 1900. The present hydraulic installation in the Dominion is nearly 2,400,000 h.p. If we assume for this country only one-half the rate of increase recorded for the United States, a total of 4,800,000 h.p. would be developed in 10 years, and 9,600,000 h.p. in 20 years, if available.—"Conservation."

Assassinating Arithmetic

THE Technical School is recognized to-day as one of the wisest provisions a country can make for the education of its youth, yet at times some seeker after notoriety, or perhaps some well-meaning, if misguided, enthusiast, recommends some radical change in the public school curricula which would have the effect of undoing the good of the technical school and leaving the majority of the rising generation without a proper foundation for earning their livelihood.

One such has recently made a statement to the effect that arithmetic should be, perhaps not altogether eliminated, but rendered quite innocuous so far as the public school pupil is concerned. He would eliminate complex fractions, recurring decimals, trains meeting and passing each other, boats going up and down stream, and true discount. While highly pleasing to the youth of the land, and while allowing time for more diverting and entertain-

ing subjects such as sculpture, music and the higher aesthetic attainments, any curtailment of the mathematical subjects mentioned could only be looked upon with apprehension.

Rather should arithmetic, and that other somewhat prosaic subject, grammar, be extended, and made to occupy more of the student's time in the public school. The true function of education is to prepare a man for his life's work and to enable him to profit by the experience or literary genius of others, and when the first of these is lost sight of it avails nothing that he be able to play the fiddle or enjoy himself otherwise if he is unable to earn his daily bread.

As a preliminary to a machine shop apprenticeship or a course of study in any one of the branches of the engineering profession, mathematics is essential, and the more knowledge of this nature a boy can assimilate in the public school, often his only chance, the better equipped he will be for his further training.

After all, the public school, high school and university are only the beginning of a man's real education, and the earlier he stops school attendance the more essential it is that he be given the most necessary and immediately useful knowledge.

Free Heat and Light Found by Hopeful Scientist?

HEAT, light and power free in every household would seem to be in the realm of possibilities, if the method described by H. H. Platt, a mechanical engineer of Philadelphia in an address before the American Association for the Advancement of Science, is practicable. Mr. Platt insisted that sufficient energy could be extracted from the air by his process to heat houses. He urged the scientists to aid in developing this new source of fuel "so as to relieve coal-oppressed humanity."

The device suggested to utilize the energy contained in sunlight consists of a very thin sheet of metal perforated with many small holes, which are prepared in such a way that air molecules, bearing energy, will pass through it more easily in one direction than in the other.

According to the accepted theory, the pressure which air exerts on a given surface is the sum of the impacts on it of rapidly moving molecules. If these molecules can pass through a sheet of metal more readily in one direction than in the other the result would be a slightly unequal pressure and the sheet of metal would tend to move toward the side of least pressure.

By mounting a number of such "partly irreversible permeable membranes" on a shaft like paddles on a mill-wheel, Platt asserted, a compact and powerful engine could be produced. The paddle-wheel would turn, generating power through its axis and at the same time removing heat energy from the air passing through its leaves—a feature that would make it adaptable for use as a refrigerating machine.

Mr. Platt depicted the householder of the future possessing a cheap machine which will furnish light, heat and power, and produce cold air for cooling the house in summer. The operating cost would be nothing.

We are unable just yet to accept the idea of fulfilment of Mr. Platt's programme in toto. As a matter of fact, it is a little difficult to follow the rapidity with which the various benefits to humanity would follow. It seems plain that if heat is transferred from one place to another, there will be a rise in temperature at the destination of the thermal units, with a corresponding drop at the point of withdrawal, providing the process should prove 100 per cent. efficient. Thus will the Philadelphia scientist obtain the advantage of refrigeration where it is needed, while supplying warmth so welcome to the oppressed rent-payer, at the same time, to say nothing of the light that the anti-daylight-savers deny us.

Someone has said that "rubbish is only matter out of place." Apparently this invention bids fair, in theory at least, to clean up a good deal of the uneconomical distribution of heat units in the world.—"Compressed Air."

Are You Wasting Coal or Conserving It?

WITHOUT accurate knowledge of how many pounds of steam you get per ton of coal consumed, you cannot know whether you are wasting coal or conserving it.

Here are a few questions which every manufacturer should be in a position to answer:

1. How many pounds of water per pound of coal are you evaporating?
2. Which of your boilers needs cleaning and repairing?
3. At what percentage of rating are your boilers most efficient?
4. Are you keeping your boilers at this point?
5. Of all the boilers in your plant, which have the greatest steaming capacity? (It is a well-known fact that all boilers, built in the same manner and apparently operated under similar conditions will not have the same steaming characteristics.)
6. What is the total amount of steam used in the engine room?
7. What is the amount used by each unit?
8. What is the total amount of steam used for manufacturing purposes?
9. What is the amount used by each department?
10. How much steam are you wasting?
11. How do you pro-rate your power charges to different departments.
12. Are your department heads satisfied with the method now used for charging them with steam?
13. Do you use the same method for electrical charges as you do for steam?

Courtesy Republic Flow Meters Co. of Canada, Ltd.

PASSING a hand over his forehead, the worried drill-sergeant paused for breath as he surveyed the knock-kneed recruit. Then he pointed a scornful finger. "No," he declared, "you're hopeless. You'll never make a soldier. Look at you now. The top 'alf of your legs is standin' to attention, an' the bottom 'alf is standin' at ease!"

The Vacant Chair

Progress in New Equipment

NEW TYPE OF PLUG VALVE

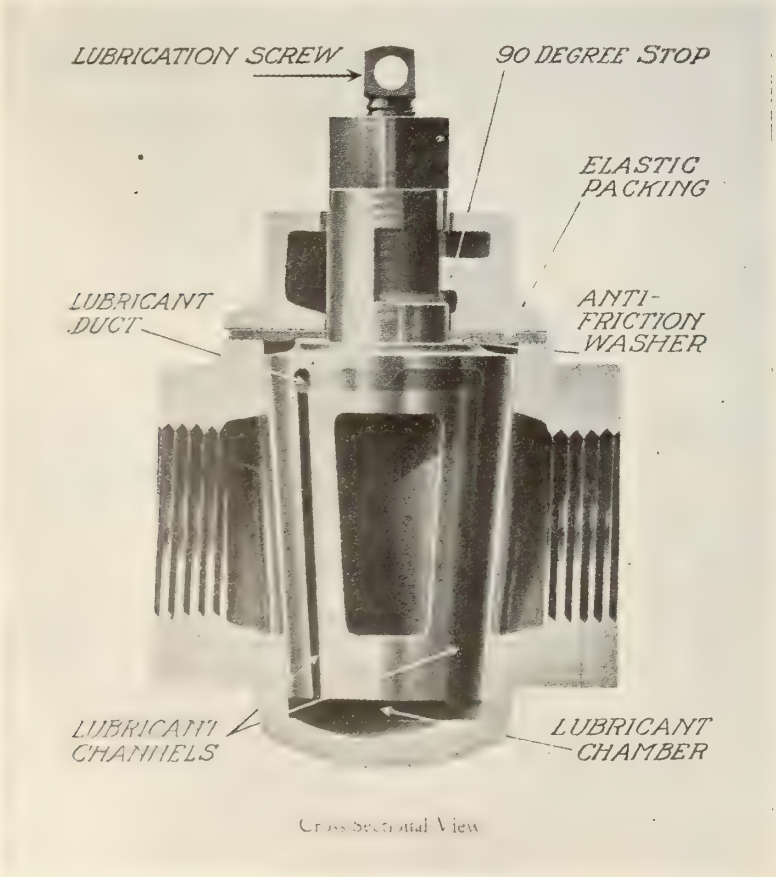
THE Nordstrom lubricated plug valve is the invention of Mr. S. J. Nordstrom, a mechanical engineer, at the time a resident in Mexico City and engaged in the design, construction and operation of cyanide plants. In the course of this work the obvious defects of standard plug cocks and gate valves for handling cyanide solutions and slimes were very evident, and to remedy these defects the valve now under discussion was devised.

The general construction and characteristics of this valve as made by the Merrill Metallurgical Company, 121 Second St., San Francisco, Cal., will be evident from a study of the accompanying illustrations. The basic principle of the Nordstrom patent is the combination in a plug valve of lubricant conduits and a lubricant chamber at the base of the plug so positioned that when pressure is applied to the lubrication screw, this pressure operates to lift the plug from its seat and simultaneously to distribute lubricant over the bearing surfaces. A flexible packing is provided between the body of the valve and the cover. This packing also rests upon an anti-friction washer forming the thrust bearing of the plug. This thrust bearing is grooved concentrically to prevent leakage. The flexible packing furnishes the necessary elasticity to allow the plug to be forced from its seat for the purposes of lubrication and to force the plug back into its seat when the pressure in the lubricant chamber is released. The location of the lubricating conduits and of the lubricant chamber are clearly shown in the illustration on page 6. A stop is cast as an integral part of the plug and cover and is so positioned that the lubricant conduits can never be exposed to the fluid passing through the valve.

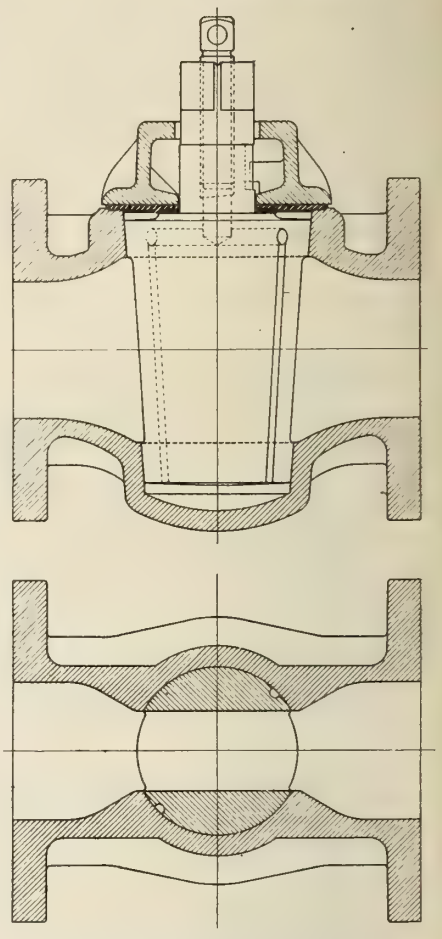
From the construction it will be evident that, no matter how firmly the plug may be stuck to the body of the valve, when force is applied to the lubricating screw, a pressure is created in the grease chamber at the base of the plug, and that this pressure must either raise the plug from its seat or else break the body of the valve.

Suitable lubricants are supplied in the form of convenient cartridges, which fit loosely into the lubricant conduit when the screw is removed. Several grades of lubricant are supplied to suit the special conditions under which the valves may be used.

Nordstrom plug valves are made with a parallel opening through the plug to minimize the friction of flow and to increase the life of the valve. As will be noted from the illustration, the flanged type of valve is constructed along lines which insure a high hydraulic efficiency and this type is recommended, particularly where such efficiency is an object.



DETAILS OF VALVE.



SECTIONAL PLAN AND ELEVATIONS OF VALVE SHOWING LARGE AREA AND STREAM FLOW LINES.

The Operators' Point of View

Re the Ontario Graded Certificate Act

Correspondence

HONI SOIT QUI MAL Y PENSE

The Editor: I seem to have raised a hornet's nest about my ears for reproving our friend Mr. Noble his undignified remark of a "Wop." I am sorry I have hurt his feelings and apologize, which leaves me a wiser man than formerly. May I ask him, in future, to try and not instil so much venom in the tone of his letters. I must still call his attention to the letter of February 20, where he states that a wop or laborer, etc. This I would say was very inconsistent with his later letter. I would ask Mr. Noble to define or give me a definition of the word technical as applied to modern engineers, also does he think that a man who takes an I. C. S. course comes under the category of technical man. If so I am afraid there is misunderstanding regarding my few remarks. Please do not misconstrue this; a technical man can get the foundation of a technical education from the I. C. S., but he has many weary hours to study and miles to travel before the can come under the category of "the technical man." Please give me this answer and we may come to a better understanding in the future in our exchange of ideas.

The engineer I had in my mind when I wrote that paragraph of a splendid mechanical engineer, is a man of good quality (his moral character does not concern us now); he had charge in his earlier years of one of the largest engineering shops as general foreman, and was noted for his mechanical genius; if given the ordinary formula he could work them out, writes a splendid hand, is a good draughtsman, but he hates slang, and is a gentleman is his conversation and dealings with his fellow men. But (that awful subordinating conjunction) he is not a technical man, so we will say x = technical training (and x is the unknown quantity). Mr. Noble, from his letter, is under the delusion that I am technical from head to toe and not practical; in my last letter he will learn different, for my road as an apprentice through the shops, was pretty rough, but when it was finished I always looked ahead with "Excelsior" as my motto. I have to thank the British navy for my good training as an engineer, for there is where efficiency counts.

I still take my old stand that the majority of engineers do not study enough nor take their profession in the serious light it should be taken; mind, I speak collectively of Canada, and when he has read "Wop's" letter he will see there is some foundation for my assertions "even in Ontario." I may add I do not spend all my time in Montreal, but I would not like to say I have visited such a number of plants, or spoken with hundreds of engineers in Ontario, but in my career as a construction engineer and also as a boiler inspector I have visited a few.

I was rather surprised at his caustic remark on the cheese factory; perhaps he has handled one of these plants, for even there brains can be used. Now, friend, please study the power plant situation in Ontario, their different horse powers, etc., and I think you will begin to see the drift of my remarks on the 2,000 horsepower question. You cannot get away from the fact that there will be more first-class engineers looking for positions than there are positions to fill in Ontario; the 2nd class engineer will monopolise them all. Why should I bother? He will say the 1st class exam. is too hard, and of his own accord he will remain there; my ambition for years has been the uplifting of our profession, but load them gently, not all at once, and the responsibility will be carried easier. This subject is worthy of a sensible discussion, and don't let us fly at one another's throats like the present Members of Parliament when any individual one makes a suggestion. In my remark about a chief who has no technical training I had in mind a 40,000 horsepower plant with its up-to-date equipment. Flow meters, CO_2 recorders, etc., and numerous other things too numerous to mention. Let the said engineer be called upon to make an efficiency test with data up to date, pick out the many errors that can be made through faulty collaboration; this requires a technical knowledge of more than common; in minor plants of 500 or 1,000 we do not expect the same, although the test should be as thorough, but there are a great many engineers in charge of heating and refrigerating plants that call themselves chief engineers who are not deserving of the title. I do not see or find any amusement in the troubles of Ontario engineers. Mr. Noble evidently misconstrues my words; I wish more to help them, and try and point out the pitfalls our province has fallen into and from which I want my brother engineer to avoid; I am sorry I cannot devote more time to Mr. Noble's letter, but must thank him for his sketch of the trap. Is it his patent or does it belong to some of his friends? I will not attempt to pass remarks on it as it is poor etiquette for one engineer to criticize another engineer, especially when he is doing his best, but I would really have liked Mr. Noble to have given us a more technical detail of the trap and its statistics, again thanking him and reminding him at the same time I am always willing to be shown where I am wrong; being an I. C. S. man and of considerable technical ability he should be willing and able to do so.

I would like to meet you, Mr. Noble, for I fancy we should be great friends after the rough spots had been smoothed out.

Now Mr. Editor, to hark back to the old subject, the "Examination of Engineers," from schoolboy days to manhood and through life, that dreaded word examination, no matter what we are trying for, what mysteries does the word enfold (the inward moniter shall I pass) those notes of exclamation: "Oh? it is too hard," etc., so the cry goes on, and now in later years when we are called upon to face that dreaded monster again our brain seems dulled with the shock, yet our success as an engineer depends on it and we approach the examination table with nerves all tingling, the final plunge and the expectation was a hideous nightmare, but the realization was paradise. Our friend Mr. Carmichael writes very clearly on "Memory is a Treacherous Thing." It is, and for any engineer to try and remember all the formulas in engineering would be impossible and would be asking for a first place in the race to the nearest asylum. What are

our engineers' pocket books supplied for? Not for ornament, but to refresh our fagged memories. One of the most difficult examinations in the engineering profession is the British Board of Trade "extra chief." Even here they supply a great many formulas, and I do not think the Ontario examinations will be any worse than that, or even if they come any where near a 2nd class certificate of the British Board of Trade.

I think the real idea is to understand how to break up a formula and find any particular quantity. The majority of examiners generally state a problem in a peculiar way and leave it to your brain to find the proper statement; any uncommon formulas are supplied; the everyday ones we can generally remember with a little thought.

I thank "Wop" for his few words and Shakesperian attitude in defending the poor mechanic without training. According to Mr. Noble's letter we should look for the cream of the engineering profession in Ontario, but "Wop" is sensible and tells us they are merely engineers like other parts of the world. Now I hope the term wop will be eliminated from any of our future discussions, for it is bad form, and very ungrammatical (at least it is neither a noun or an adjective), and from technically educated men very ungentlemanly. I should deem it a personal favor to know the gentleman writing under the nom de plume of Wop, so why camouflage. I must not forget to thank Mr. Elbthon for some of the sympathetic remarks on the nervous movements of chiefs of large plants; he is perfectly correct, they have an awful lot on their minds, which cannot be confided to every one, but as the horsepower grows so do the grey hairs (I do not possess any hair to go grey) but I must plead guilty to being a bunch of nerves at times, due to a former nervous breakdown through excessive study; however, with the man of iron nerve occasions arise when everyone is looking to the chief for the next move in some very grave crisis, when a false move may cause untold damage and loss of life, but as he says, it is not the technical man who realizes the danger, oh no, it is the man who has worked his way from the bottom rung of the ladder and understands the danger signals and steers his plant to safety. The paragraph advising operating engineers not to study too much is a word to the foolish and should not be taken seriously, for it is quite different from that given by most of us, although if a man studies 1½ hours a day he will be surprised how much he can cram into his brain in the course of a year, and don't forget, no study on duty; concentrate your mind on the work, for if you do not, some confounded thing is bound to go awry, and when you wake up and come down to earth—What a mess.

Believe me I have had some, and have scars to show. Before finishing my letter I would like to apologize to the consulting engineers who read POWER HOUSE, especially Mr. Coombs, whose photograph appears in the March 20 issue. He is a personal friend of mine; he called me over the phone after the February 5 issue and asked why are you knocking the consultant? I apologized for I had not such intention. In his conversation he gave me to understand that he wished to be a help to the engineers and try and steer the younger engineer through the rough roads. I hope he may be successful. for he deserves it. Our heads have been together on more than one occasion, his brain dominating.

How different to another person who came under my observation. The other day a friend and I were discussing engineering in general, when the conversation turned to another acquaintance, Mr. Blank, who has just finished his fourth term in college. I remarked what is he going to do and my friend replied: "Oh, he has opened an office and has started as a mechanical consulting engineer." Needless to say my remarks would not look well in print. I think I have taken up my allotted space, but I shall follow with great interest the path of the graded certificate of engineers in Ontario and sincerely hope it may be the means of lifting the status of that body to the pinnacle of perfection and ability and also financially.

HENRY WRIGHT.

THE TRAINING OF THE ENGINEER

Will you permit me to use a bit more of your valuable space? There are several points in a "Wops" letter, March 20th issue, that require a little clearing up. He says, "It would be interesting to know where the deciphering of mathematics and formulae can be acquired." He had the answer before his eyes when he was reading POWER HOUSE. It is impossible to read any one number without absorbing considerable technical knowledge, including some part of mathematics and rules or formulae, complete instruction in the theory and practice of power plant management and operation has been given in former numbers of POWER HOUSE. There are also a number of reliable correspondence schools which give first class instruction along this line to anyone who can read and desires knowledge and who will study a few minutes each day. "Wop" tells us he learned the rule of three. If he uses the rule in connection with questions dealing with power plant men, money or material, he is using technical knowledge. The man who can read and write, who can do addition, division, multiplication and subtraction, can learn a great deal about the theory and the technical part of power plant engineering in a few weeks with little study.

The only power plant man who has the slightest claim to consideration for being completely ignorant of the theory of engineering is the man who cannot read. There are so many good power plant journals, any one of which only costs a few cents a month, that the only excuse any man who can read can give for being in such a condition is because he is so full of conceit that he thinks he knows it all.

The trouble may be that the ignorant man is contented. Contentment has been defined as stagnation when applied to engineering. The real artist is never completely satisfied with his work, be he a pick and shovel trench digger or a portrait painter. In the former case he feels that if he had taken a little more care he could have made a trench straighter and the sides more even.

In the latter case the workman is sure he could have improved on the tints if he had been more careful. If a man is contented he will never exert himself to help others or do any unselfish act.

When I was at school my teacher once told me to always try to do the problems I thought I could not do, and I would often be surprised to find that they were quite simple. Anyhow it is better to aim high and fail than to aim low and succeed. Surely the men who can read and have never learned anything beyond what they were compelled to learn are no high aimers. If a man can figure out the horsepower of a steam engine he has some technical knowledge. If he knows why the steam piston is larger than the water piston on a pump, he has some knowledge of theory. In fact it is practically impossible for any man in charge, or assisting to operate, a power plant, to be absolutely ignorant of the theory of some part of the equipment, even if he never read one word about engineering.

Understand, the man who understands theory only is not in the same class as the good practical man. Nevertheless, the good practical man's value is more than doubled when he has a wide knowledge of the theory of engineering. Unless a man desires to secure first class papers in a purely techincal knowledge test a knowledge of simple arithmetic is all that is required to understand and work out countless rules and formulae.

JAMES E. NOBLE.

In your March 20th issue of POWER HOUSE, a correspondent signing himself a "Wop" is peeved because engineers with no engineering knowledge outside of that secured by personal operating or practical experience is called a wop or laborer. The following extracts are taken from an engineering text book by N. Hawkins, M.E. Quite recently a distinguished professor of Harvard University published an article in which he grouped the engineers now working side by side for the development of our material resources into three classes. First, those men, many of them eminent in the profession, who are the product of the workshop, whose experience and education have been obtained entirely in the field or workshop, and from any text books available.

Second.—Men who have graduated from literary or natural science departments of colleges and have learned practical engineering after leaving their classes—drawn to it by a strong taste for the profession or by the pressure of circumstances.

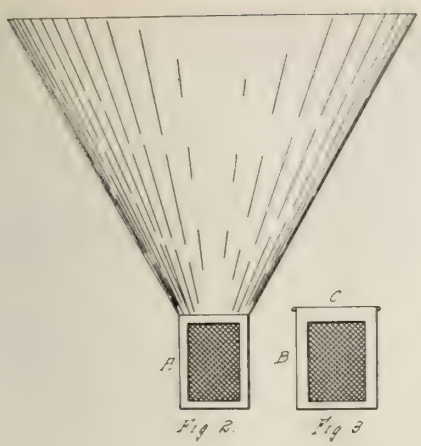


Fig 2. Fig 3

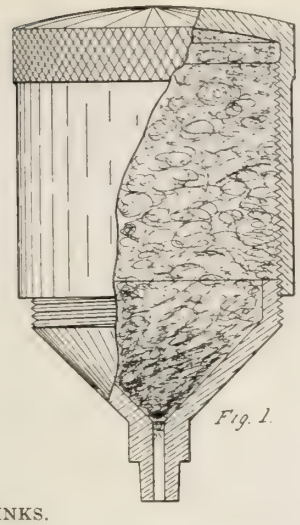


Fig. 1.

POWER PLANT KINKS.

Third.—The younger men, graduated from schools avowedly technical, or from technical departments of universities. These men are gradually supplanting the other two classes, as the demand for greater attainment and better education increases, and as competition and the invention of labor-saving machinery turns the mechanic into a laborer and raises the status of the educated engineer. The next generation, the professor believes, will see the men with only practical or academic training practically cut off from all large modern power plants as chiefs of same.

JAMES SCOTCH.

EMERGENCY MEASURES

There are many simple ideas in use in power plants, the only reason they are not more generally known is because those using them consider them so simple that most any one would know them, their very simplicity is one reason for their limited use,, for it is the very simple idea that is often the last to come to a person's mind. One such idea is shown in Fig. 1. Often times the supply of grease for the compression cups runs out and a hurry call for more is sent in. The grease shortage can be overcome by filling the grease cup with waste or sponge soaked in cylinder oil, screwing down just as if grease was in the cup.

Fig. 2, Shows an oil straining funnel that can be made at a small cost, and it gives excellent results.

The outlet is made about 3 inches in diameter, pieces are cut from opposite sides and a covering of brass gauze soldered over the holes, this itself makes an excellent strainer as most of the dirt will settle on the bottom which is closed and has no screen on it. The piece shown in Fig. 3, is made to slip over the part A, it also has brass gauze as at B. When using B a piece of cheese cloth is laid over it at C, and pulled over the part A, the oil has often to pass through the two, brass gauze and cheese cloth; and, believe me, it is mighty little sediment that will get through.—James E. Noble.

THE SYNCHRONOUS MOTOR AND REFRIGERATION

(Continued from page 181)

improperly and which provides protection from loss of voltage and over loads.

The fourth panel carries the following instruments for the main circuit; power factor meter, ammeter, voltmeter, graphic wattmeter, and integrating wattmeter. The two right-hand panels control the light and the small motors throughout the plant.

An excellent example of the superior economy of the synchronous motork as compared with the steam engine, for driving ice machines is the installation in the Manhattan Street dairy of the Sheffield Farms Company, New York, where 80,000 quarts of milk are handled every day.

This plant contains four 80-ton Newburg ammonia compressors, and a 12-ton York compressor, which were driven by steam engines before the war. After the Americans went to war, however, fuel was hard to get, its price rose rapidly, and the Government ordered all inefficient engine-driven ice plants to be closed down. The necessity of making some change in their drive was realized by the officials of the Sheffield Farms Company, so they decided to use an electric motor and obtain power from the local lighting company.

The present drive, which is shown by the illustration, consists of a 500 H.P. Westinghouse synchronous motor, operating on a 440-volt, 60-cycle circuit, and which has a speed of 350 r.p.m. This motor is belted to a line shaft, from which all of the compressors are driven and, in addition two 14 x 10 inch air compressors and two generators of 110k.w. and 125 k.w. respectively used for supplying current for local lighting. Current is supplied by the *m*nited Electric Light & Power Company.

While this installation, being originally planned for engine drive, is not arranged in an ideal manner, nevertheless the officials state that the efficiency of the motor supplied with central station power is so much greater than that of the older drive that its savings and increase in capacity amount to $30,000 a year.

One of the interesting features of the installation which is now recognized to be great importance in ice-plant management, is the careful attention given to the graphic meter chart which shows the amount of power being used. Since the load is practically constant under given conditions, the curve drawn by the meter should ordinarily be a straight line. But any variation in the factors of production, such as, the depreciation of any part of the machinery, a change in the temperature of the brine, water, etc., or the alteration of any other, detail, at once changes the power demand which is noted by the meter. An investigation is immediately madde as to the cause of the variation and correction is applied as soon as possible. Thus the efficiency of the plant is kept maximum at all times.

The use of a synchronous motor, instead of an induction motor, for this installation is in line with the present tendency in refrigerating engineering practice. The synchronous motor is favored because of its high efficiency, uniform speed, and ability to improve the power factor of the electrical system in the plant; and an ammonia compressor is well adapted to be driven by this type of motor because, with the use of by-passes, the starting conditions are light and the speed is constant.

At the Sheffield Farms Plant, 110 tons of ice are produced daily from purified and filtered city water.

THE ABSORPTION SYSTEM OF REFRIGERATION

(Continued from page 181)

as nearly level as possible with the lower flange joint of the shell and head. The shell condenser should show from 4 to 6 inches in the gauge glass while the receivers of atmospheric or double pipe condensors must contain sufficient liquid to cover theoutlet to the expansion valve so that gas cannot blow through. In the brine cooler there should be sufficient anhydrous ammonia to frost both gauge cocks; the gas line should be slightly frosted back to the absorber, but frost showing on the purge line indicates that liquid ammonia is being carried out of the cooler, which condition should be promptly remedied. Care must be taken in handling the anhydrous ammonia cylinders. The manufacturers instructions should be carefully followed either in charging or in withdrawing ammonia into cylinder as an over full cylinder is a source of great danger.

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH
THE E.S.MANNY Co
27 COTE ST MONTRAL. CAN

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
⅛	$ 6 00	$ 8 00	$.....	$.....
¼	4 83	6 96	5 31	7 44
⅜	4 83	6 96	5 31	7 44
½	6 42	7 99	7 10	8 67
¾	8 11	10 24	9 03	11 16
1	11 99	15 13	13 35	16 49
1¼	16 22	20 47	18 06	22 31
1½	19 39	24 48	21 50	26 68
2	26 09	32 93	29 95	35 80
2½	41 24	52 07	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white. 20 Dark colored. 09
Mixed colored 10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

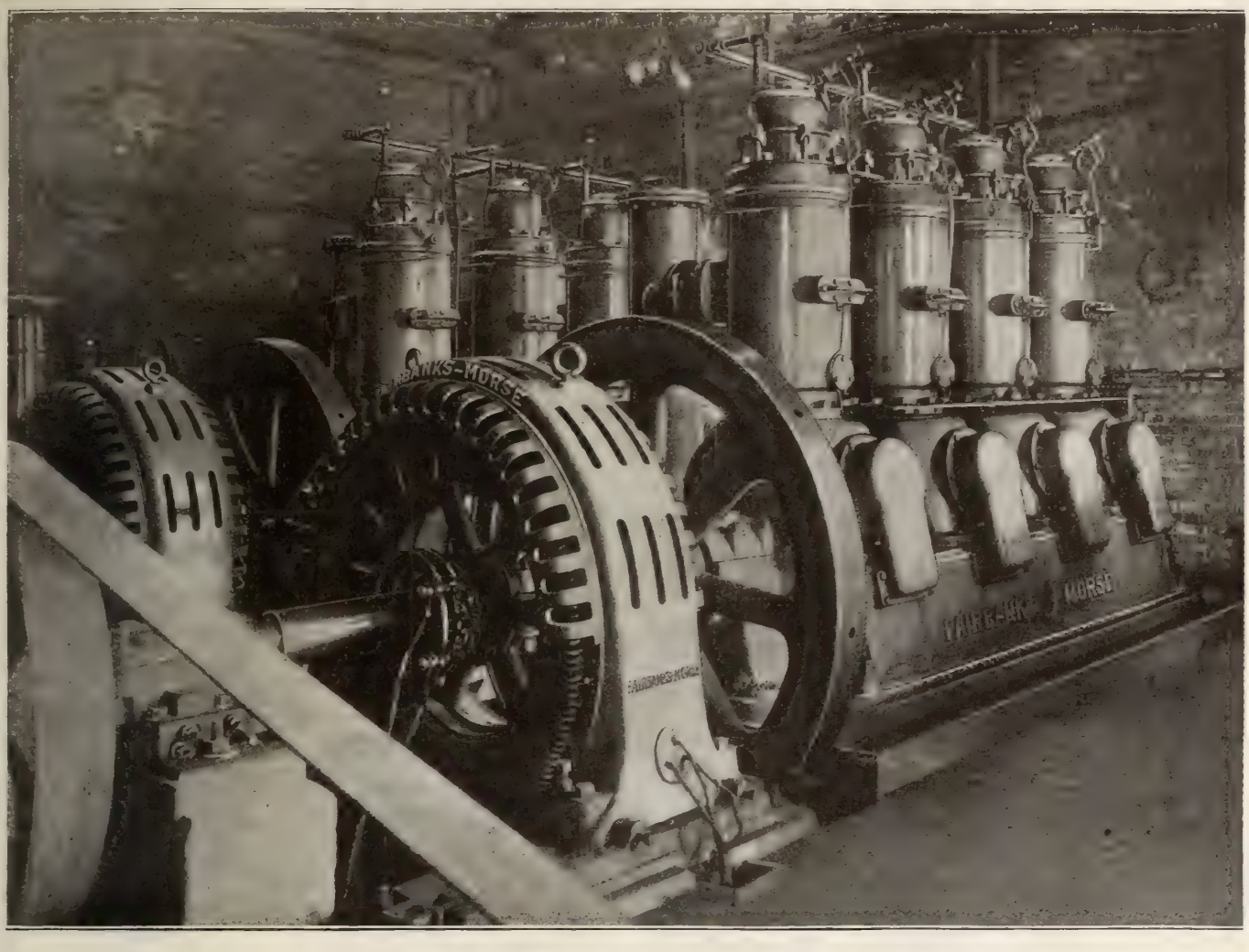
	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



FAIRBANKS-MORSE
ELECTRIC POWER MACHINERY

Each of the units shown above consists of a 200 H.P. Semi-Diesel Oil Engine and a 170 K.V.A. Generator.

Our smallest plant is a 1½ H.P. 9 K.W. Automatic Suburban Lighting Outfit.

Fairbanks-Morse Electrical Machinery covers the entire range between the above sizes.

Our experience is at your service.

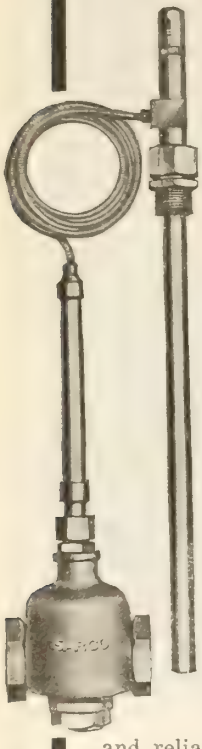
The Canadian Fairbanks-Morse Co. Limited

"CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS"

FAIRBANKS-MORSE QUALITY F M 100%

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON
WINDSOR WINNIPEG SASKATOON CALGARY
VANCOUVER VICTORIA

An ALL-IN-ONE Temperature Regulator



Here is a temperature Regulator that is entirely self-contained and self-operated. It requires no exterior operating means such as electricity, compressed air or water. It necessitates no involved connections or complicated attachments which require constant adjustment and cause trouble.

Sarco does its work by itself and does it accurately and dependably. It is simple and compact.

SARCO controls the temperature in the natural and reliable way — by utilizing liquid expansion and contraction.

A heavy hydro-carbon oil surrounds a spirally corrugated metallic tube. When the temperature reaches the point at which Sarco has been set, the oil expands. This produces pressure on the corrugated tube and operates a valve that at once shuts off the heat. It operates reciprocally when the temperature falls below the desired point.

That's all there is to it. Sarco effects a saving in first cost, a saving in installation cost and a saving in labor.

Sarco Regulators are also supplied for room control.

We ship the Sarco Temperature Regulator on a 30-day free trial.

May we send you Booklet J-54?

SARCO COMPANY INC.

239 BROADWAY, NEW YORK

Ellicott Square, Buffalo; Majestic Building, Detroit; Monadnock Block, Chicago; Drexel Bldg., Philadelphia; Williamson Bldg., Cleveland. Representatives in all principal cities. Peacock Bros., Montreal.

ANNOUNCEMENT

Mr. E. C. Hanson, president, announces the organization of the Republic Flow Meters Company of Canada, Limited, and the establishment of the head office at 145 Wellington Street West, Toronto, Ont. This company has been organized for the purpose of handling the Canadian business of the Republic Flow Meter Company of Chicago and to give a service superior to that possible through agencies. A complete stock of meters and parts will be carried in Toronto and the new company will be in a position to supply without undue delay any demands made upon it. Mr. Hansen is in charge at the above address.

AMALGAMATION

Special meetings of the stockholders of J. H. Williams & Co., at Brooklyn, N. Y., and of The Whitman & Barnes Manufacturing Company at Akron, Ohio, have been called for April 2, for the purpose of ratifying an agreement entered into by their respective presidents, made subject to the approval of the stockholders, for the merging of the Chicago, Illinois and St. Catharines, Ontario plants of The Whitman & Barnes Manufacturing Company with J. H. Williams & Co.

When ratified, this plan will contemplate the operation by J. H. Williams & Co., of drop forging and drop forged tool plants at Brooklyn, N. Y., Buffalo, N. Y., and West Pullman, Chicago, Illinois, in the United States, and at St. Catharines, Ontario; and the business will be operated by the individuals now connected with these plants.

The plants of J. H. Williams & Co., under this arrangement, call for a considerably extended business, and for the service of all their customers in the location most convenient to them.

Crude Oil Engine For Sale

90 H.P.—built by the Blackstone Company who are the recognized leading manufacturers of Crude Oil Engines. All in splendid condition and can be inspected set up. Complete with 60 KW, 550 Volt Generator, if so desired. This is an opportunity to get an economical power installation at attractive price to immediate purchaser.

Address:

Williams & Wilson, Limited
84 Inspector St., Montreal, P.Q.

OPPORTUNITIES

Freezing System For Sale

Complete — 12½ tons capacity, c o n t aining cooling coils; covers and framed work; crane; hand hoist and can dump.

GUNNS LTD., West Toronto, Ont.

FOR SALE

One 45 K.E. Generator complete, $600.
One 65 H.P. Motor, 220 Volts, complete, $600.
The above machines are perfect.

Minimax Electric Co.
323 3rd Ave., Maisonneuve, Montreal
Phone La Salle 1797

FOR SALE

One 300 H.P. Leonard Automatic Engine; one Closed Feed Heater; one 8 H.P. 220 v. D.C. Motor; one 15 H.P. 220 v. D.C. Crane Type Motor.

H. N. BROWN, New Glasgow, Nova Scotia.

HELP WANTED.

DESIGNING ENGINEER—IF YOU ARE EQUIPped to take hold of an established line of Pressure Reducing Valves and push them to perfection, you have an opportunity before you. Answer clearly and fully on the following points.

(1) Have you basic knowledge of designing and actual experience? This is absolutely essential.

(2) Can you design special Valves such as Relief, Globe, Check-Reducing Valves for High Pressure. Any experience?

(3) As designer and Production Engineer, could you take active charge of mechanical end and maintain maximum production? Any experience?

(4) Give age, experience, full references, and salary expected. Strictly confidential. Will not write references without your consent.

The business is established, located in the Middle West. A good paying proposition with a bright future. Write immediately. Apply Box 1, A.P.H., Power House, 143 University Ave., Toronto.

WANTED—5 TO 7½ H.P. A.C. 25-CYCLE 110-volt Induction Motor in good condition. Box W.F.S., Power House, Toronto.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co.

27 COTE St. MONTREAL, QUE

Mr. Jos. W. Hays, *Author*

Mr. Joseph Harrington
Chicago
Formerly Advisory Engineer, National Fuel Administration for State of Illinois

Mr. Fred R. Low
New York City
Editor of Power

Prof. S. W. Parr
Urbana, Ill.
Department of Chemistry, University of Illinois

Mr. Arthur L. Rice
Chicago
Editor, Power Plant Engineering

W. L. Abbott,
Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill.

Mr. David Moffat Myers
New York City
Formerly Advisory Engineer, National Fuel Administration

These Men are America's Leading Combustion Experts

Every step of the training has their careful censor-ship, giving you the fruits of their broad and successful experience.

Hays School of Combustion
1108 State-Lake Bldg.
Chicago, Ill.

Better Jobs— Bigger Salaries

Let These Men Show You How to Get Them

Are you interested in sure and rapid advancement to a really worth while position in one of the best paying professions in the country today? If you are it will pay you well to read this announcement. It tells how you, with or without previous training, can prepare yourself in a short time for an attractive position that insures a lucrative salary and an assured future.

Remember—this profession is a new one—unlike all others, it is still uncrowded—and the demand for trained men far exceeds the supply. That's why your services will be in demand when you have acquired the necessary training. That's why you can count every effort a sure and wonderfully profitable investment.

Easy to Learn— No Experience Necessary

In most professions, to become proficient, long periods of intensive study, followed by years of hard training, are necessary. In this new profession—Combustion Engineering—the necessary training can be acquired in a few short months. Why? Because all the knowledge and experience—all the scientific research and experiments—all the labor and study of seven of America's leading Combustion Engineers have been condensed and classified to such a remarkable extent that what formerly required years of study can now be learned in a fraction of that time.

This training from the very first can be applied to the practical every-day problems of any power plant. At some point in the course you must spend some time in power-plant work if you have not already had the experience. That may prove to be your field or you may make it the stepping stone to an executive position. In either case your services will increase in demand and value as you progress in the training.

America's Leading Combustion Engineers Teach You

On this page are photographs of our educational staff. Probably you know some of these men personally. At least, all or most of them, are known to you by reputation.

Jos. W. Hays is the author. His reputation as a writer on Combustion Efficiency is world wide. In this course he has surpassed himself. Every lesson, every chapter, is written in such an interesting, comprehensive way, that the reading of the course is as pleasant as it is profitable.

Associated with Mr. Hays as reviewing and advisory editors are **I. E. Moultrop, W. L. Abbott, Jos. Harrington, Fred R. Low, David Moffat Myers, Prof. S. W. Parr and Arthur L. Rice.** These names alone are proof positive of the thoroughness and completeness of the course.

Especial attention has been given to make this course easily understood by everyone. It is stripped of all unnecessary technicalities and is written in a way that you can quickly grasp and understand. It is prepared especially for the man on the job—the busy man in office or boiler room who can commence putting his knowledge into practice the moment he starts the course.

Send for this FREE BOOK—TODAY

To enable you to get a better idea of just what this course is—just what it covers—why it is a guide to a better job and a bigger salary—why it enables *you* to cash in on the big salary awards that fall to the Combustion Expert—to make all these things clear to you, we have prepared the book "Opportunities for the Combustion Expert." Send for a copy of this book today. It's free.

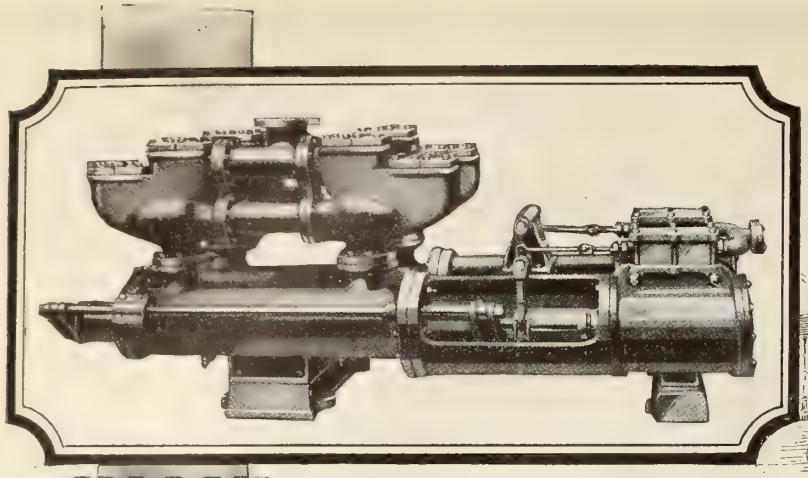
Mail the Coupon

Simply fill in the coupon and mail it to us. We'll send you a free copy of "Opportunities for the Combustion Expert" by return mail. Time is valuable. Get started today while the opportunities are greatest. Mail the coupon—Now.

HAYS SCHOOL OF COMBUSTION
109 North State St., Chicago

Without obligation, send me a free copy of "Opportunities for the Combustion Expert and details of the Hays Course.

Name.....
Street.....
City.....State.....
Firm.....
Position..... P.H. 4-20



Pot Valve Boiler Feed Pump

Team Work in the Power Plant

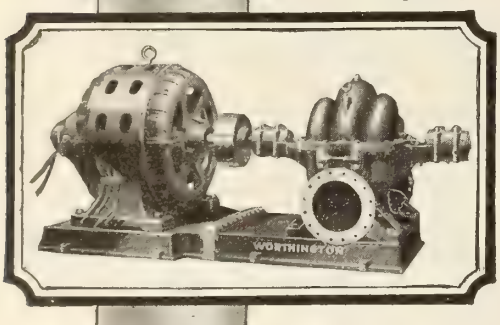
TEAM WORK is just as essential between working apparatus in the power plant as it is between men in the shop. Between men, team work is a matter of training—between machines, it is a matter of "picking 'em right" and fitting them to the job.

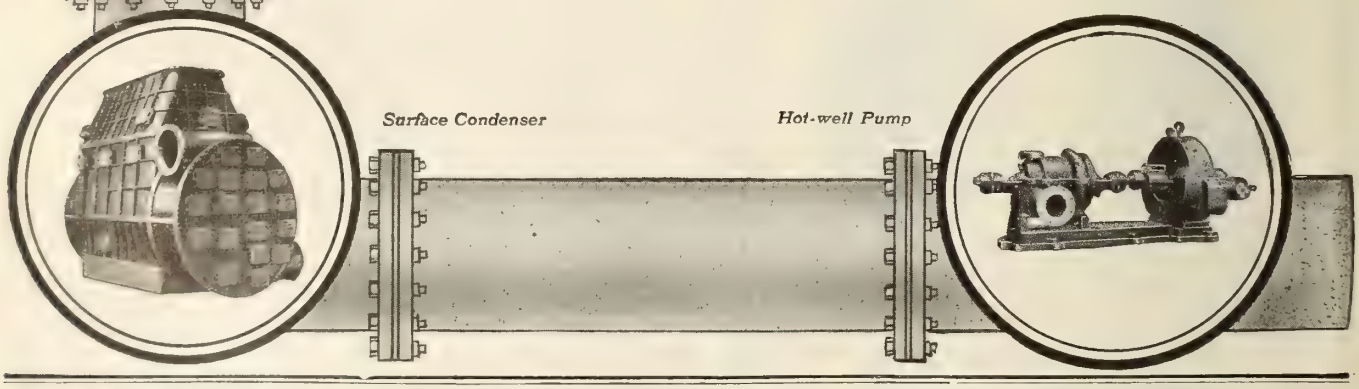
Services vary so, that to satisfy them requires an immensely wide range of apparatus for selection—and that's where Worthington comes in. Through a period of 80 years in industry Worthington has developed apparatus that will fit any power plant need, no matter what the requirement or duty. Whether a single pump or a complete layout, Worthington has the right type and capacitied apparatus and the engineering experience and knowledge necessary to correct installation. There is hardly a problem in power plant equipment that Worthington cannot successfully solve with Worthington apparatus.

The freely tendered engineering service is yours at request and without obligation.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

Centrifugal Circulating Pump





Surface Condenser

Hot-well Pump

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Epping-Carpenter, *Pittsburgh, Pa.*
Laidlaw Works, *Cincinnati, Ohio.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*

Jenkins Valves

In every part of the World you will find Jenkins Valves the standard. They are recommended by leading engineers because of their modern design, quality of material and absolute dependability under the most severe conditions. They require the least attention and have the lowest maintenance costs. They have been "quality" equipment for half a century.

Long experience has developed the perfect design of Jenkins Valves. Each part is scientifically proportioned to its duty, has the excess weight and strength that mean dependability. Every Jenkins Valve—and there's a valve for every requirement—has the same superior qualities.

Make sure on your new equipment — specify Jenkins Valves, and see that the valves you get have the Diamond Trade Mark cast on body.

Stocked by all Dealers

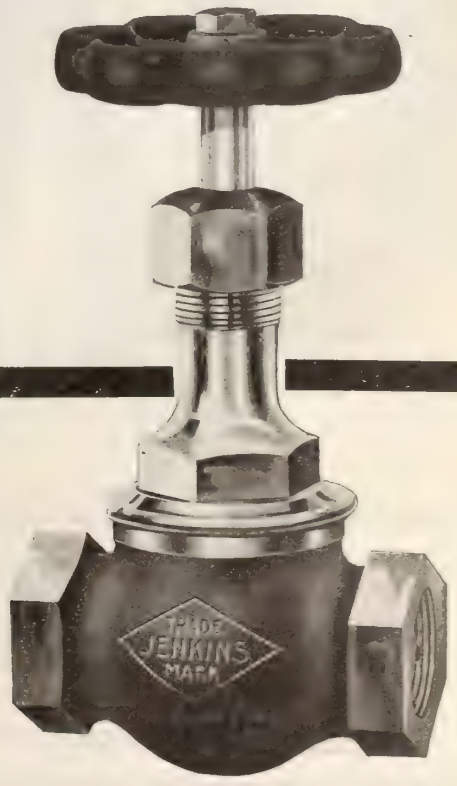
Catalogue No. 8 free on request

Jenkins Bros. LIMITED

Head Office and Works :
103 St. Remi Street
Montreal, Canada

Agencies in all the
Principal Countries
of the World

European Branch :
6 Great Queen St., Kingsway
London, W.C. 2, England



TRADE JENKINS MARK
Jenkins Bros

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

DART

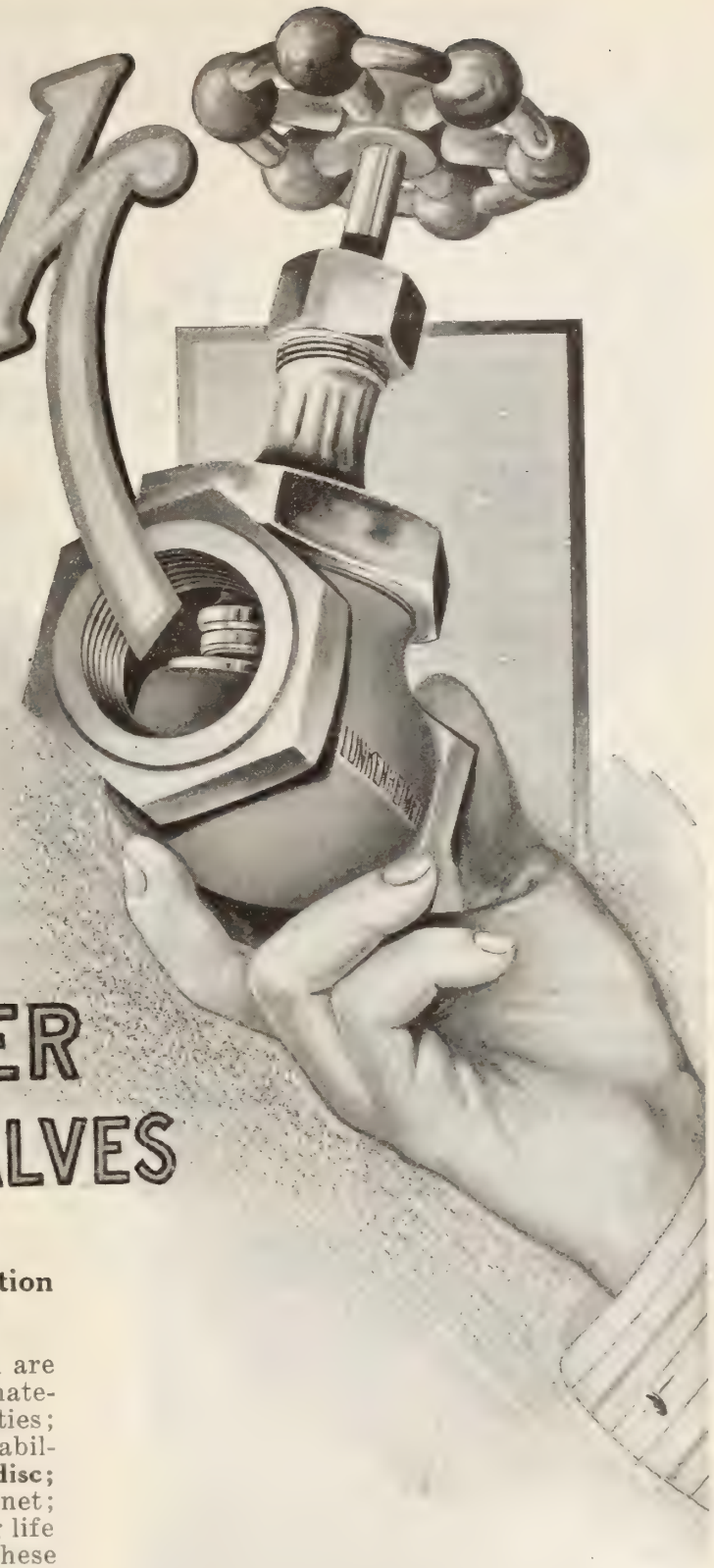
UNION PIPE COUPLINGS

Troubleproof and Economica

Your Jobber Has Them

Manufactured by DART UNION CO., LTD., Toronto, Ont.

Look



and satisfy yourself of the many advantageous features embodied in

LUNKENHEIMER "FERRENEWO" VALVES

The body is made of a Ferrous Composition specially alloyed for these valves.

Note the **seat ring** and **disc,**—both of which are made of Lunkenheimer "Valve-nickel," a material having exceptional wear-resisting qualities; the regrindable seating surfaces, the renewability of all parts, including the **seat ring** and **disc;** the full areas through the body; union bonnet; special composition stem, which insures long life to the stem threads; deep stuffing box, etc. These features combined with Lunkenheimer "quality" materials and workmanship make the "FERRENEWO" **the** valve of exceptional merit. Globe, Angle and Cross, and Horizontal and Angle Check Patterns, for working steam pressures up to 150 pounds.

Your local dealer can furnish them; if not, write us. Write for descriptive Booklet No. 576-DC.

2-11-43

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

New York Chicago CINCINNATI Boston London

Your Heart, *to the Human Power Plant*

is like the

"Cole" Return Trap *to the Steam Power Plant*

THE COLE
FOR COAL ECONOMY

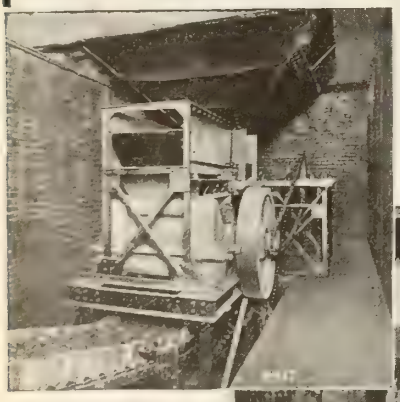
Both are especially designed to insure proper circulation. May we send you some interesting literature?

Geo. W. Cole, Limited

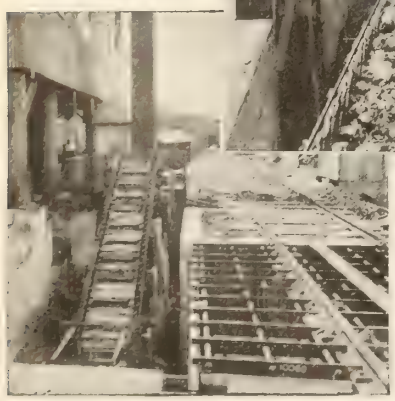
2002-4 Dundas Street, W., TORONTO

WESTERN REPRESENTATIVE:
Geo. A. Young, 203 Scott Block, Winnipeg

EASTERN SALES OFFICE:
76 St. Gabriel St., Montreal



Upper illustration shows a Jeffrey Standard Steel Apron Conveyer handling coal from Jeffrey Single Roll Crusher to Jeffrey Pivoted Bucket Carrier in Power Plant.



Center illustration: A Jeffrey Steel Apron Conveyer handling coal from track hopper to boiler house.

Steel Apron Conveyer handling coal at Gas Producer Plant of a large glass company.

For Economical Coal Handling In Power Plants Install

Jeffrey

Steel Apron Conveyers

For more than a quarter-century JEFFREY engineers have been in intimate contact with the material handling needs of the industrial world. The experience gained has enabled them to design and standardize conveying units which will fill satisfactorily the conveying needs of every industry.

The advantages gained are the elimination of special design, the saving in manufacturing costs, and the practicability of maintaining a permanent stock of standard units.

Our new Catalog No. 258-4 explains clearly how you can select a standard JEFFREY Conveyer which will solve your "special" problem. Write TO-DAY.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms: Montreal

What protection do you provide your men against the hazards of Ammonia Fumes?

Wherever there is a refrigerating machine there should be a

BURRELL Ammonia Mask

Protection from ammonia fumes is positive, quick, simple and easy with the BURRELL.

It makes possible the immediate repairs of the most serious breaks — even in fumes so heavy they would blister the skin.

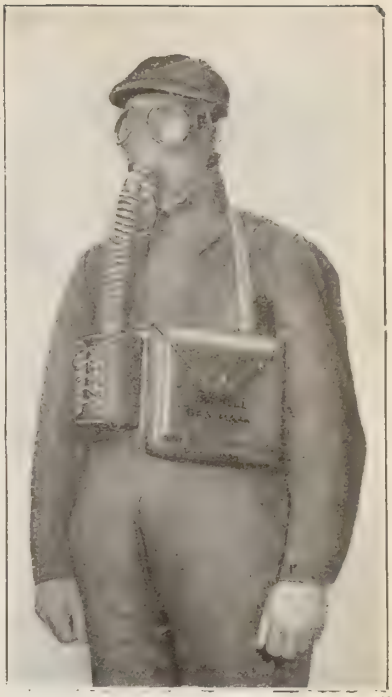
The Burrell has every feature for safety, for convenience, for ease and efficiency. A single high-duty canister, free from all complications.

In use in big city fire departments, in the larger packing houses — one company recently installed 121 additional Burrell Masks.

The BURRELL CANISTER

has longer life, greater efficiency, than any other Ammonia Canister ever built. You can use it with any mask. Order the Burrell for your "spares."

Write to-day for descriptive folder giving full details. Immediate shipment from our factory or branches.



This man can go into dense Ammonia Fumes—he can work in comfort and safety

MINE SAFETY APPLIANCES COMPANY

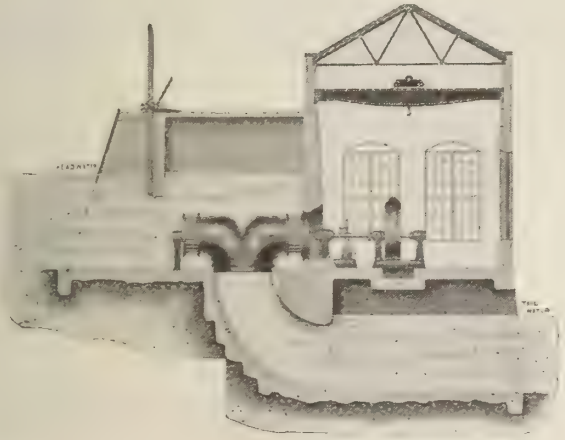
Chamber of Commerce Building, PITTSBURGH, PA.

Offices in many principal cities.

IF you are interested in safety appliances for any purpose, send for our complete catalog, "Everything for Mine and Industrial Safety."

"Everything for Mine and Industrial Safety"

Water Wheels and Hydraulic Power Plant Equipment



Horizontal Twin Turbine in open concrete flume.

Hydraulic Turbines
Governors
Head Gate Hoists
Stop Log Winches
Steel Feeder Pipes
Trash Racks
Butterfly Valves
Surge Tanks

Send for Bulletin No. 54

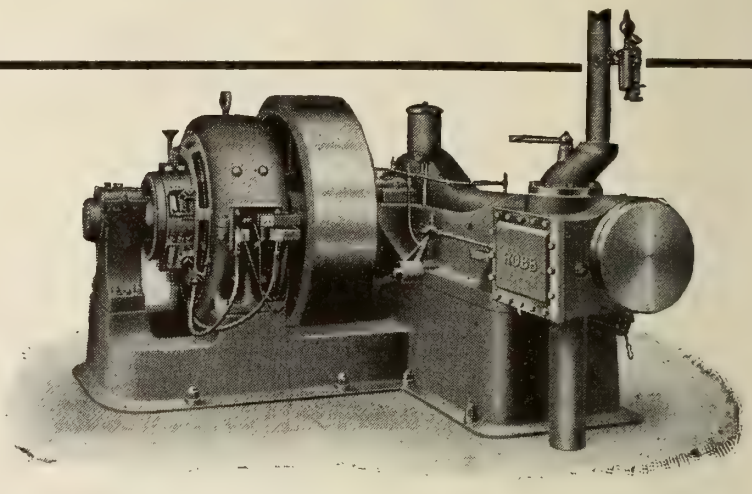
William Hamilton Co., Limited, - Peterboro, Ont.

ROBB POWERPLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines and Water Tube, Return Tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market — remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
Phone
Westmount 6800

Toronto Office:
20 Victoria
Street

31st Annual Convention

of the

CANADIAN ASSOCIATION

OF

STATIONARY ENGINEERS

To be held at

Woodstock, Ont.
June 22, 23, 24

Address all communications to
John McCalley, Sec.-Treasurer of Convention,
20 Riddell St., Woodstock.

Here's Another Efficient Silent Chain Drive

700 H. P., 8ft. Centers

A LEATHER belt drive could never transmit this large amount of power on such short centers, yet Link-Belt Silent Chain transmits the power with highest efficiency. It combines the best points of the leather-belt drive with the positive action of the gear drive. It is more efficient than either.

Probably you have a machine which could be operated more efficiently by a Link-Belt Silent Chain Drive. Send for one of our Drive-Chain Engineers and get his recommendations. Also write for our 128-page Data Book No. 125.

328

CANADIAN LINK-BELT CO. LIMITED
WELLINGTON AND PETER STREETS
TORONTO

LINK-BELT
SILENT CHAIN DRIVES

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets
- ☐ Complete Sand and Gravel Plants

Write for Catalogs
Place X in Square

Reduce Your Fuel Bill

In a series of tests made by eminent mechanical engineers it was shown conclusively that 10% to 40% of the heat units of coal are lost, due to leaky boiler settings that allow an excess of cold air to enter the furnace or combustion chambers.

BETSON'S REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

Makes it easy for anyone to mould into place a solid, one-piece, monolithic boiler setting lining that is jointless, airtight and capable of withstanding the stress and strain because expansion and contraction have been neutralized.

With airtight linings and gastight baffles you not only save the 10% to 40% of wasted heat units, but reduce the repair and upkeep costs in your boiler room as well.

Betson's Plastic Fire Brick linings outlast other linings not only because of high quality and experienced compounding, but for the very logical reason that in the one-piece lining there are no bricks to work loose or joints to open up.

Betson Plastic Fire Brick Co.

Post Office Box 386-4, ROME, N.Y.

Canadian Distributor:

International Chemical Co.

44 Lombard Street, TORONTO, ONT., TORONTO

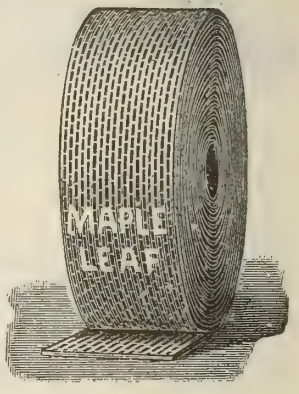
A pamphlet showing how to use Betson's Plastic Fire Brick is yours for the asking

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

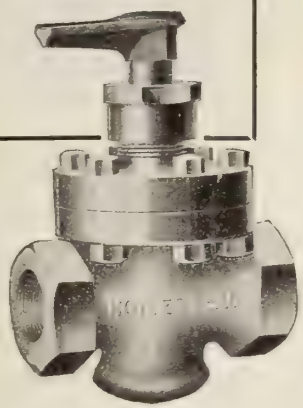
DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

HOMESTEAD
Quarter-Turn Valves

The Most Simple and Effective of All Valves

A quarter turn only, and a Homestead Quarter-Turn Valve is changed from absolute tightness to a straight unobstructed flow. Ordinary globe or gate valves require from six to ten turns of the wheel! Is it any wonder that Homesteads have replaced the globes and gates in hundreds of plants?

Homestead Valves are made in Straightway, Threeway and Fourway patterns. They are used for air, steam, water, oil and acids with perfect satisfaction.



Homestead Valve Mfg. Company
PITTSBURGH, PA.
Works: Homestead, Pa.

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

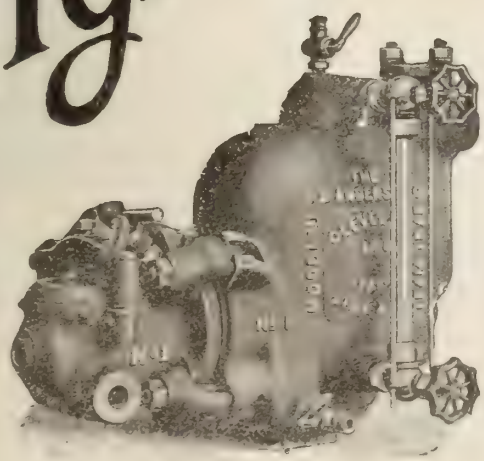
Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED
TORONTO

Stays Tight

The ANDERSON
Model "D"
Steam Trap



Just think of the satisfaction you have once this perfected trap is in your steam-room!

Tight from the day you put it in! Of that you can be sure.

It is operated by a counterbalanced Lake Superior Copper Float. Its large air valve is ever under deep water seal, and never will it wire draw.

Furthermore, every part is machined to solid gauge. Self-contained strainer and self-contained by-pass are Anderson features. Note the outside gauge glass. And the simple design! It gives you complete accessibility to every part.

Write for full particulars.

The V. D. ANDERSON COMPANY
1935 West 96th Street, CLEVELAND, OHIO

CLINTON CEMENT

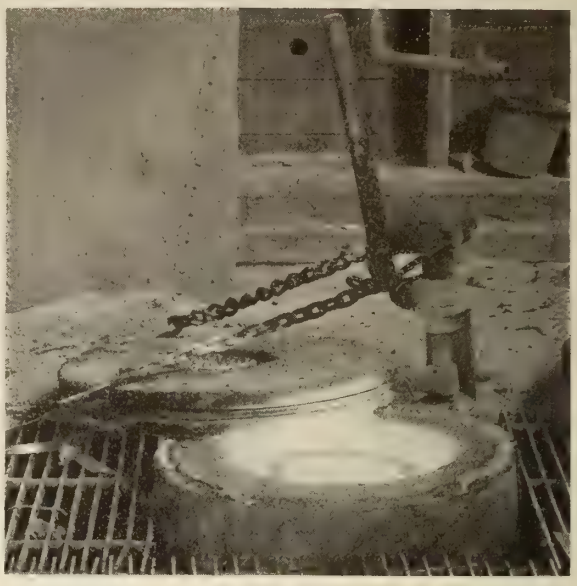
To Withstand Such Conditions As These!

The condition that exists in a brass furnace like this, is a real test for the refractory lining. The enormous temperatures, the expansion and contraction—only the finest linings can stand up under it.

The success with which Clinton Cement meets such conditions, is due to the unusual properties procured by our process of manufacture. Clinton sets to a flexible, glass hard surface which is unaffected by temperatures up to 3,000° F.

For all refractory work, particularly that which usually gives trouble, use Clinton Cement.

A five pound trial tin will gladly be forwarded upon request



Clinton Cement Joints Are Superior to Fire Clay Joints.

Standard Machinery & Supplies Limited
261 Notre Dame St. West, Montreal

TWO FACTORS

determine the value of a paper's circulation to the advertiser—quality and quantity.

The quality may be judged by the methods of obtaining subscriptions.

The quantity may be known absolutely by an independent and expert audit of the circulation records.

Both points are covered by the reports of the Audit Bureau of Circulations.

The advertiser who buys space on a business basis asks for an A. B. C. statement and studies it.

If an advertiser who does not demand an A. B. C. statement conducted the other branches of his business on the same method, he soon would not have any business to conduct.

An advertiser is entitled to the facts. An A. B. C. paper has nothing to hide.

The A. B. C. report of POWER HOUSE will be sent to advertisers on request.

"A little learning is a dangerous thing".

You will know **how to buy intelligently,** only when you know **where to buy.**

The **Arrow** has a point for you.

Kellogg Chimneys

The Logical Selection for Your Power Plant

Made of Corrugated Perforated Radial Brick

Foremost Method of Chimney Construction

Kellogg Chimneys are the logical selection for your power plant for the reason that they represent the most advanced ideas in chimney construction. The **corrugated** feature of Kellogg Chimneys offers a big advantage over other chimneys.

Tests have proven conclusively that the adhesion between mortar and Kellogg Corrugated Brick is 62½% greater than between mortar and ordinary straight or plain-sided brick.

Kellogg Bricks are shaped to proper radius, and in addition they are moulded with vertical perforations, permitting thorough burning, so increasing their density and strength and reducing weight.

Recently Completed

Wayagamack Pulp and Paper Company, Baptist Island, Que. —250′x 10′.

Palmolive Co. of Canada, Ltd., Toronto, Ont.—150′x 5′ 6″.

Canadian Woollens, Limited, Peterboro, Ont.—145′x 5′.

Peterboro Milk Products, Peterboro, Ont.—90′x 4′.

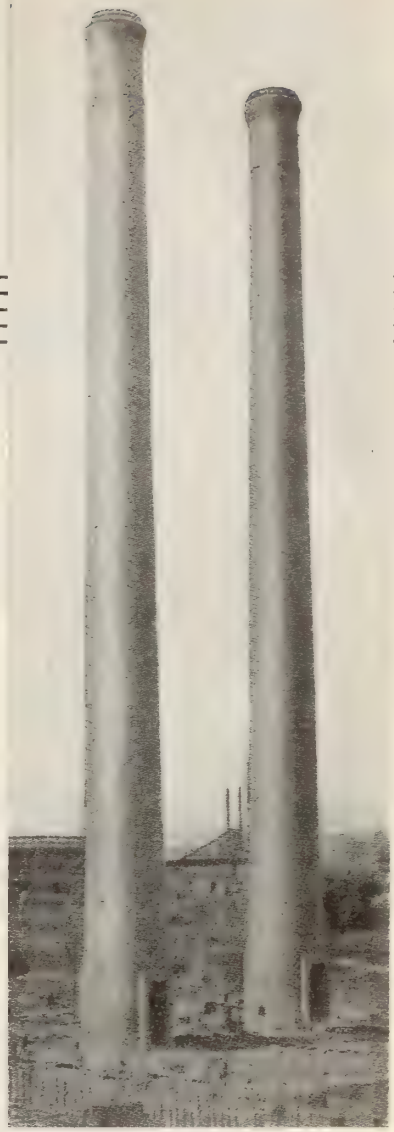
Prest-O-Lite Company, Toronto—110′x 5′ 6″.

Kellogg Chimneys represent stability and permanence. They have many features you should be thoroughly familiar with and we will be glad to furnish the full details.

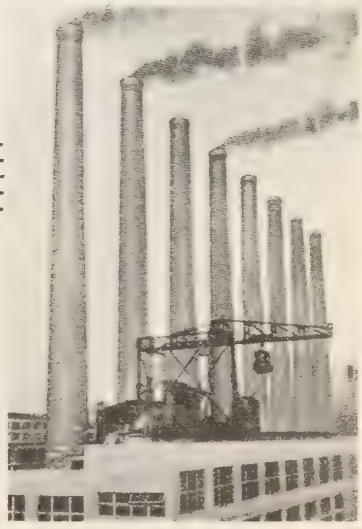
CANADIAN AGENTS

The Arthur S. Leitch Co.

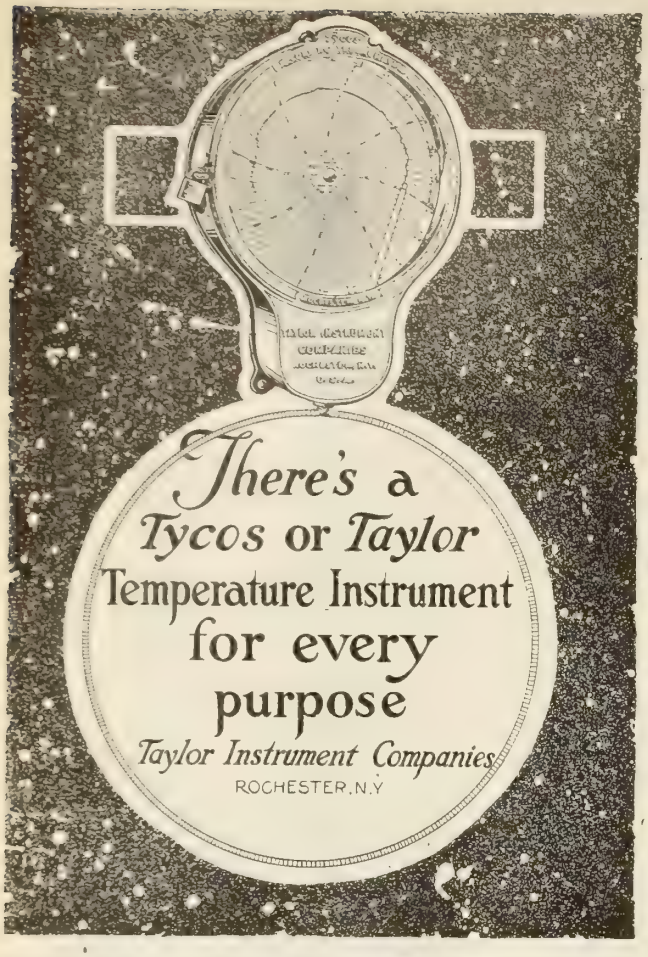
Kent Building **TORONTO**



Dominion Power and Transmission Co., Ltd., Hamilton, Ont., Canada—240′x 12′.

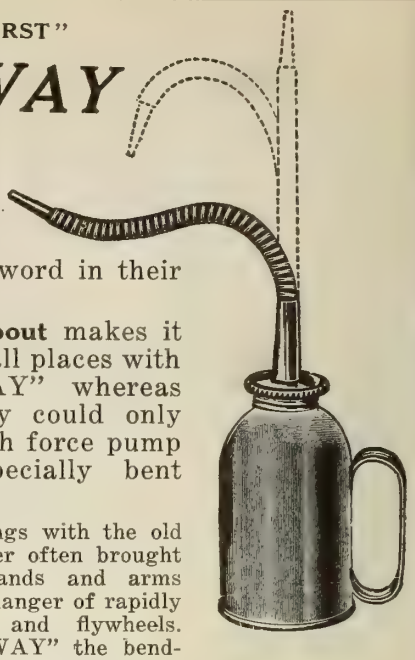


Corn Products Refining Co., Argo, Ill.—150′x 7′.



"SAFETY FIRST"

ALL-WAY
RAILWAY
OILERS



are the latest word in their line.

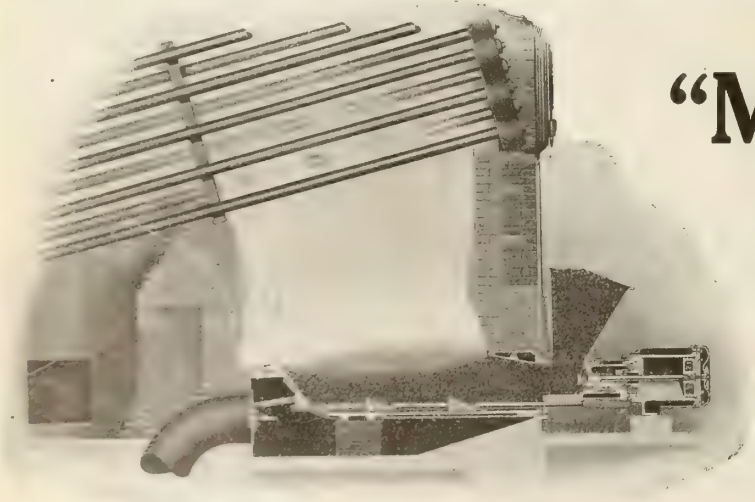
The **flexible spout** makes it possible to oil all places with one "ALL-WAY" whereas previously they could only be reached with force pump cans with specially bent spouts.

Lubricating bearings with the old straight spout oiler often brought the engineer's hands and arms very close to the danger of rapidly revolving gears and flywheels. With the "ALL-WAY" the bending of the spout removes this danger. Sizes: No. 4, 1 pint—10-in. spout. No. 5, 1 quart—11-in. spout.

If your dealer cannot supply you write us.

We also manufacture the well-known "All-Way" Oil Can—saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO



"More Steam"

The demand for steam is steadily increasing—and fuel, in addition to being more expensive, is not of a higher grade. Have you noticed the effect of this on **your** boiler plant? Are there complaints of no steam? Is your coal bill steadily mounting? If so, you have need of a

JONES UNDERFEED STOKER

A Jones Stoker equipment will increase the steaming capacity of your boiler—with an immediate saving of 15 to 20 per cent. over your regular hand-fired conditions.

The Jones Underfeed Stoker will save you as much as **one ton in every five**—and keep your chimney smokeless. Isn't this worth investigation? Let us send you full particulars without delay.

Jones Underfeed Stoker Company, Limited
37-41 Britain Street, Toronto

Where Performance Outweighs Price

When required for only a few minutes' occasional use, a low-priced, low-efficiency hoist or trolley may be an economical buy. But for steady, every-day service, the most efficient hoists and trolleys have always been the best investment, and now that labor costs are so high, they are the only sound one. This principle points straight to

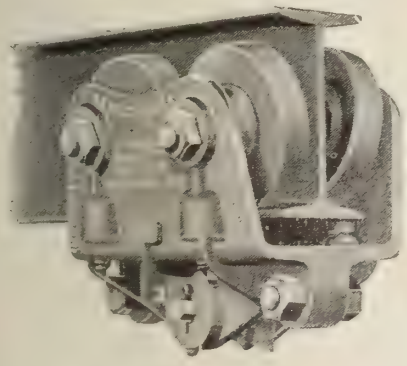
"CYCLONE" High Speed Chain Hoists

When you see the remarkable mechanism of the Cyclone Hoist—how it gets leverage and power without the use of any small gears or pinions—you will understand why it will lift a load with more speed and less effort than any other chain hoist made.

There is less friction—no vibration—just a smooth, easy motion that reduces wear to a minimum, with the result that the Cyclone runs as well after years of service as when new.

Cyclone Hoists are made in sizes from ¼ ton to 40 tons—all sizes as single, self-contained units. Would you be interested in a descriptive booklet or in a demonstration of one of our working models?

Fit running mates for Cyclone Hoists are



"Matchless" Trolleys

The flangeless track wheels of the Matchless never cramp or bind. The trolley is kept in line by free-running vertical guide rollers, adjustable to I-beams of different widths, and the wheels turn on hardened steel roller bearings.

Made plain and geared, in sizes from ½ to 12 tons.

We also supply combined trolley-hoists, single and double I-beam travelling cranes, jib cranes, hand and power winches, trolley frogs and switches, and special hoisting and conveying equipment to suit customers' requirements.

Makers—The Chisholm-Moore Mfg. Co., Cleveland, Ohio

Canadian Distributors:

LYMAN TUBE & SUPPLY CO., LIMITED

MONTREAL TORONTO WINNIPEG NEW YORK

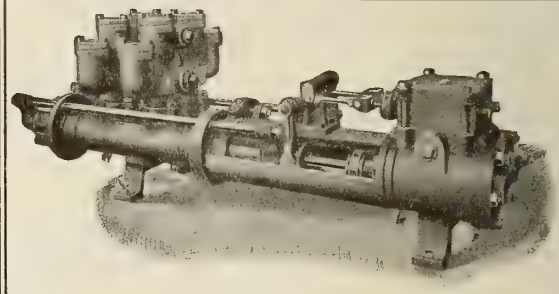
HINTS TO BUYERS

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

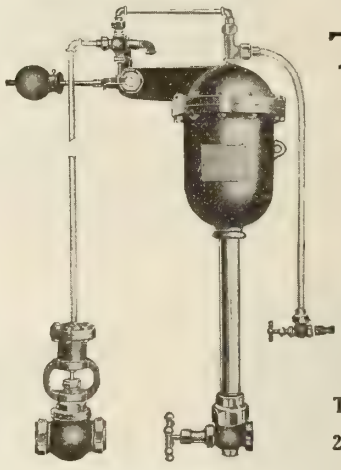
The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300



PUMPS that give
Better Service Longer Service
THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

CRANE FITTINGS

CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary



The Safe Way

Vigilant Water-Feed Regulators

There need be no worry on the part of you or your men in feeding boilers.

The "Vigilant" will automatically hold the water level at middle gauge—the safe, desirable point at which the boiler contains the maximum steam liberating surface.

Write for full particulars to-day?

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

CUT GEARS

In Grey Iron, Steel, Semi-Steel and Bronze.
On a Gleason Gear Planer Bevels cut up to 8 inches diameter.
Spurs cut up to 110 inches diameter.
Any pitch and width of face desired.
We employ three Gleason Gear Dividing Heads in our Plant, and cut wooden cogs in mortise gears with Gleason Attachments.
Largest range of Gear Patterns in Canada.
Our Pattern Shop, Foundry and Enginering Plant at your service.
Send in your inquiries and orders for immediate attention.
THE J. C. WILSON MFG. CO., LIMITED
BELLEVILLE, ONTARIO

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P.Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

LANCO BALATA BELTING
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO
SCANDINAVIA BELTING

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon. W. R. Rollo — **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

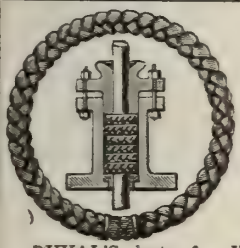
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal

MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

ECONOMIC Carling BLOWERS SUPERIOR

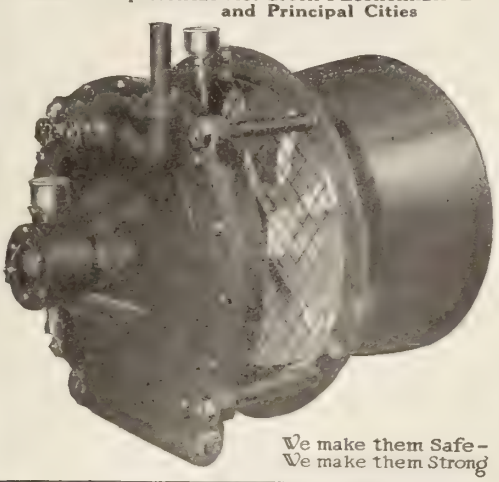
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

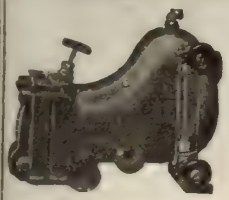
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY,
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong



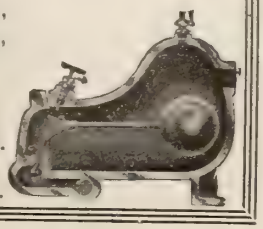
McDANIEL IMPROVED **STEAM TRAP**
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

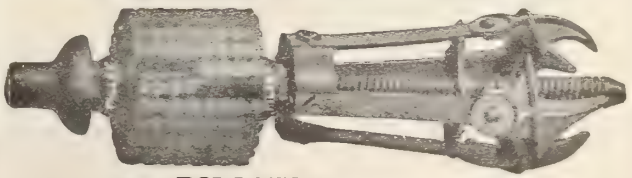
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.

Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

"MEAD-MORRISON"

CANADIAN MM ©

HOISTING

and

Conveying Machinery

Manufactured in Canada

Did you ever figure the cost of a breakdown? It might tie up the whole job.

The "MEAD - MORRISON" name on:—

MINE HOISTS
STEAM or ELECTRIC HOISTS
DREDGING MACHINERY
CLAM SHELL BUCKETS
ORANGE PEEL BUCKETS
CONVEYING MACHINERY

stands for DEPENDABLE SERVICE because they were designed and are built with two ideas in view—low cost of operation and upkeep and absence of breakdowns.

Engineers - Manufacturers - Contractors

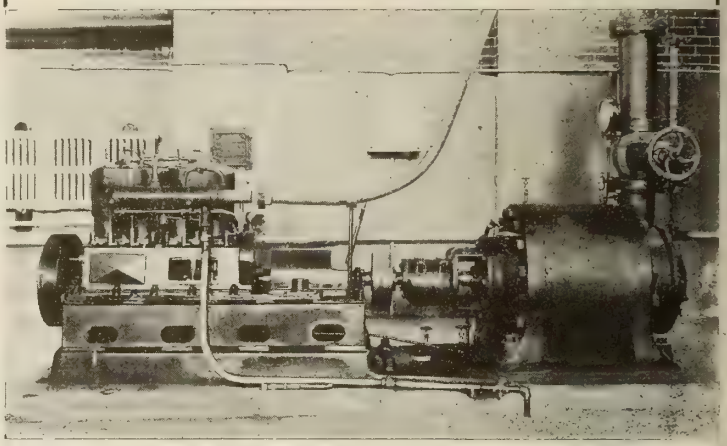
Put Your Problem Up To Us!

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Full Power And Full Speed Immediately!

Sterling gasoline motors are equipped with electric starters and generators and get under way by simply pressing the switch. They are backed by 16 years' leadership in the marine industry, by extensive Navy use, Army Ordnance use, and by many creditable performances as high speed commercial and marine engines.



Sterling 45 H.P. motor direct connected to Allis-Chalmers 2-stage fire pump, suction 8", discharge 6", speed 900 R.P.M., installed at Westmount, Montreal, Quebec.

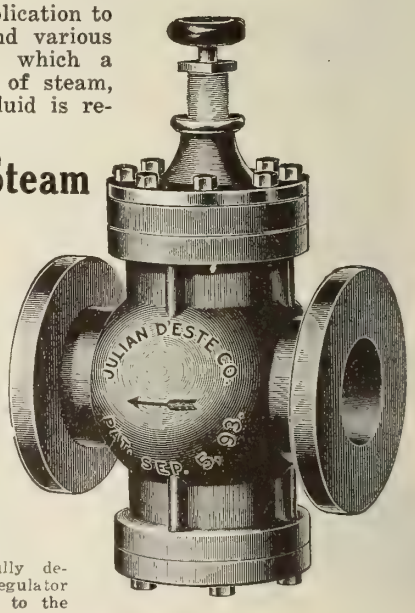
Sterling Engine Co., Dept. C-4, Buffalo, N.Y. U.S.A.
12 to 300 H. P. Speeds of 400 to 1,400 R.P.M.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip or leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

MANUFACTURED BY THE
JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.

Tough as a Tire Tread—
This Hose Cover

IN mines, quarries, tunnel work, shipyards and structural steel work, the tough cover on Goodyear Air Drill Hose and Goodyear Pneumatic Tool Hose has resulted in more work and a lowering of hose cost.

The life of hose in this work depends about 75% on the cover. Dragged over rock and ore and steel girders, tramped on and run over, it takes a tough and well-designed hose to give any length of service.

We have records of Goodyear Air Drill Hose in constant service for 18 months to 2 years.

The cover of white rubber is as tough as a tire tread. It is extra thick. It wears long, even under rough handling.

To balance such a good cover is a specially developed, oil-resisting inner tube; and fabric of extra strength.

So good are Goodyear Pneumatic Tool Hose and Goodyear Air Drill Hose that five-ply is found as satisfactory as six or seven-ply of old-style hose.

The thoroughness with which Goodyear Air Drill and Pneumatic Tool Hose has been designed and built, is paralleled in every kind of Goodyear Industrial Hose. The problems of each industry have been studied carefully. The solution to those problems has been worked out in the Goodyear laboratories. The Goodyear Industrial Hose man has a mighty interesting story to tell to industrial executives. No obligation on your part if you have him call. Just phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service Station Stocks in other Cities

GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Beveridge Paper Co., Montreal, Que
Babcock & Wilcox, Ltd., Montreal.

Your Next Boiler

Most successful Plants have devised "wrinkles" and "betterments" of their own which have given them an outstanding position in their respective industries. We have our full share of them, which is perhaps only what you would expect from a firm like ours with 35 years of experience and the reputation for Quality, Workmanship and Service which our products enjoy. All of which should be taken into consideration when you place your next Boiler order.

Engineering and Machine Works of Canada Limited

St. Catharines, Ont.

Eastern Sales Offices:
Birks Bldg., Montreal, and Hall Machinery Co., Sherbrooke

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd. Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES

Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton. Ont.

COUNTERS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal. Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS

Ministry of Munitions, London, England.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk, Con.

The
Disposal Board have

STOCKS

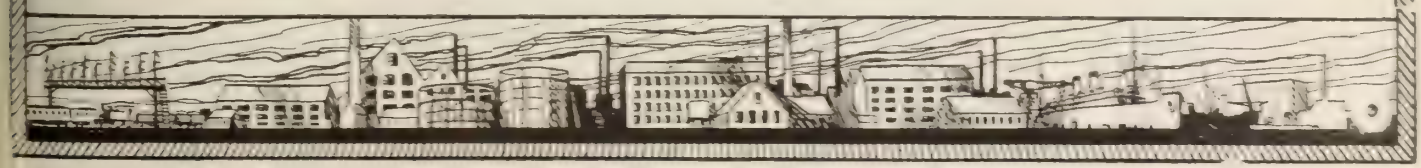
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."



If interested tear out this page and place with letters to be answered

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babock & Wilcox, Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Empire Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Marco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall. Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Fischer Wm. & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Beveridge Paper Co., Montreal, Que.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

The Beginning—

A Good Hide

D. K. McLaren Leathers

Good from Start to Finish

The Hide

Selecting the hides is a very important item in the making of D. K. McLaren's Belts. The greatest care is taken to use exclusively the **FLAWLESS BACKS** of the hides of the choicest steers.

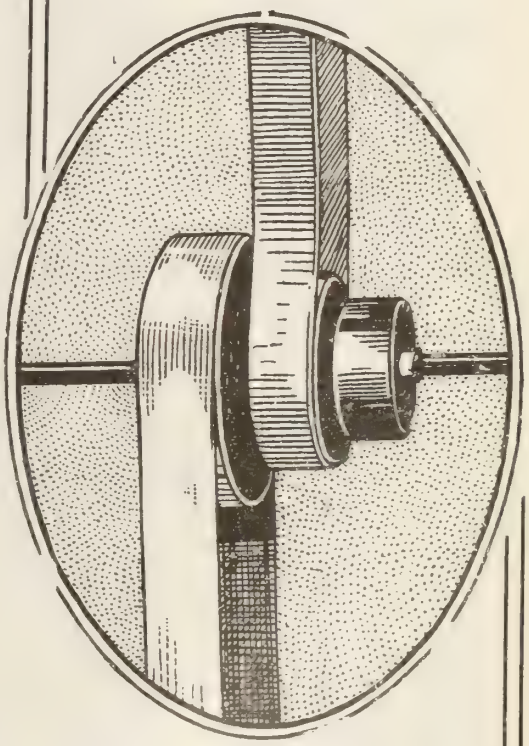
The Tanning

Genuine British Oak Tanning. Therein lies the secret of the toughness and durability of McLaren's Leather Belting. The British Oak Tanning Process is the best process known for preparing belts for hard service. Every bit of the hide's natural strength is preserved.

The Finished Product

Belt slipping is reduced to a minimum by the use of D. K. McLaren's Leather Belting. It transmits all the power a leather belt can transmit. Good quality makes it practically stretchless. Time, labor and attention are saved wherever it is used.

To know what others think of it, write for list of users, then ask them.



The Completion—

A Good Belt

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

HEAD OFFICE AND FACTORY

351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

TORONTO, ONT.	ST. JOHN, N.B.	VANCOUVER, B.C.
194 King St. West	80 Germain Street	334 Cordova West

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co, Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

Showing ease with which Pilbrico is laid in place.

Use PLIBRICO

In Building Your Boiler Furnace Lining

It will outlast any fire brick. An ideal material for front door arches, side walls, combustion chamber linings, bridge walls and baffles. It's jointless. Makes your furnaces Airtight and Saves Coal.

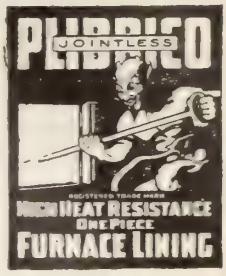
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
№ 60 BROADWAY.

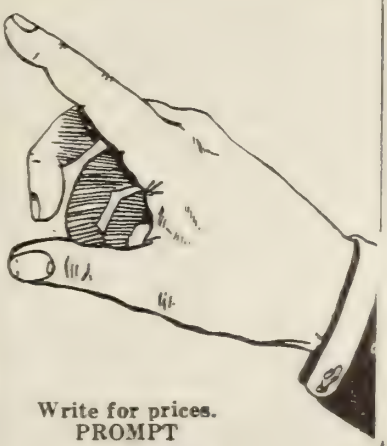
SAN FRANCISCO
RIALTO BUILDING.

Structural Steel and Steel Plate Work

of every Description

Penstocks
Thimbles
Draft Tubes
Wheel Cases
Steel Gates
Racks
Gate Steelwork
Power House Steelwork

MacKinnon Steel Co. Limited



Write for prices.
PROMPT DELIVERIES

Sherbrooke, Que.

Montreal Office:
404 New Birks Building

FOR REMOVING SCALE

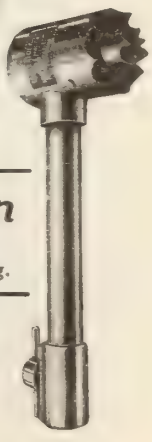
from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★



Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Belford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

LADD

WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

GEORGE T. LADD COMPANY

Farmers Bank Building

PITTSBURGH - - PENN., U.S.A.

'Bishop's Gauge Adamant' Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for

LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

Self-Lubricating

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Practically Frictionless

In Bulk

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

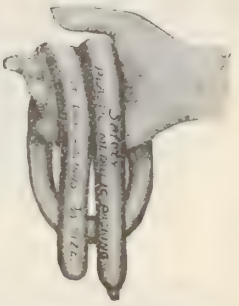
GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED



In Cotton Tubes

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

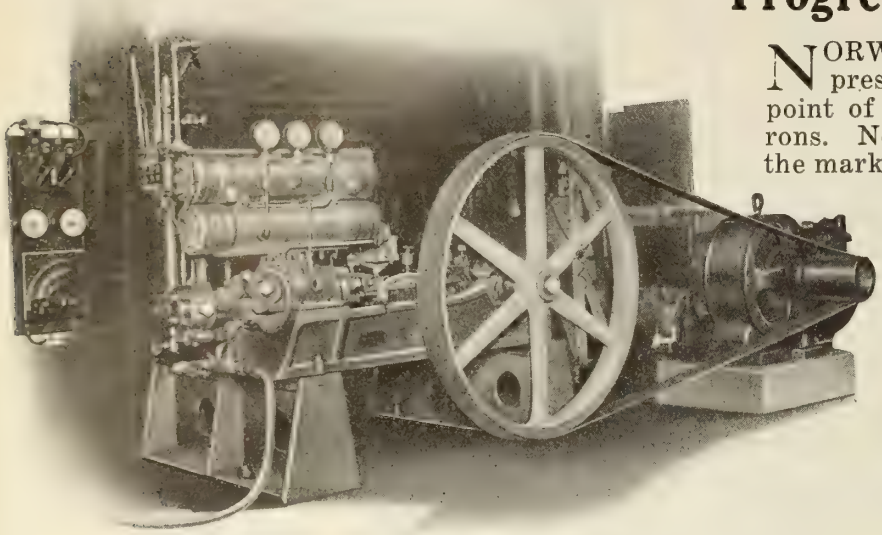
WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

NORWALK
AIR & GAS · COMPRESSORS



A NORWALK COMPRESSOR ON TESTING STAND

Progressive—But Cautious

NORWALK designing of air and gas compressors is progressive—but never to the point of experimenting at the expense of patrons. New features do not find their way into the market on Norwalk machines until they have made good in the factory under long tests—three times as severe as any you will ever be able to impose in actual service.

When considering the purchase of a compressor for any kind of service investigate Norwalks. Bulletins on air, oxygen, hydrogen, crabolic acid gas or acetylene mailed on request. Write for the ones you need.

THE NORWALK IRON WORKS CO.

Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

INDEX TO ADVERTISERS

Anderson, The V. D. 53
All-Way Oiler Manufacturing Co..... 56

Badger & Sons Co., E. B. 7
Betson Plastic Fire Brick Co..... 52
Bishop & Co., S. & C..... 71
Busch-Sulzer Bros.—Diesel Engine Wks 69

Canada Link Belt Co. 51
Can. Fairbanks-Morse Co. 41
Can. Farnsworth Co.....Inside back cover
Can. Mead-Morrison Co. 60
Carling Turbine Blower Co. 59
Chaplin-Fulton Manufacturing Co..... 58
Crane, Limited 58
Cole, Limited, Geo. W. 48
Coppus Eng. and Equipment Co..... 11

Darling Bros. 58
Dart Union Company 46
Detroit Stoker Company 14
Department of Labor 59
D'Este Company, Julian 60
Dominion Belting Company 52
Durabla Manufacturing Company..... 12

Electric Welding Company, The..... 58
Eng. and Mach. Works of Canada, Ltd.. 63

Federal Engineering Company 58

Gattos Refractories, Limited 2
Gilman, Frank 69
Goldie & McCulloch Co. 16
Green's Economizer, Limited 53
Goodyear Tire and Rubber Co. 61
Gunns, Limited 42

Hamilton Co., Ltd., William 49
Hays School of Combustion 43
Hints to Buyers 58
Homestead Valve Manufacturing Co.... 53
Hoyt Metal Company 2

Imperial Oil Company 3

Jeffrey Manufacturing Co. 48
Jenkins Bros. 45
Jointless Fire Brick Co..... 69
Jones Underfeed Stoker Co. 56

Ladd Co., The George T..... 71
Laurie & Lamb 59
Leitch Co., The Arthur S..... 55
Leonard & Sons, E. .....Inside front cover
Linde Can. Refrigeration Co., Ltd., The 10
Lunkenheimer Company 47
Lyman Tube and Supply Company..... 57

McAvity & Sons, Ltd., T..... 4
MacKinnon Steel Company 69
Manny Co., The E. S. .....40 and 42
Mason Regulator and Engr. Co..... 1
Minimax Electric Company 42
Morrison Brass Manufacturing Co., Jas.
Outside back cover
Mine Safety Appliance Co..... 49
Ministry of Munitions 65
McLaren, D. K. 67
Murphy Iron Works 7

Northern Electric Company 5
Norwalk Iron Works .....10 and 72

Page-Hersey Iron, Tube and Lead Co... 12
Penberthy Injector Co., Ltd. ..Front cover
Philip & Sons, E. J..... 8
Pittsburgh Pipe, Coil and Bending Co... 9
Pilley Packing and Flue Brush Mfg. Co. 59

Refrigeration Department 10
Robb Engineering Works 50

Sanford-Riley Stoker Company 7
Sarco Company, Inc. 42
Scaife, Wm. B., & Sons Co..... 72
Sexton Boiler Setting Company..... 13
Shell-Bar Boico Supply, Ltd..... 46
Smart-Turner Mach. Co..... 58
Standard Mach. and Supplies, Ltd..... 54
Starrett Co., L. S. 7
Steel Mill Packing Company 71
Sterling Engine Company 60
Sturtevant Co., B. F. 15

Tagliabue Company C. J..... 9
Taylor Instrument Company 56

Valve Engineering Co. 6
Victoria Foundry Company 58

Wall, J. W. 59
Watson & McDaniel Co..... 59
Wilson Manufacturing Co., J. C..... 58
Williams Co., J. H..... 4
Worthington Pump and Mach. Corp..... 44

York Manufacturing Company..... 8

Put a Farnsworth System to Work in Your Steam Plant

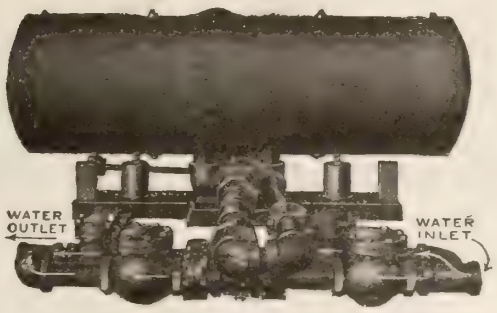
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no trunnions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE

Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

MORRISON

STEAM GOODS

J.M.T. Globe Valve

J.M.T. Reducing Valve

Made to Give Long and Satisfactory Service

Every time you send in an order for Morrison products you may be sure you are going to receive goods which will give really efficient, long service—goods that are approved by the Provincial Inspection Departments—that are tested and guaranteed by us.

Some of Our Lines

Stop Valves	Steam Traps	Vacuum Gauges	Lubricators
Check Valves	Injectors	Ammonia Gauges	Pipe Fittings
Gate Valves	Ejectors	General Boiler Mountings	Steam Whistles
Safety Valves	Inspirators	Gauge Board Outfits	Engine Indicators
Relief Valves	Jet Pumps		Pipes, Tools, etc.
Reducing Valves	Steam Gauges		

We shall be pleased to forward full information of the lines in which you are interested.

The James Morrison Brass Mfg. Company, Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

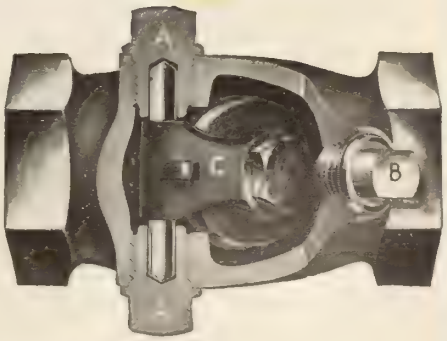
Vol. XIII.—No. 9. Publication Office, Toronto—May 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE PENBERTHY MARK.

SWING CHECK VALVES

External View

Registered and approved for 200 lbs. steam pressure



Sectional Top View

"BUILT FOR SERVICE"

Note the correct angle at which the disc rests when closed. Prevents opening of same from pressure of condensed water in pipe, or from pipe line getting out of true. The body of the valve proper is not subject to wear from action of disc, as the hinge pin "C" bears on the two end plugs "A," and these parts can be renewed at very little cost. In some makes of valves the hinge "C" rides in a groove of the body proper and in case wear throws the disc out of line, the whole valve has to be replaced.

The double plug construction enables the valve, if installed in a wall pipe, to be taken apart without taking down the pipe line, as one plug is always accessible. The valve can be reground in a very few minutes, making same as good as new. The metal is of excellent quality and is distributed evenly and liberally throughout body and diaphragm to insure strength.

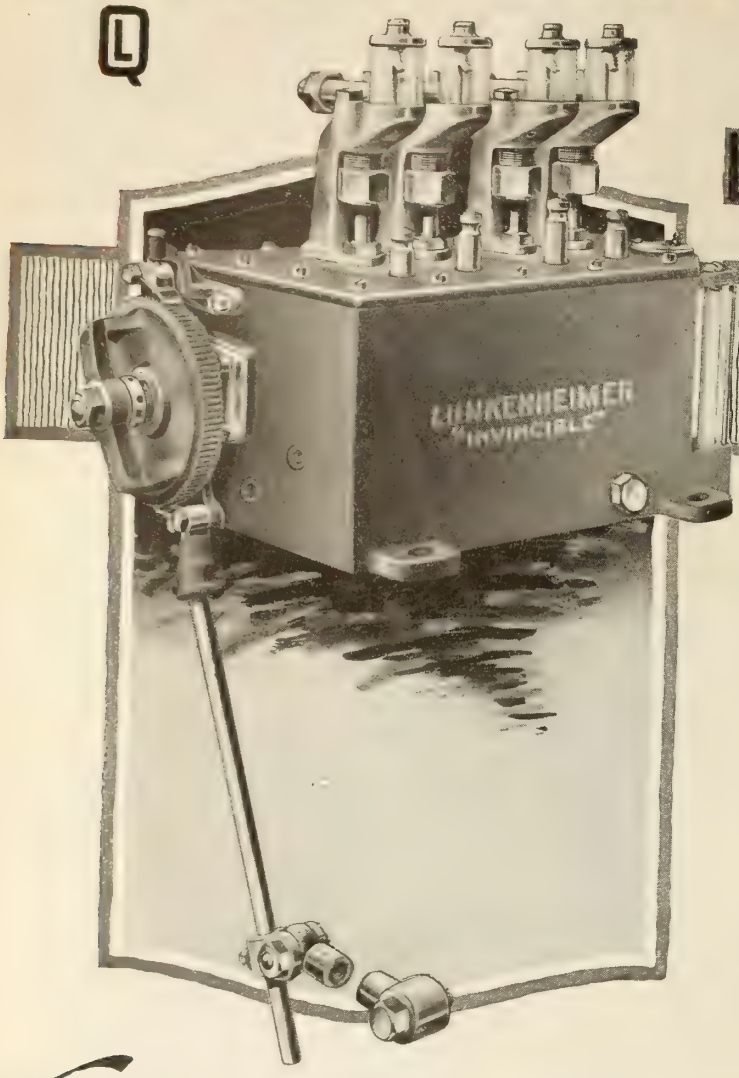
BE SURE THIS NAME IS ON THE VALVE YOU BUY

MANUFACTURED BY

PENBERTHY INJECTOR CO., LIMITED - WINDSOR, ONTARIO

LUNKENHEIMER

CYLINDER LUBRICATORS



AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862

For Steam and Oil Engine, Pump and Air Compressor Cylinders

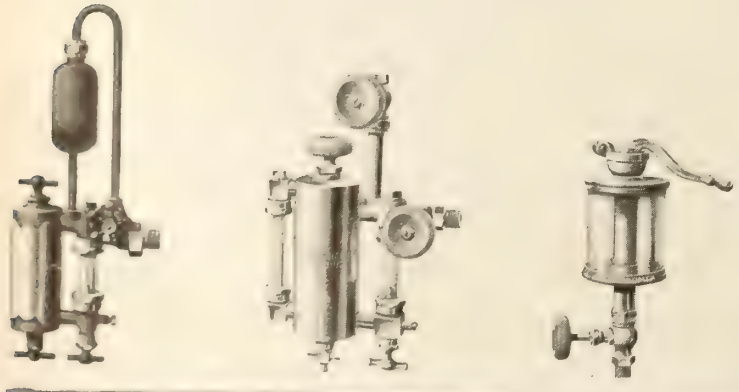
Dependable lubrication,—the delivery of the proper quantity of oil to the cylinders—is assured when power units are equipped with Lunkenheimer Cylinder Lubricators. They are positive in operation, delivering uniformly until reservoir is empty the exact quantity of oil for which the feed is set.

The feed regulation permits of close adjustment, the oil drops form perfectly and are clearly visible in the large sight-feeds. Lunkenheimer Cylinder Lubricators are made in a variety of types, including Hydrostatic, Hand and Mechanically operated,—practical in design, and durable because of the high quality materials used. All the parts are interchangeable and can be renewed should necessity require.

Equip with "LUNKENHEIMER" CYLINDER LUBRICATORS and satisfactory service is assured.

Write for descriptive booklets No. 526—DC. and 572—DC.

Their installation means permanence; their simplicity and durability—continuous service



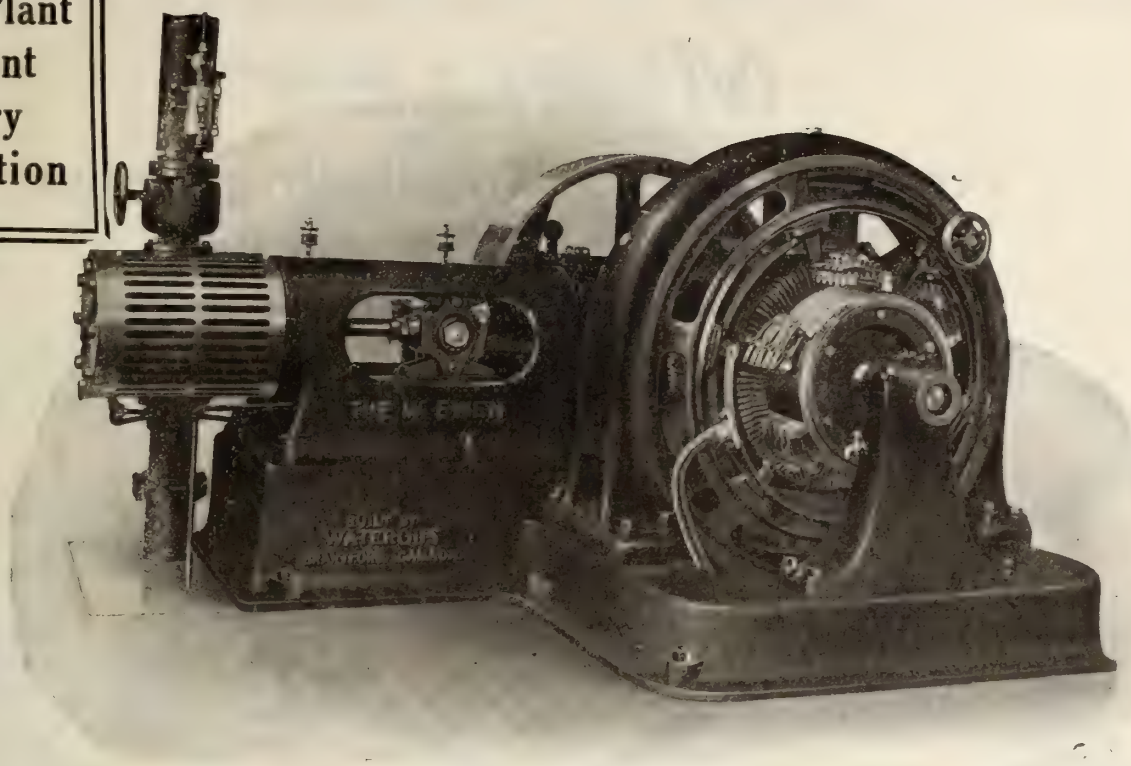
THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

Your careful investigation of their actual service performance record in all parts of the country specially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

Waterous

BRANTFORD, ONTARIO, CANADA

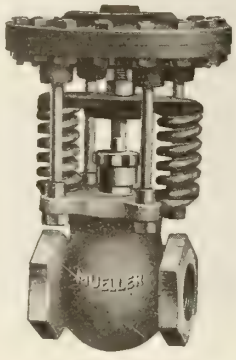
POWER HOUSE, May 5, 1920, Vol. XIII., No. 9. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

MADE IN CANADA

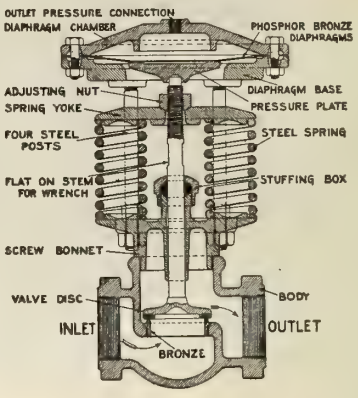
MUELLER

Reducing and Regulating Valve and Pump Governor

For Steam and Oil; Single Seat; Direct Operated



No. A5120
Code—*Ranchero*



This valve is for protection against abnormal rises in initial pressure and where a reasonable variation in the delivery pressure is not objectionable.

For pump governors, power purposes and blower engines it is unexcelled.

It operates most efficiently where the initial pressure is constant and the required reduction is not too great.

Regulators of this description are suitable for pressures up to 150 pounds. For pressures in excess of 150 pounds, submit specifications.

WE MAKE MUELLER

Basin and Bath Trimmings, Bibbs, Sill Cocks, Ferrules, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps; Regulators and Reducing Valves for Water, Air, Steam and Oil; Bubbling Fountains, Gas Cocks, Globe, Angle and Check Valves, Etc. Forgings in Brass; Castings in Brass, Bronze and Aluminum; Specialties for Automobile Companies, including Bronze Bushings, Gasoline Cocks, Etc.

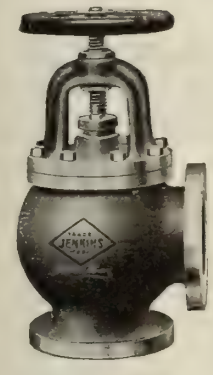
H. MUELLER MFG. CO., LTD.
SARNIA CANADA

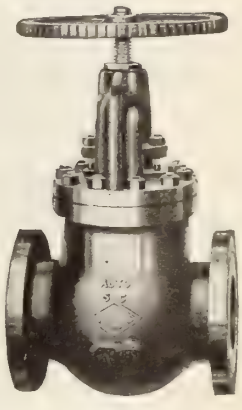
Are you on our Mailing List

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS

JENKINS VALVES

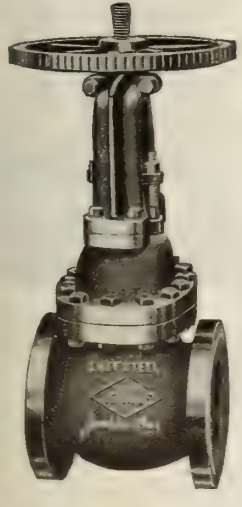
TRADE JENKINS MARK





Jenkins Bros.

Built With a High Safety Factor

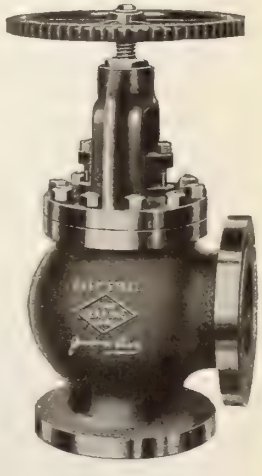


Jenkins Valves are carefully constructed to withstand excessive strains at particular points—and then some! To stand up under the greatest strain to which they may be subjected is not enough—a high safety factor must maintain the Jenkins reputation.

Scientifically Selected Metals

Jenkins Valves are made of metals scientifically chosen to balance the varying temperature to which valves may be subjected or — as with manganese bronze and monel metal spindles, to withstand corrosion.

Correct design, scientifically chosen metals and careful construction—these are the reasons why you can depend on Jenkins Valves for reliable service.



TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi St. Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway London, W.C. 2, England

TRADE JENKINS MARK Jenkins Bros

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

Alloys are solutions of one metal into another and the degree of solubility varies.

The term "fusible metals" is usually applied to alloys whose melting point is below that of tin. The lowest freezing point in a series of alloys was first designated by Doctor Guthrie as an Eutectic. The eutectic structure is defined as being composed of the different constituents in juxtaposition. There is a natural limit of saturation in a solid compound, just as there is in a liquid compound, and when that limit is reached the undissolved portion separates and falls out, as it were, into the matrix or eutectic and at that point occurs the lowest freezing point or eutectic, which is also the lowest melting point.

In an alloy composed of lead and antimony, 13 per cent. of antimony is the natural limit of saturation and any antimony in alloy in excess of 13 per cent. can be easily seen in the eutectic compound under moderate magnification in the form of crystals, but the antimony dissolved in the eutectic compound is so intimately mixed and finely divided that the highest magnification is required for its resolution. As the undissolved antimony crystals multiply and become attached to one another, forming bridges, the alloy becomes increasingly brittle to the extent of the antimony used in excess of 13 per cent.

The fusing point of an alloy is always less than the mean of its constituent metals and the fusing point of trianary or quaternary alloys containing, respectively, three and four elements, are lower than a binary alloy. The molecules of different elements combined are supposed to be in constant motion in effort to adjust their crystalline structures, which likely accounts for alloys having lower fusibility than the single metals of which they are composed.

Continued next month.

For copy of complete article:

"New Truths and Old Fallacies"

Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:

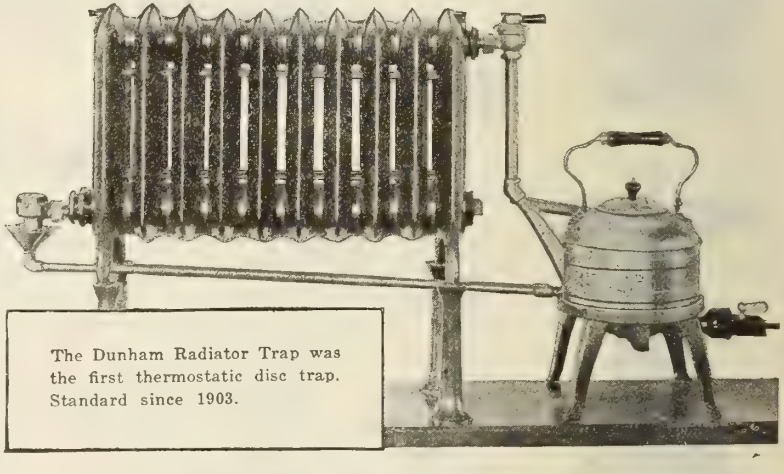
Montreal: 225 St. Ambrose St.

Heating a radiator with a teakettle

It was done at the Ottawa Technical School before a group of engineers who were amazed at the demonstration. It proved beyond question that low pressure steam will quickly heat a radiator to 100% efficiency if the trap is right. It undisputably proved that the Dunham Radiator Trap functions perfectly.

Since 1903, the Dunham Radiator Trap has been eliminating any chance of trap trouble in thousands of installations. It was the first thermostatic disc trap. Think of this when you think of traps, and remember that the Dunham Trap is only one element in Dunham Heating Service. The entire service offers much to the man who plans, sells and installs the heating system—and more to him who pays the bills.

If you welcome suggestions that do not obligate you, get in touch with our nearest office. For authoritative information, write for booklet, "Data on Dunham Heating."



The Dunham Radiator Trap was the first thermostatic disc trap. Standard since 1903.

The DUNHAM HEATING SERVICE

Made-in-Canada

C. A. DUNHAM COMPANY, LTD.

TORONTO, ONTARIO

HALIFAX OTTAWA VANCOUVER MONTREAL WINNIPEG CALGARY

LONDON: 64 REGENT HOUSE, REGENT STREET, W.1

For forty years the accuracy of machine shop work has been measured by

Starrett Tools

Catalog No. 21 "CD" sent on request

The L.S.Starrett Co.
THE WORLD'S GREATEST TOOLMAKERS
MANUFACTURERS OF HACK SAWS UNEXCELLED
Athol, Mass. U.S.A.

Starrett Tools

Firing that is Different

WITH the RILEY STOKER the coal is fed—the fire cleaned—the ash discharged, *continuously* and *automatically*. All done without waste or effort, efficiently and economically.

It is not only the things the RILEY STOKER does but the way it does them. For instance, when steam is wanted quickly and time is precious, you can get this steam instantly and economically by increasing the motion of the grates.

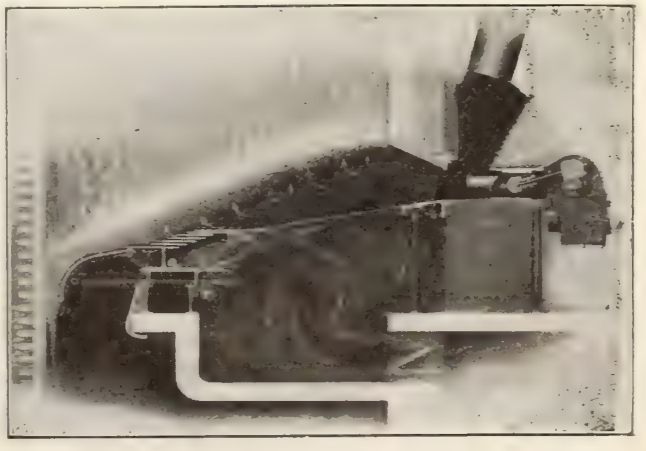
With the first turn of the cranks the grates start moving—the whole fuel bed is thrown into action. There is no watching nor waiting—poking nor slicing—the stoker responds instantly and in two or three minutes the boiler will be operating at 200 or 250% of rating.

It is this kind of flexibility that saves not only for the central station but for the industrial plant.

Riley Stoker Catalog HR-5 sent on request

For information on Murphy Automatic Furnaces for small boilers, see April 25th advertisement or send for Murphy Furnace Catalog HM-5.

Sanford Riley Stoker Co.
WORCESTER, MASS.
British Licensee: Erith's Engineering Co., Ltd., London
French Licensee: Erith, Leroy & Cie., Paris, France



Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

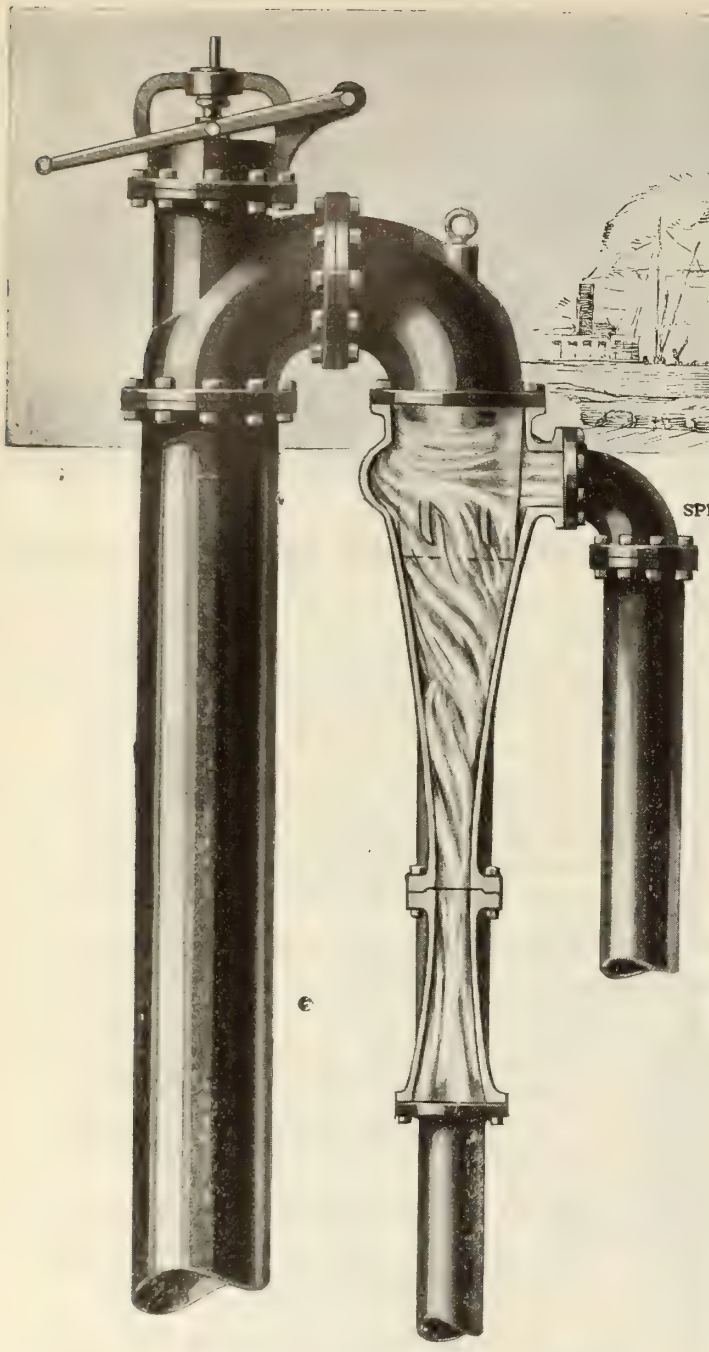
Permanent CO_2 Record in Engineer's Office
Fireman's CO_2 Guide on Boiler Front
Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet
"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.
Combustion Engineers
2008 EMPIRE BLDG., NEW YORK

WORTHINGTON
SPIROJECTOR CONDENSER



Utility and Economy are both served by Worthington

FOR installations of condensing machinery where first costs, economical maintenance and efficient performance are equally vital, Worthington Spirojector Condenser enjoys great favor.

Worthington Spirojector is of the syphon type with particular Worthington construction features that assure steady, perfect vacuum without aid of vacuum or dry-air pump. Air and non-condensable vapors are entrained and carried out by the falling water which is injected at opening below elbow in exhaust pipe and discharges as a rapidly descending spiral current of water.

Worthington builds all types of condensing machinery and since 1840 has developed a service and organization which is world-wide. Engineering service is freely tendered and carries with it no obligation to you.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

Other Worthington Products:
Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, and Vacuum Pumps.

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

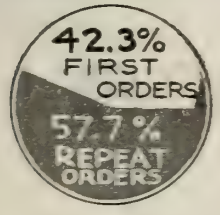
WORTHINGTON

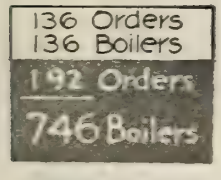
Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Epping-Carpenter, *Pittsburgh, Pa.*
Laidlaw Works, *Cincinnati, Ohio.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.

420,500 hp. BOILERS EQUIPPED in JAN.-FEB., 1920

Industrial America Says "Yes!"

When, in a period of sixty days, Industrial America orders Diamond Soot Blowers to equip the enormous total of 420,500 H. P. of boilers—the event is of national importance. It seems probable that never before in the history of power equipment has a single make of boiler room apparatus of any type for any service, been ordered or applied to as many boilers. What is the secret behind this tremendous vote of confidence? Is it to be found in a record of 18 years of genuine service—during which Diamond Soot Blowers have saved millions of tons of coal and millions of dollars in labor—and have stood up and performed their functions satisfactorily under the hardest operating conditions, justly earning a reputation as ***"the best paying investment in the power plant?"*** Industrial America says "Yes!"





Tremendous Horsepower Involved: Measured in central stations, the boilers equipped with Diamond Soot Blowers in January and February are equivalent to twenty large Edison plants. They are as powerful as harnessed Niagara. It would take a train of flat cars eight miles long to hold them.

25 Makes of Boilers Equipped: A total of 328 orders to equip 932 boilers and economizers was received. These included 23 different makes of water tube boilers, to say nothing of fire tube boilers and economizers. Among prominent makes were B.&W, Badenhausen, Bigelow-Hornsby, Casey Hedges, Connolly, Edgemoor, Erie City, Heine, Keeler, Kidwell, Stirling, Union, Wickes, etc.

57.7 Per Cent Repeat Orders: Of the 328 orders received, only 139, or 42.3% were first orders. The remaining 57.7% were repeat orders. Note the records of a few representative concerns.

Penna. Utilities Co. . .	9th order
Ford Motor Co. . . .	11th "
Texas Co.	11th "
Inland Steel Co. . . .	11th order
Cent. Illinois Pub. Ser. .	12th "
W. Va. Pulp & Paper Co.	14th "
Standard Oil Co. . . .	16th "
Brooklyn Edison Co. .	16th "
Armour & Co.	16th "
General Electric Co. . .	27th "

Two-Thirds of Orders Cover Two or More Boilers: Of a total of 328 orders to equip 932 boilers, 136 orders covered one boiler each, and 192 orders covered 796 boilers—an average of four each. Here are some typical orders:

Minnesota Steel Co. . .	11 Boilers
Standard Oil Co. . . .	12 "
Brooklyn Rapid Transit .	18 "
Minn. & Mt. Power Co. .	24 "
Naragansett Elec. Co. .	28 "
Great Northern Paper .	30 "
Proctor & Gamble . .	50 "
W. Va. Pulp & Paper Co.	23 Economizers

The savings in fuel and labor, and the increased boiler efficiency effected by Diamond Soot Blowers are directly responsible for these orders. If your boilers are not equipped, you owe it to yourself to write for full information.

Obey That Impulse

TEAR HERE

DIAMOND SPECIALTY COMPANY
WINDSOR, ONTARIO

Please send me your bulletin and complete information on Diamond Soot Blowers.

No. boilers_____ H.P. ____

Make boilers_____ Pressure

Name and Address_____

P H.

DIAMOND SPECIALTY COMPANY
Windsor, Ontario

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

(Look for this trade mark)

GUTTA PERCHA & RUBBER LIMITED

TRADE P.M.S MARK

PAPER MILL SPECIAL

TORONTO — CANADA

The Belt that Set the Pace

For Cone Drives and other Difficult Transmission Service

Manufactured solely by

GUTTA PERCHA AND RUBBER LIMITED

Head Offices and Factory: TORONTO

Branches in all the leading cities of the Dominion

How do you buy a steam trap?

DO you look for simple, sturdy construction? Sure you do—the simpler the better—because that means fewer, easier repairs, if any.

Do you look for steady, reliable, uncomplicated operation? Of course—if it doesn't work you don't want it.

Do you look for a good record of results accomplished for other users? Certainly—you want a trap with a good reputation—one in which others feel confidence.

All right; now here's the Johns-Manville Steam Trap, the simplest Steam Trap made—and unequalled for rugged strength. It operates continuously and faithfully—without any fussy mechanism to get out of order. And thousands in satisfactory service bear witness to its good repute.

How it works

It's a hollow copper ball that does the work. As water flows into the trap, the ball rolls up, exposing the outlet, and water is discharged. Any air that may be present is also drawn off. But when the water level falls, the ball rolls down with it and steam cannot pass the trap.

Canadian Johns-Manville Co., Limited.

Montreal Toronto Vancouver Winnipeg
London Hamilton Ottawa

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION *that keeps the heat where it belongs*
CEMENTS *that make boiler walls leak-proof*
ROOFINGS *that cut down fire risks*
PACKINGS *that save power waste*
LININGS *that make brakes safe*
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE

POWER PLANT MATERIALS

LINDE

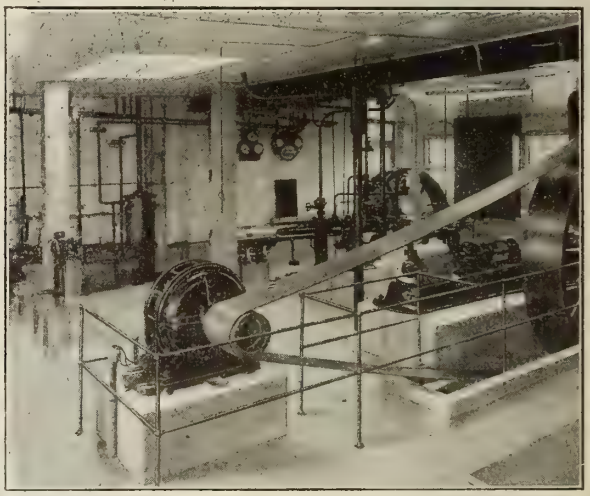
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

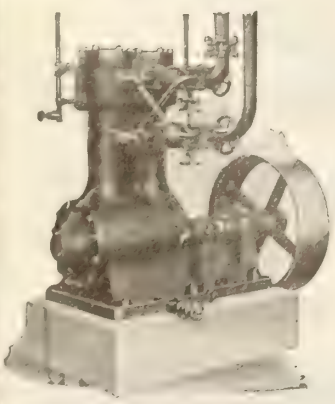


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Saving Time and Money

Nonpareil Corkboard Insulation is manufactured in three separate factories—two on this side of the Atlantic Ocean and one on the other—and is stocked in warehouses located in many of the principal cities of the United States and Canada.

Such extensive manufacturing and distributing facilities afford significant advantages to the buyer of insulation—particularly in these days of crippled transportation systems. They make possible shorter railroad hauls, quicker deliveries, and a substantial saving in freight charges on less than carload shipments.

Top—Factory at Camden, N.J.
Centre—Factory at Beaver Falls, Pa.
Bottom—Factory at Seville, Spain.

The merits and various uses of Nonpareil Corkboard are explained clearly in the 152-page illustrated book, "Nonpareil Corkboard Insulation." Send for a copy to-day--it will cost you nothing.

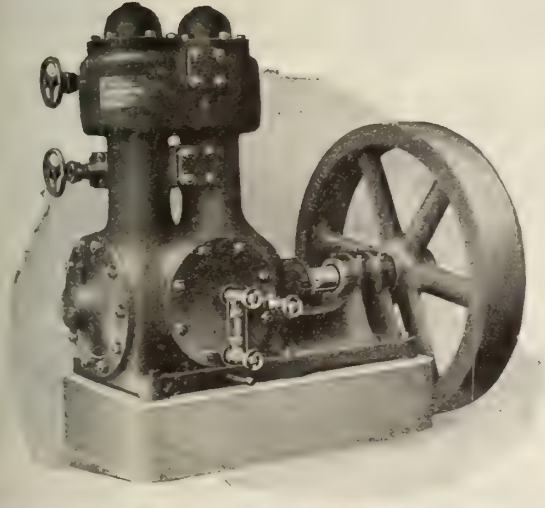
ARMSTRONG CORK & INSULATION COMPANY 504 McGill Building., Montreal, Quebec.

Also manufacturers of Nonpareil Cork Covering for cold pipes; Nonpareil High Pressure Covering for steam lines: Nonpareil Insulating Brick for boiler settings, etc.; Nonpareil Cork Machinery Isolation for deadening the noise of machines; Circle A Cork Brick for cold storage room floors; and Linotile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to **your** business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St.
TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals
MONTREAL, 324 Craig St. West
CALGARY, 605 Second St.

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

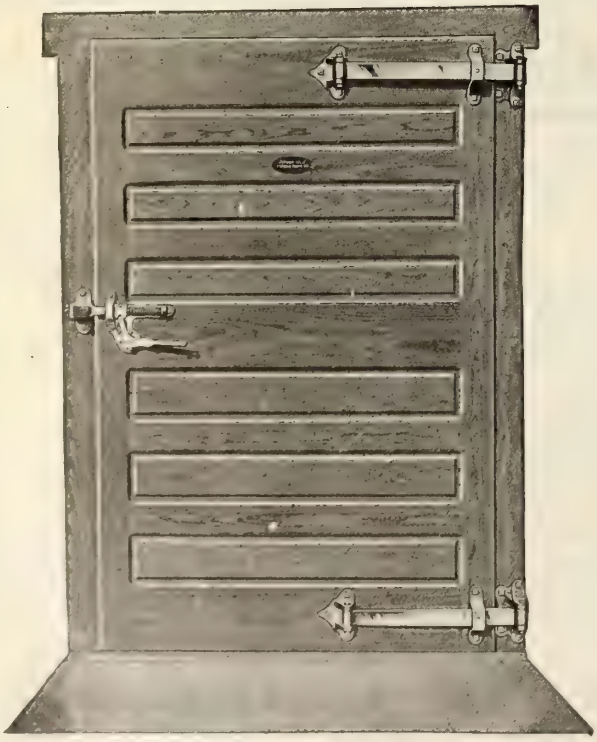
Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant**, as we find **them substantially made** and the **insulation perfect.** We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are **equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The **doors supplied by you, in use at both plants, have been in every way satisfactory,** and we think the **Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

GARLOCK PACKING

For High Pressure Steam Rods
Use Garlock Style No. 200

For Medium Pressure Steam Rods
Use Garlock Style No. 446

For Low Pressure Steam Rods
Use Garlock Style No. 333

For Worn or Scored Piston Rods
Use Garlock Style No. 336

For Cold Water Piston Rods
Use Garlock Style No. 99

For Inside Packed Plungers
Use Garlock Style No. 260

For Outside Packed Plungers
High Pressure Hot Water
Use Garlock Style No. 1907

For Outside Packed Plungers
High Pressure Cold Water
Use Garlock Style No. 960

These Packings are Guaranteed to Give Satisfactory Service Under the Above Mentioned Conditions.

THE GARLOCK PACKING COMPANY
Hamilton, Ont.
BRANCHES IN PRINCIPAL CITIES

A Boiler Plant where–

Engineering practice in boiler building has seen many changes in the last 35 years. We have been through them all. Our shop is fully abreast of the times—and we have a few exclusive "betterments" that we have worked out for ourselves. But we have never yet found any idea to beat the one we started with—to build every Boiler so well, so "whole-heartedly" if you will, that it will be certain to sell at least one more for us. We may not be able to suit everybody, but our work assuredly appeals to the man who wants THE BEST.

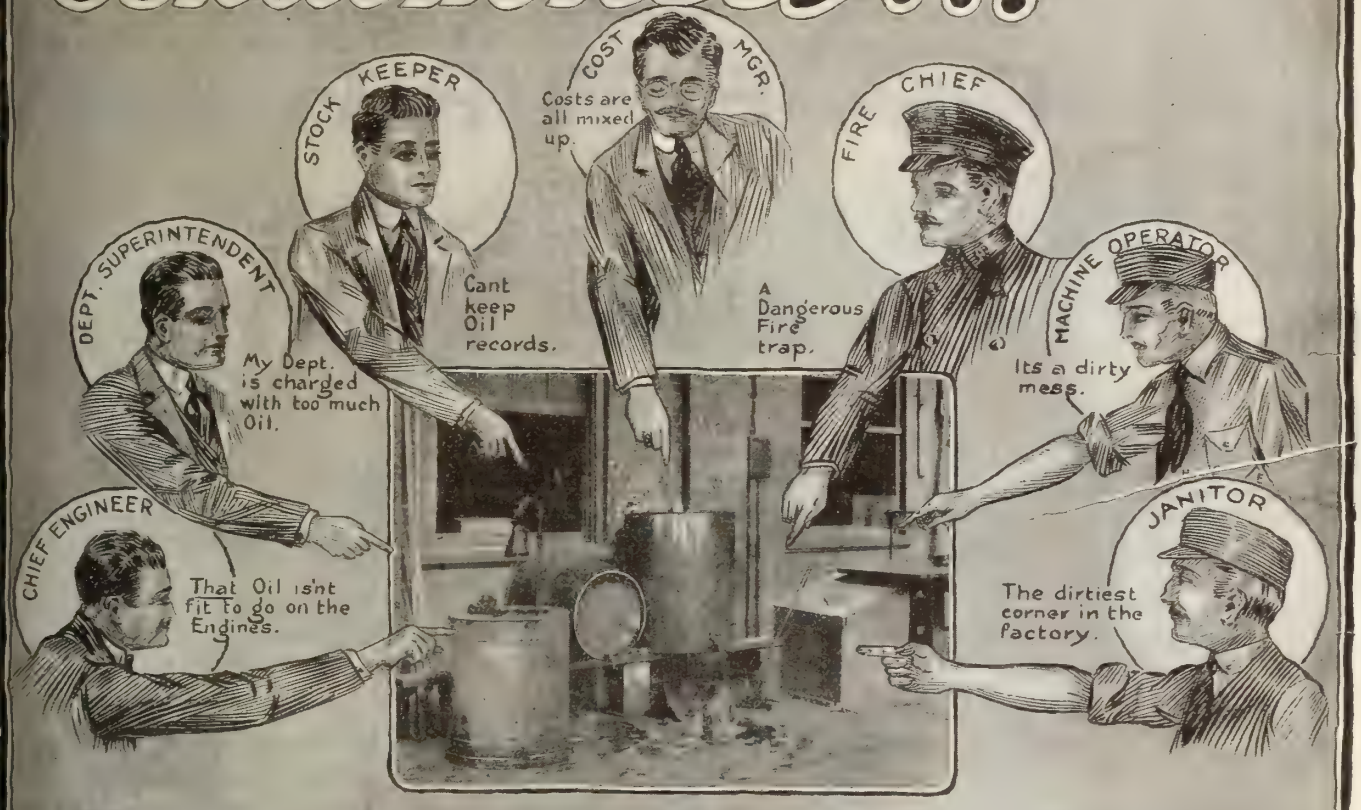
Service Counts

Engineering and Machine Works of Canada
Limited

St. Catharines, Ont.

Eastern Sales Offices:
Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Condemned!!!



MEN WHO KNOW, condemn tin tank and barrel storage, because they *waste time, money, labor,* and *oil.* Besides they are a *dangerous fire risk.*

BOWSER
ESTABLISHED 1885

Systems Remove Such Conditions

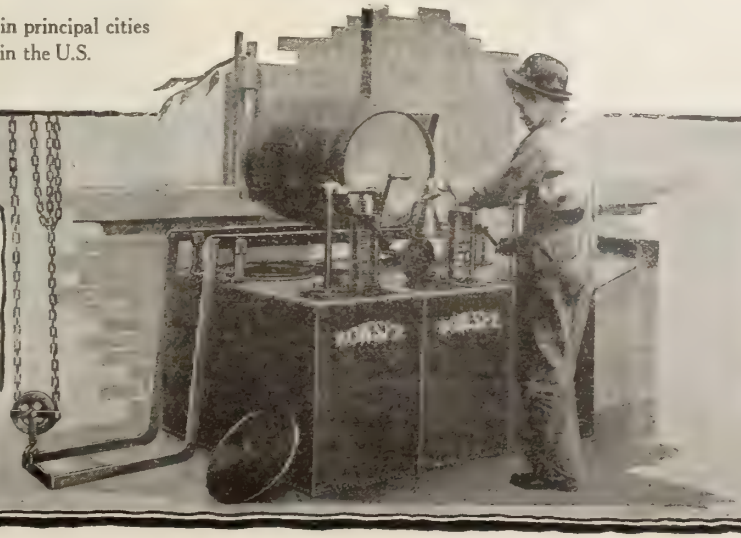
They are clean, safe and compact; efficient, accurate and reliable. Fire and explosion proof.

"THE OIL YOU'VE LOST WOULD PAY ITS COST"

Start buying yours today. Write for details.

S. F. BOWSER & COMPANY, LTD.
66-68 FRASER AVE., TORONTO, CANADA

Offices in principal cities in the U.S.



LONDON
32 Victoria St S W 1

HAVANA
Lonja del Comercio 427

PARIS
5 Rue Denis-Poisson

SYDNEY
6 Castlereagh Street

Illustration at the left shows Bowser Battery, Fig 64's, installed in place of the barrels shown in above view.

Notice the improvement in surroundings and method of handling oils

REES RoTURBo

Rotary Jet Condensers and Vacuum PUMPS

Sole Canadian Manufacturers

The REES-RoTURBo products are widely used in Great Britain and United States and are recognized as the very latest development in this class of apparatus, which include REES-RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Vacuum Air Pumps.

The Rotary Jet Condenser is used in connection with steam turbines and reciprocating engines. It is particularly adaptable to sugar and salt boiling plants, etc. The Rotary High Vacuum Air Pump is identical in principle with the Jet Condenser and possesses similar advantages. **Made in Canada by the G. & McC. Co. only.**

The engineering profession of Canada is well acquainted with the **quality** in construction that typifies all G. & McC. Co. products —this **quality** is thoroughly maintained in REES-RoTURBo Rotary Jet Condensers and Vacuum Pumps.

Catalogues Containing Complete Description will be Mailed on Request

The Goldie & McCulloch Co., Limited

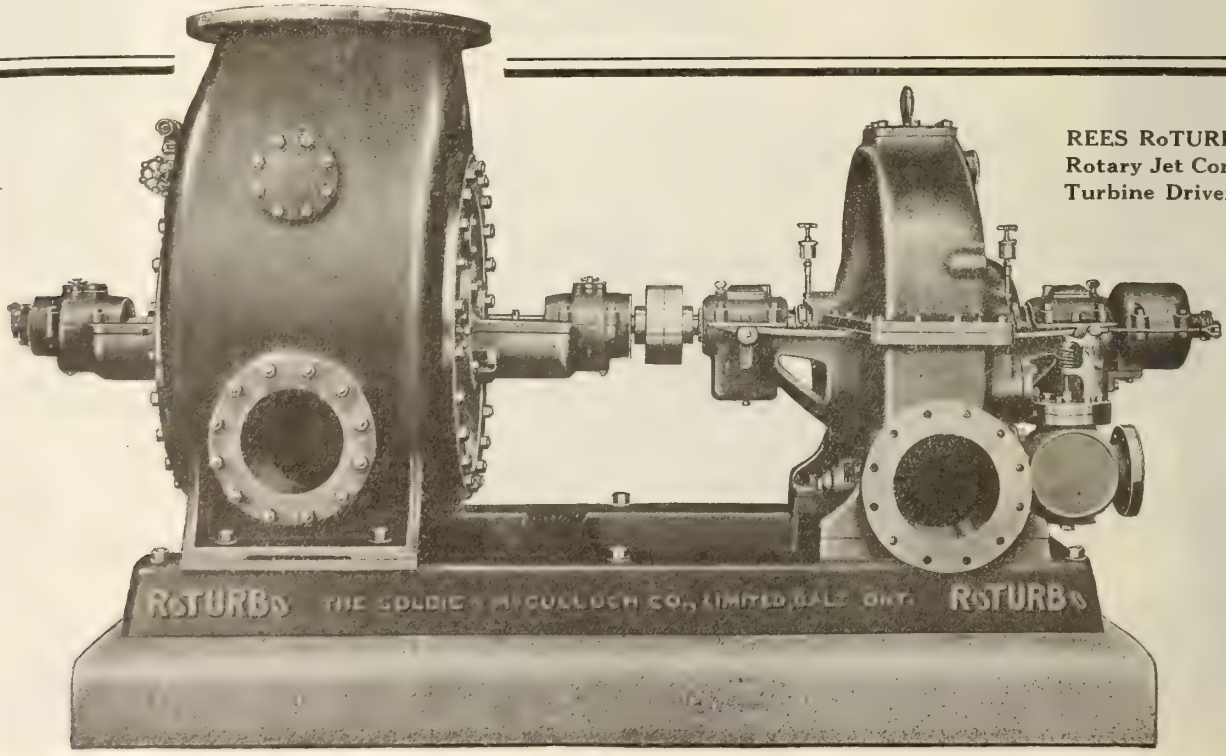
Head Office and Works, GALT, Ontario, Canada

Toronto Office
Suite 1101-2
Bank of Hamilton Bldg.

Western Branch
248 McDermott Ave.,
Winnipeg, Man.

Quebec Agents
Ross & Greig,
400 St. James St., Montreal.

British Columbia
Robt. Hamilton & Co.,
Bank of Ottawa Bldg.,
Vancouver, B.C.



REES RoTURBo
Rotary Jet Condenser
Turbine Driven

POWER HOUSE

Established 1907 | Canada, $2.00 per year; U.S. $2.50 per year. | Published Semi-monthly

A Paper on Modern Boiler Practice

The Following Paper Read Before the Engineering Institute of Canada Gives a Very Complete Account of the Trend in Modern Boiler Design and the Economies Effected Thereby

By F. A. Combe, A.M.E.I.C., Consulting Engineer

THE object of this paper is to give a brief outline of the principles governing boiler and furnace design, with a review of our present knowledge of the laws related thereto, and the trend of modern practice, together with some general notes regarding boiler installation and operation which may be of interest to Canadian engineers and possibly timely in view of the number of new steam plants and extensions to existing plants which it is expected will be undertaken in this country, now that war restrictions have been withdrawn.

During the last eight years there has been a considerable advance in the art of generating steam, following a better understanding of the combustion of fuel and heat transmission in boilers, which, while not leading to any radical change in actual construction, has resulted in improved arrangement of boiler heating surface, with more efficient furnaces, boiler settings and plant operation, and engineers and plant owners are beginning to pay more attention to this very important part of power production.

In the past it has been too often thought that anyone could lay out a boiler room, with the result that plants have been put in without proper consideration of their suitability for the particular conditions, or, even when good boilers, stokers and main apparatus were installed, no facilities for economic operation were provided. More money can be saved or lost in the boiler room than in any other part of the plant, yet, while the latest refinements may have been added to the engine room and electrical side, the boiler room has been considered as a necessarily dirty place to be avoided as much as possible. The condition of this same boiler room under operation is, however, usually a direct indication of the ability of the plant designer or management, or both, as a boiler room need not be dirty, and dirt generally means inefficiency and bad management somewhere. At the present time when the question of fuel supply is of such importance in Canada, every effort should be made to ensure its efficient use, and steps taken where possible, through education and control, to cut down the enormous waste which occurs annually through inefficient operation, or the

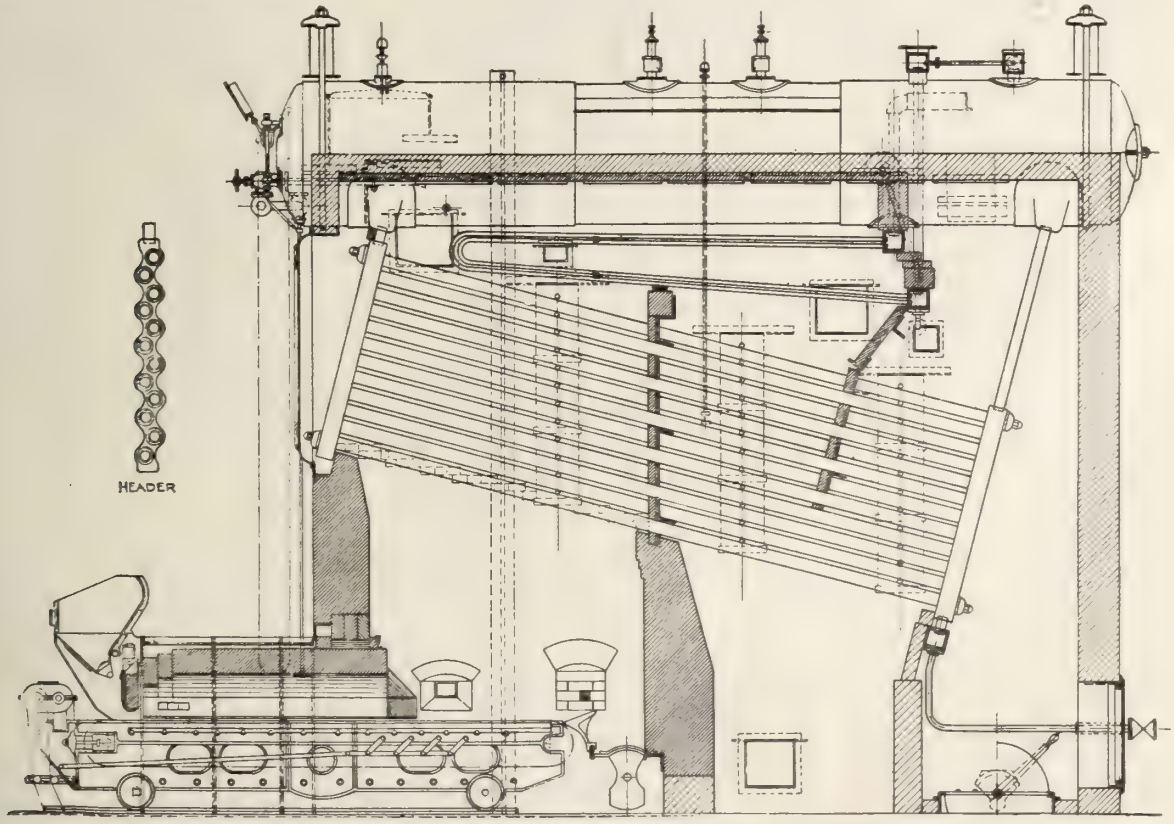


FIG. 1—STANDARD LONGITUDINAL DRUM SECTIONAL HEADER BOILER.

false economy or indifference of the plant management.

The operating efficiency of the engine room machinery is largely inherent in the design, that is to say, beyond the control of the attendant, but, although a boiler and furnace must be properly designed, its actual efficiency in service is, to a great extent, dependent upon intelligent operation and supervision, and for that reason warrants the placing of the most intelligent and highest priced men with every modern appliance in this part of the plant, since an increase of even a fraction of one per cent. in efficiency represents the saving of a considerable quantity of coal annually. Such a distribution of labor and superintendence is very seldom the case at the present time.

The present day tendency towards high steam pressures and temperatures, concentration of power and larger unit capacities have led to the practical elimination of the shell boiler for this service and to certain modifications in the setting and rating of water tube boilers. The different water-tube boilers made to-day, suitable for these conditions, resolve themselves into two general classes horizontally inclined straight tube boilers and vertically inclined bent tube boilers. Fig. 1 shows a section of a standard longitudinal drum boiler of sectional header construction with vertical baffles, fitted with a superheater and chain grate stoker, having a high furnace setting; and Fig. 2 shows a large double setting vertically inclined tube boiler with superheater and underfeed stokers. For the purpose of illustrating the application of the principles entering into boiler design, the author will confine his attention chiefly to the former type of boiler and its recent development.

The peculiar conditions under which boilers must necessarily work affect their design to a greater etxent than with most machines. It is possible to design a boiler which would give a higher efficiency under test conditions than any yet built, but taking into consideration the general class of service, attention, ease of cleaning, first cost and maintenance, a compromise must be made for continued satisfactory and efficient service.

The more severe demands of modern service and a better realization by engineers of the possible economies to be effected in the boiler room has been encouraging the development of boilers for higher efficiency and rating, but it must be understood that, as with any other machine, the higher the rate at which a boiler is operated the more careful attention is needed and the less abuse it will stand. Boilers, engines, or anything else can be, and are, built to stand rough usage, but, if the highest efficiency and rating be desired, they must be treated with respect and for the purpose for which they are designed, for instance:

The function of a boiler is to make steam and it is not at any time the proper place for the treatment and deposit of the impurities in the feed water. Boilers designed for, and operating under, moderate loads will stand a lot of abuse in this way, albeit at a loss in efficiency, and under such conditions the use of chemicals or boiler compounds fed into the boiler with the feed water may be justifiable to lessen adherent scale, but pure soft water must be used in any type of boiler which is to be operated at high rates of evaporation in order to get proper benefit from the installation, and to avoid tube troubles, and this usually necessitates the provision of an independent water purifying plant for the raw make up water in the feed supply.

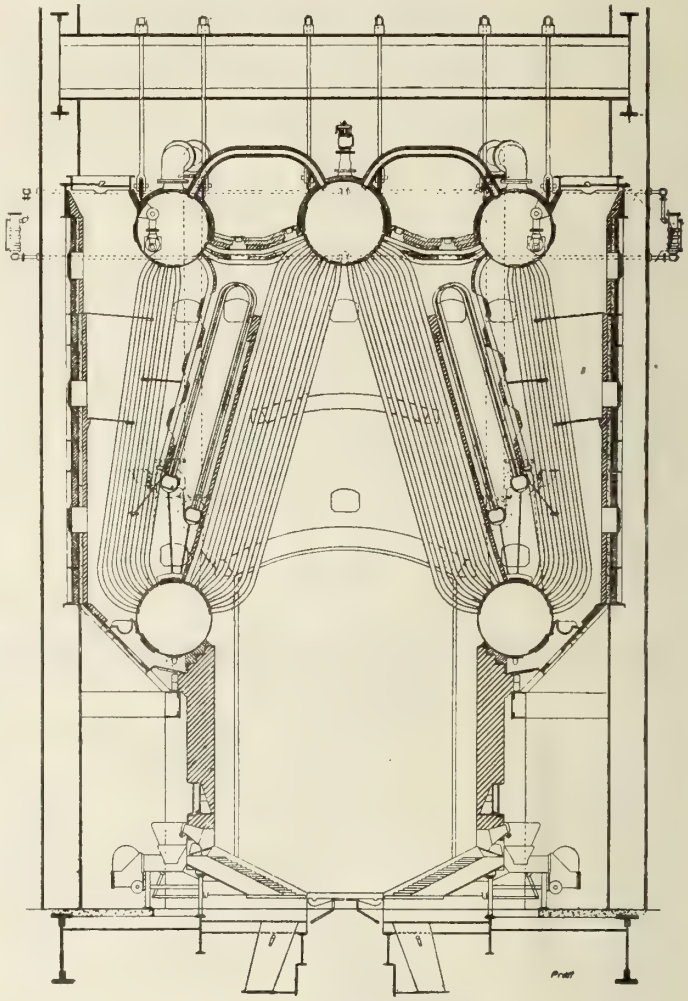


FIG. 2—DOUBLE SETTING STIRLING BOILER.

Rating and Capacity

When speaking of boiler loads or high and low rates of evaporation of boilers, it is necessary to have a clear understanding of the unit on which such evaporations are based, that is, what constitutes a normal full load? In Europe and other countries boilers are usually rated on the quantity of water which they are capable of evaporating per hour under certain conditions with a specified heating surface, but in Canada, following the custom of the United States, boilers are generally rated simply in boiler horsepower, a term often very loosely used.

A boiler horsepower, in its true sense, is solely a unit of evaporation, being equal to 34.5 lbs. of water evaporated per hour from and at 212°F. and equivalent to the standard adopted by the boiler committee of the Centennial Exposition in Philadelphia in 1876. The term has nothing to do, strictly speaking, with the heating surface of the boiler, but at different stages of progress of the art, manufacturers of stationary boilers have adopted as arbitrary standards, certain amounts of boiler heating surface which could be taken as suitable for economically evaporating one boiler horsepower under average conditions of service and with a definite ratio of heating to grate surface. In recent years 10 square feet of heating surface per boiler horsepower or the equivalent of approximately 3½ lbs. evaporation per square foot heating surface has been considered a nominal full load rating for a water tube boiler of standard construction, but considerably higher rates are adopted in modern stationary boilers designed for high duty service, as also in marine boilers where average evaporative rates of 6 lbs. and over per square foot heating surface are usual.

The normal rating, or rate of evaporation, of a boiler, and its point of maximum efficiency is entirely dependent on the design, and while higher rates than 3½ lbs. per square foot heating surface per boiler may constitute a so-called overload on a boiler designed for 10 square feet heating surface per boiler horse-

power, with a ratio of heating surface to grate area of about 50 to 1, and the efficiency may drop with such overload, it does not follow that the same condition will exist with a boiler and furnace designed for a different rating.

The rate of conductivity of the metal of the heating surface is sufficiently high to carry away considerably more heat than can possibly be transmitted in boiler service without danger of burning, provided that water be in contact with the one side of the metal, so the limit of capacity alone is practically only governed by the positive circulation of the water in the boiler, the cleanliness of the heating surface, inside and out, and the amount of fuel that can be burned, or the gases which can be passed through the boiler.

There is very little difference in temperature of the water throughout any part of a well designed water tube boiler, the circulation being caused by a pumping action set up by the steam bubbles, in a similar manner to an air lift pump, either in the front tubes of a vertically inclined tube boiler, or in the uptake headers of a sectional horizontally inclined tube boiler, and, as with an air lift pump, the rapidity and efficiency of the pumping action is dependent on the avoidance of large chambers in the water passages in which eddies and down currents impede the pumping action. Tests recently carried out on a horizontally inclined tube boiler of the header construction, 28 tubes high, showed that this pumping action amounted to the equivalent of some 18 inches of water head when the boiler was operating at rated capacity and that it increased progressively as the load increased. Boilers similar to that shown in Fig. 1, equipped with a duplex furnace are in service operating up to 400 per cent. rating during peak load periods or an average evaporative rate of 14 lbs. per square foot heating surface when using purified feed water, so that as far as capacity alone is concerned, a boiler having good circulation can be run at considerably higher rates than has been the usual practice, provided it be kept clean. Cleanliness and positive rapid circulation become of increasing importance as the rate of evaporation is increased.

In order to better appreciate the significance of evaporative rates, let us examine the mode of heat transfer in a boiler in the light of our present knowledge, and at the same time see how the general principles are applied in modern boiler design.

Assuming coal to be burned under a water tube boiler at an efficiency equivalent to the production of 12,500 B.t.u. per pound with 18 pounds of gaseous products of combustion; then the temperature above the surface of the fuel bed would theoretically be approximately 3800 deg. The heat is transmitted to the boiler heating surface by direct radiation from the surface of the fuel bed and furnace walls and by convection from the hot gases passing over the tubes.

Radiation

The amount of heat absorbed by the surface of the tubes directly exposed to radiant heat from the furnace is generally proportional to the difference of the fourth powers of the two surfaces, or $= C(T^4-t^4)$ where C is a constant for any unit of surface and time. The laws governing radiant heat or heat rays are analogous to those for light, the heat transfer being extremely rapid, but the great proportion of the heat energy is supplied by the obscure or dark rays, only a very small amount being carried by the actual light or visible rays.

The value of the coefficient in the above radiation formula was determined experimentally for black surfaces by Stefan about 30 years ago, and while this coefficient has been taken as applicable to the partly sooted surfaces in a boiler furnace it is probably far from gases in the furnace to heat rays, their capability of radiating heat themselves, the reflecting and absorbing power of the fire brick furnace walls and the proper consideration of the exposed areas, are all points on which there is little authoritative data, although investigations are being made into this subject at the present time. Of course a close determination can never be made if the area of the hot surface of the fuel bed is to be a determining factor, as it is obviously impossible to do more than very roughly estimate the average extent of the irregular surface, and there will be, in addition, radiation from the incandescent carbon particles in the gases; but it is questionable if this surface is a necessary factor. With gaseous or oil fuel, we have to deal with volume radiation which presents a somewhat similar case to that in a gas engine cylinder where the heat from the explosive charge is transmitted to the water jacketed cylinder walls chiefly by radiation, as brought out in investigations undertaken by the explosives committee of the engineering section of the British Association some years ago.

One thing we do know is that in a Babcock and Wilcox boiler, the amount of water evaporated per hour per square foot of surface of the lower rows of tubes exposed to furnace radiation, with a furnace temperature around 2,500 deg. F. is at least from 50 to 65 lbs., and as this may represent over one-half the total evaporation of the boiler at normal rating, the importance of a full knowledge of the subject of radiation is evident, while it incidentally shows how high the evaporative capacity of a tube is, and that an average evaporation rate of 3½ lbs. per square foot heating surface for the whole boiler gives no indication of the amount of work which any part of the heating surface is doing.

Failure to take into consideration the extent of heat radiation often leads to considerable error in boiler work, both in testing and recording and also in details of the boiler and furnace setting. For instance, it is extremely difficult, in fact impossible with the usual type of instruments procurable, to measure exactly the temperature of the gases in a boiler setting owing to radiation from the thermometer bulb or end of pyrometer element to the hot furnace or to the cooler boiler heating surface in close proximity. H. Kreisinger, of the U. S. Bureau of Mines, Washington, presented a paper to the American Society of Mechanical Engineers, in 1917, dealing with this subject, in which he gave the probable error, arrived at by experiment, in temperature measured by a thermo-couple placed amongst the tubes of a water tube boiler as from approximately 600 deg. too low at 2,000 deg. F. to 40 deg. too low at 500 deg. F. when using a common form of pyrometer with a ½ in. diameter element; also showing that the error was proportional to the size or exposed area of the instrument. The author has had some success with a special cap screen surrounding the end of the instrument element, that is, measuring success by the higher temperature recorded, but in any case there will be some correction to make. Even the measurement of the temperature of the flue gases leaving the boiler setting is liable to considerable error unless proper precautions are taken.

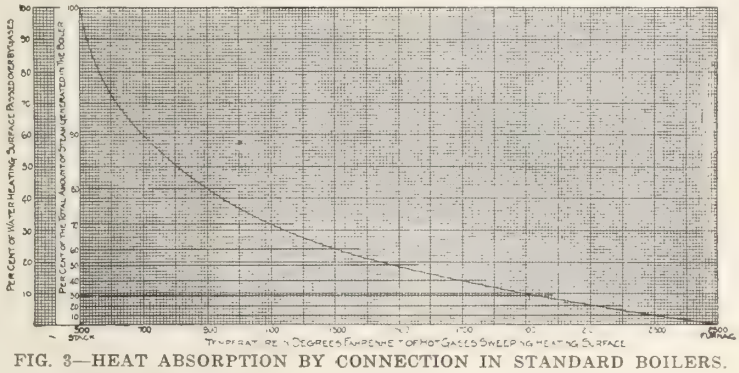


FIG. 3—HEAT ABSORPTION BY CONNECTION IN STANDARD BOILERS.

Again, the opinion was held until recently that an air space in the walls of a boiler formed a good heat insulator. Actually, it is useless and even a disadvantage, as, although still air is a poor conductor of heat, the rate of conduction is proportional only to the actual difference of temperature of the surfaces, whereas radiant heat will pass across the

air space at a rate proportional to the difference of the two surfaces. For low temperatures, as in refrigeration work, air spaces are beneficial, but with a high temperature difference, the heat transfer becomes very great.

To obtain a better insulated wall than that of ordinary red brick for a boiler setting, special insulating material is to-day often used, either as a middle course between the firebrick lining and the outer wall facing, or on the outside of the brick wall, but it should be realized that if too good an insulation is made, it becomes increasingly difficult with certain types of furnaces to get a firebrick lining to stand the higher temperature attained. Sometimes the entire boiler brick setting is enclosed in a steel casing, but this is rather to give a tight seal preventing the infiltration of air, which occurs through any ordinary brick wall, especially in boilers operated at high ratings with a corresponding greater draft suction in the setting. The cost of these castings is high, but, if properly constructed, are of considerable value and in many cases are undoubtedly a good investment. If they are used, there should always be a course of asbestos or other insulating material between the brickwork and the casing, otherwise the radiation loss may be increased owing to the metal presenting a beter radiating surface than the brickwork.

Furnace Duty

Returning to the furnace and the assumed case, it will be seen that, with the same efficiency of combustion maintained, since heat will be radiated as quickly as generated, the actual apparent temperature will not reach the theoretical figure of 2,800 deg. until sufficient coal is being burned to generate the heat necessary to satisfy the radiation equation for 2,800 deg. in addition to raising the temperature of the products of combustion to a figure dependent upon their rate of liberation. The stage when this condition is reached will depend on the area of the cool surface exposed to radiation and it does not necessarily mean that apparent high furnace temperature is essential to high efficiency, although they will coincide to an extent dependent upon the constituents of the fuel.

In brick lined extension furnaces or when the lower row of boiler tubes over the fire are encased in brick tiles, as for certain forms of baffling, higher temperatures are attained at a low rate of combustion on the grate, but this means that the gases also enter the bank of tubes at a higher temperature for the same load, resulting in a corresponding higher exit gas temperature and consequently reduced efficiency, while the higher furnace temperature shortens the life of the furnace brickwork.

With such a horizontal baffling, there will, of course, be radiation from the furnace or hot brickwork to the exposed tubes of the gas passage beyond the tiles, while heat will be conveyed from the furnace to the lower tubes through the encircling tiles by conduction and possibly secondary radiation, but following the fourth power law of temperature difference the amount will be considerably less than for a direct exposure, and it is, therefore, preferable, wherever a high furnace temperature is not necessary for proper combustion, for a lower horizontal baffle to take the form of flat tiles laid on the second row of tubes from the bottom so as to gain the full effect of direct radiation, which is the most active, and, therefore, the most economical mode of heat transfer.

If the furnace efficiency could be maintained constant, the temperature of the gases entering and leaving the boiler heating surface would increase with increasing coal consumption, resulting in a continued decrease in overall efficiency as the load increased, but in general practice, the furnace and grate efficiency increases with the load up to a certain point dependent on the proportions of boiler, furnace and grate, so offsetting the drop in efficiency due to the higher flue gas temperature. With a standard setting of boiler designed for 10 square feet of heating surface per boiler horsepower, or an equivalent normal full load evaporation of 3½ lbs. per square foot heating surface, and a ratio of heating surface to grate of about 50 to 1, the maximum efficiency will usually be maintained fairly constant from 90 per cent. to 130 per cent. rating. Below 90 per cent. rating the loss in efficiency is chiefly due to incomplete combustion in the furnace and grate and above 130 per cent. rating chiefly due to the increasing exit gas temperatures, the furnace and grate having then reached their highest efficiency. For other proportions and designs of boiler and furnace the point of maximum efficiency will be different; (for instance, the very complete tests carried out on the large Stidling boilers at the Detroit Edison Company's plant some years ago showed the highest normal evaporation rate) and dropping in a straight line to 76 per cent. efficiency at 200 per cent. rating. This remarkably high efficiency over such a wide range of load was due to the exceptionally large combustion chamber, promoting almost complete combustion even at low loads; the skilled regulation and operation; and the small proportional radiation loss from the walls with such a large unit. Fig. 2 shows a section of one of these boilers.

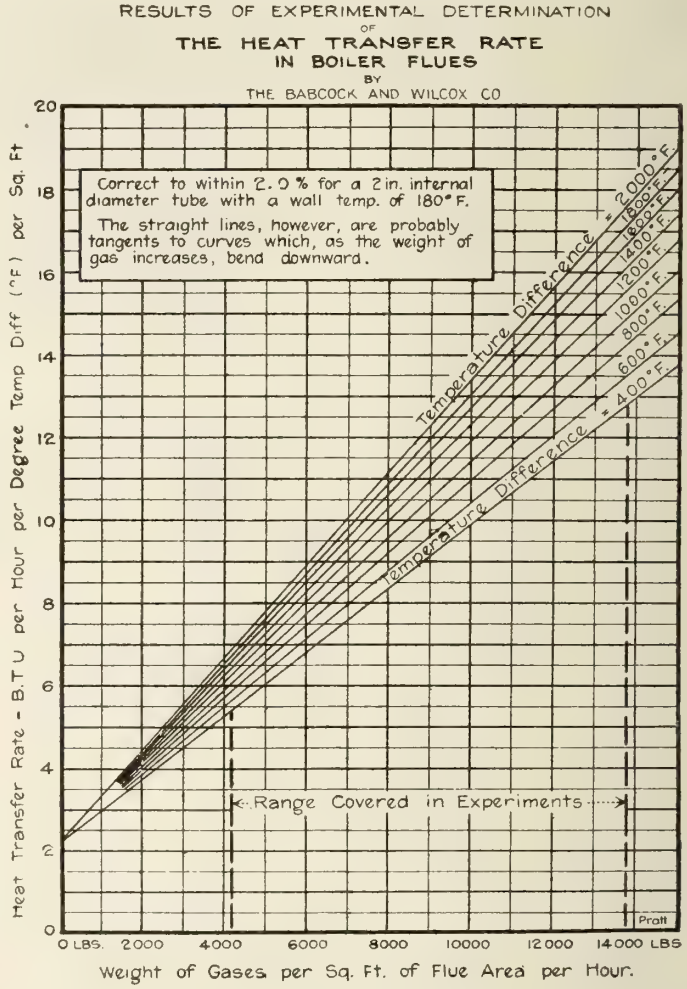

RESULTS OF EXPERIMENTAL DETERMINATION
OF
THE HEAT TRANSFER RATE
IN BOILER FLUES
BY
THE BABCOCK AND WILCOX CO
Correct to within 2.0 % for a 2 in. internal diameter tube with a wall temp. of 180° F.
The straight lines, however, are probably tangents to curves which, as the weight of gas increases, bend downward.
Temperature Difference = 2000° F.
1800° F.
1600° F.
1400° F.
1200° F.
1000° F.
800° F.
600° F.
400° F.
Heat Transfer Rate - B.T.U. per Hour per Degree Temp Diff (°F) per Sq. Ft.
Range Covered in Experiments
Pratt
0 LBS. 2000 4000 6000 8000 10000 12000 14000 LBS
Weight of Gases per Sq. Ft. of Flue Area per Hour.

FIG. 4—HEAT TRANSFER IN BOILER TUBES.

The general tendency in modern design is to provide greater and greater furnace volume to ensure more complete combustion before the gases reach the comparatively cool boiler heating surface. Not many years ago the ratio of cubic feet of furnace volume to square foot of grate usually provided was about 3 or 3½ to 1, whereas to-day we may have 5½ or 6½ to 1 for natural draft stokers and even more for forced draft

stokers, particularly when high overloads are demanded. In the Detroit Edison boilers mentioned above the ratio was approximately 9 to 1. For horizontally inclined tube boilers this increased combustion space generally means that the mean height from the floor line to the lower tubes over the fire has been increased from approximately 6 or 7 feet to 9 or 10 feet and over, where conditions permit, and as required by the nature and volatile content of the coal, type of stoker and duty.

Convection

The best method of passing the gases over the tubes, and the relative advantage of different form of baffling have been discussed at various times, but it seems reasonable that a cross flow over several passes of staggered tubes avoids stratification by ensuring the most thorough breaking up of the gas currents, with the consequently better contact of all particles with the walls of the tubes, while with the first pass at the upper end of the tubes, a contra flow action to the circulation of the water in the boiler is obtained, and, at the same time, with a horizontally inclined tube boiler, the circulation will be improved, and the danger of blistering the lower row of tubes lessened by procuring the quick release from the tubes of the steam bubbles formed.

The laws governing heat transfer by convection from the gases passing over the boiler heating surface has been the subject of many investigations, and formulae have been put forward based on mathematical deduction and laboratory experiment, but the great majority of these formulae, while holding good within the limits of the experiments, are not applicable without considerable correction for the conditions existing in a full size commercial boiler, especially where the gases pass across a bank of tubes, in which case the area of the gas passage is not constant. In view of the lack of authoritative data on the subject, the Babcock & Wilcox Company, a few years ago, conducted a series of experiments with a specially constructed plant to determine a formulae with coefficients which could be depended upon, for the rate of heat transfer in boilers.

The relation of the heat absorbed by convection only from the gases to the amount of heating surface passed over in a boiler of standard proportions under coal fired conditions on the basis of 10 square feet heating surface per boiler horsepower is given by the curve, Fig. 3, which shows that the great proportion of the total evaporation takes place in the first pass of the boiler and very little in the last pass; for this reason it does not pay, with these proportions, to increase the heating surface by adding another pass.

A test was published a few years ago of a 4 pass boiler in which the actual drop in temperature through the last pass was only 67 deg. and even this drop was obtained only by reason of the low steam pressure carried (117 lbs. per sq. in.). With a steam pressure of 200 lbs. and a corresponding less difference of temperature between the gases and the water, the flue gas temperature must have been higher and the value of the fourth pass still further reduced.

Waste Heat Boilers

In direct fired boilers where furnace temperatures are high, and the weight of gas per boiler horsepower comparatively low, there is not a great deal of difference in heat transfer between several different types of standard boilers, fire tube or water tube, when new and clean; but with boilers arranged to utilize the heat from waste gases where larger gas weights are handled, with generally, lower temperature differences, the area, length and arrangement of the pas passages must be very carefully considered in order to obtain transfer rates for an absorption comparable to direct fired practice, and so extract the maximum heat from the gases with an amount of heating surface which will make the installation of a waste heat boiler a commercially economical proposition.

It was principally for such work that the experiments on heat transfer above referred to were undertaken, as with waste gases, the radiation factor being largely negligible, it is possible, with a proper knowledge of the laws governing heat transfer, to calculate very closely the results that will be obtained with a given boiler and vice versa to design a boiler to give the maximum return for the investment.

The results of the investigations are given graphically in Fig. 4, which shows the effect of gas velocity on heat transfer rates. For ease in computation, owing to the variation in density of the gases with the temperature, the velocity is considered in terms of gas weight per unit area.

It will be seen that at low rates of gas flow, as found generally in boiler practice, the transfer rates are affected by the velocity to a much greater extent than by any rate of temperature difference, also that the effect of temperature difference increases as the rate of gas flow increases. The effect of gas velocity on heat transfer rates. For ease in computation, owing to the variation in density of the gases with the temperature, the velocity is considered in terms of gas weight per unit area.

It will be seen that at low rates of gas flow, as found generally in boiler practice, the transfer rates are affected by the velocity to a much greater extent than by any rate of temperature difference, also that the effect of temperature difference increases as the rate of gas flow increases. The effect of gas velocity on heat absorption had previously been appreciated to a certain extent, but its full importance for waste heat work, as brought out by these experiments, has led to developments in boiler design which has opened up this field to a remarkable extent.

Up to a comparatively few years ago, when boilers were installed to utilize the heat in the waste gases from furnaces, kilns, etc., it was the practice to use boilers of the same general design as for direct coal fired puposes, or even with still larger gas passages in order to interfere as little as possible with the draft at the primary furnace. This meant working on the upper part of the curve, Fig. 3, and necessitated the provision of such an excessive amount of boiler heating surface for the steam produced that the installation became a doubtful investment.

Following the better understanding the laws governing heat transfer and the possibility of economies from the utilization of a greater proportion of the heat from waste gases, this subject has been receiving particular attention during the last few years and efficient boilers are now in successful operation in connection with all kinds of kilns, furnaces and ovens with temperatures as low as 1,000 deg. F.

The high gas velocities necessary for efficiency in waste heat boilers results in greatly increased frictional resistance through the setting, the draft loss running in many cases to over 2 in. water pressure, and, of course, requiring the use of induced draft fans to handle the gases. The power required to drive the fan is, however, many times offset by the increased efficiency and capacity obtained, while, in many cases, the installation of waste heat boilers has actually resulted in an increased output from the primary furnace owing to the possibility of greater draft at the outlet by the use of a fan in place of the original chimney.

Many factors have to be taken into consideration in waste heat boiler work, peculiar to the particular nature and origin of the gas, for instance, the dust held in suspension in many forms of waste gases, especially from cement kilns, has a considerable influence on the weight of gas handled and the draft resistance, and a knowledge of the effect of such factors and the proper way of taking care of them can only be obtained by experience.

A good story is told of an Englishman who was being entertained by some Americans in New York City. At the conclusion of a story, told by one of the Americans, everybody except the Englishman burst out laughing. The story-teller was rather nettled at the Englishman's unsmiling face and remarked: "I have always heard that Englishmen are lacking in humor; perhaps our English friend will see the joke and laugh next year."

Very seriously the Englishman said: "No, I shan't laugh next year for the reason that I laughed at that joke last year, and I always make it a point never to laugh at the same one twice."

Electrical Energy Generating Stations—IV

The Third of a Series of Articles Dealing With the Design of the Power Plant. This Article Discusses the Adaptability of the Three Different Classes of Prime Movers for Different Services

By TERRELL CROFT

[Copyright; all rights reserved by the author]

APPLICABILITY OF ENGINES.

(1) Non-condensing units, direct-connected or belted and used for driving.

(a) Electric generators of all classes excepting exciter sets of small capacity, unless belted from the main engine.

(b) Centrifugal pumping machinery, operating under variable head and quality conditions, and at relatively low head, say up to 100 feet, depending on the capacity.

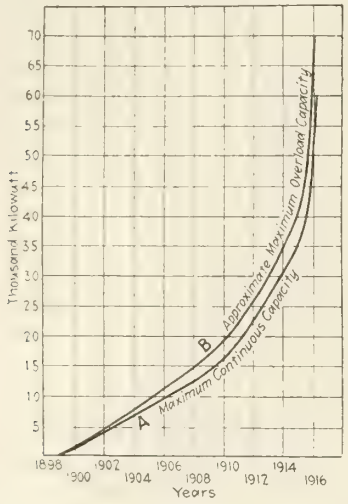


Fig. 36—Graphs showing how the capacity of steam-turbo-generator units has increased with the development of the art.

(c) Pumps and compressors for delivering water or gases in relatively small quantities and at relatively high pressures—in the case of pumps at pressures above 100 lb. per square in., and in the case of compressors at pressures from 1 lb. per square in. and above.

(d) Fans and blowers (including induced draft fans) for handling air in variable quantities and at relatively low pressures, say not over 5-in. water column.

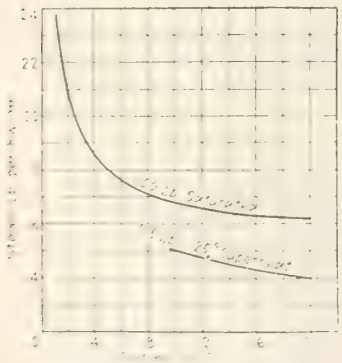


FIG. 37—STEAM CONSUMPTION OF SMALL TURBINES.

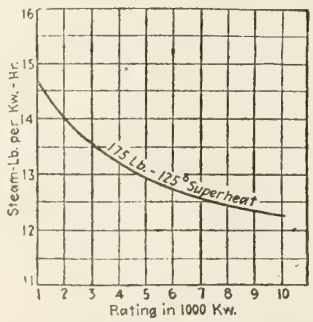


FIG. 38—STEAM CONSUMPTIONS OF STEAM TURBINES OF MODERATE CAPACITIES.

(e) Line shafts of mills, where the driven apparatus is closely grouped and the load factor is good.

(f) All apparatus requiring reversal in direction of rotation, as in hoisting engines and engines for traction purposes.

(2) Condensing units direct-connected or belted, for all the above purposes, particularly where the condensing water supply is limited, and where the water must be re-cooled and re-circulated.

*The Steam Consumption of Small and Medium-Capacity Turbines** is indicated by the graphs of Figs. 37 and 38.

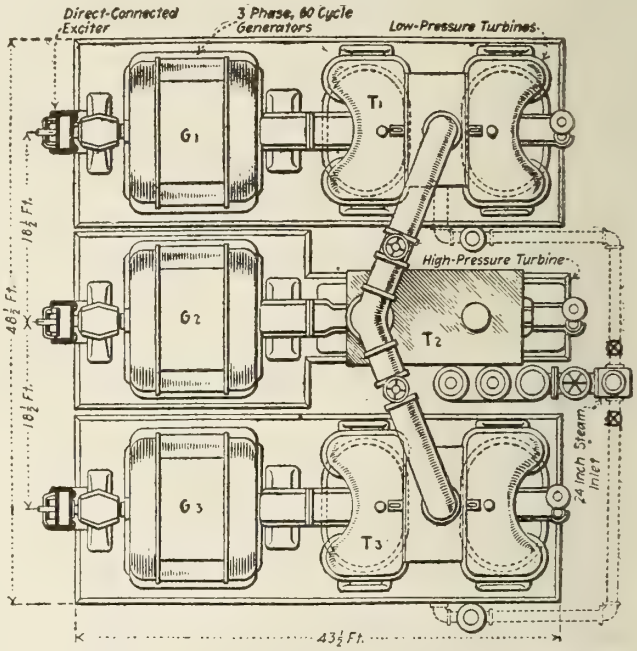


FIG. 40—THREE CYLINDER TWO-STAGE TURBO GENERATOR UNIT OF 60,000 KW. CAPACITY.

The graph of Fig. 37 indicates the economics which may be effected through the use of a high steam pressure and superheat. Fig. 39 indicates the approximate cost of small and moderate capacity turbo-generator units.

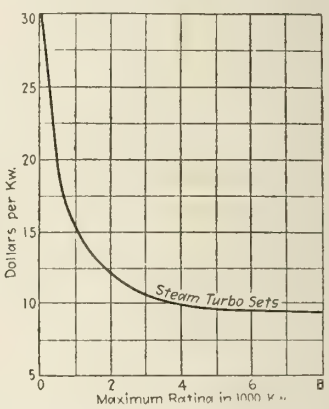


Fig. 39—Approximate relative costs of turbo generator units. (Cost of labor and materials are now fluctuating so widely that it is not feasible to give actual costs.)

The Cross-Compound Principle as Used in Large Turbines is shown in Fig. 40, which illustrates the 60,000-kw. three-cylinder, two-stage unit purchased by the Interborough Rapid Transit Company, of New York. Tests on this unit indicate at the point of maximum efficiency a water rate of 11.25 lb. per kwh.

*David Llwellyn, in a paper presented before a New England National Electric Light Association.

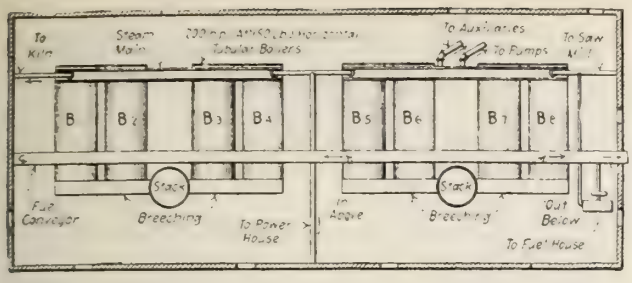


FIG. 41—THE BOILER ROOM IN WHICH THE WOOD WASTE IS BURNED.

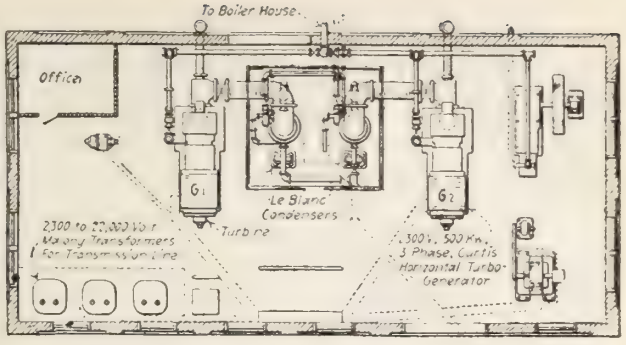


FIG. 42—TURBO GENERATOR STATION UTILIZING STEAM GENERATED WITH SAW AND PLANING MILL WASTE.

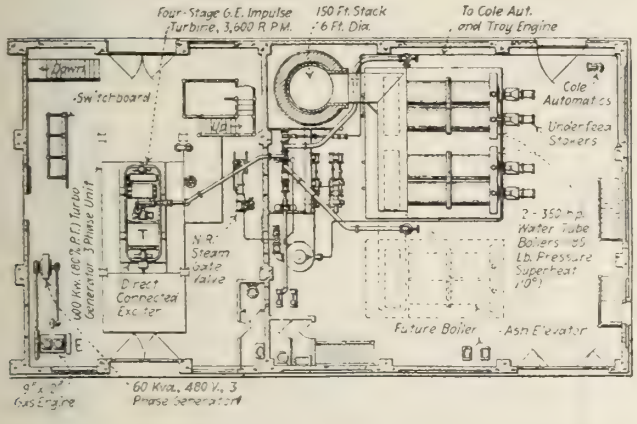

Four-Stage G.E. Impulse Turbine, 3,600 R.P.M.
150 Ft. Stack 6 Ft. Dia.
To Cole Aut. and Troy Engine
Dam
Switchboard
Cole Automatics
Underfeed Stokers
2 - 350 h.p. Water Tube Boilers 165 Lb. Pressure Superheat (70°)
N.R. Steam Gate Valve
Direct Connected Exciter
Future Boiler
Ash Elevator
9" x 9" Gas Engine
60 Kva., 480 V., 3 Phase Generator

FIG. 43—PLAN VIEW OF THE PLANT OF THE COMMERCIAL MILLING COMPANY.

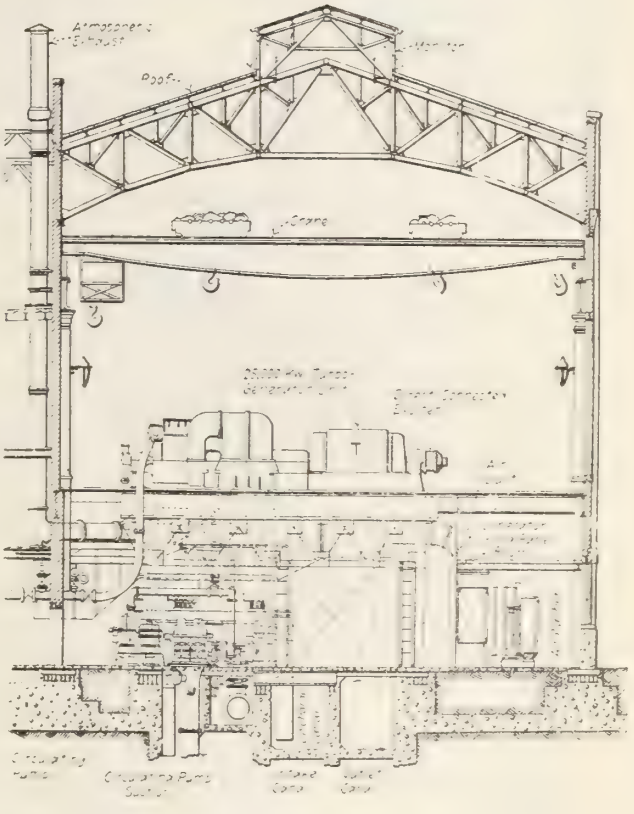


FIG. 44—SECTIONAL ELEVATION OF THE TURBINE BUILDING OF THE ESSEX STATION.

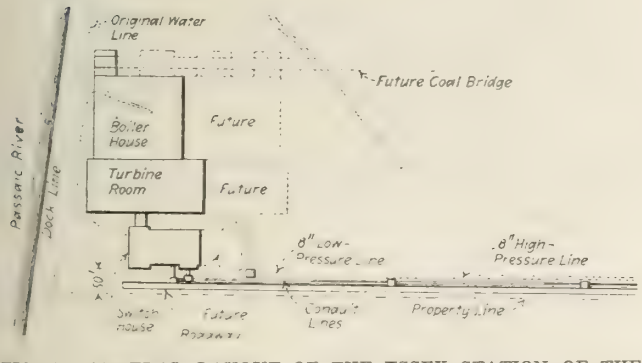


FIG. 45—GENERAL LAYOUT OF THE ESSEX STATION OF THE PUBLIC SERVICE CORPORATION OF NEW JERSEY.

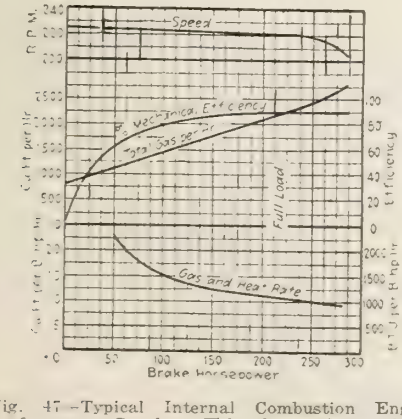


Fig. 47—Typical Internal Combustion Engine Performance Graphs. This shows the performance of a 225 h.p. Westinghouse Vertical Gas Engine.

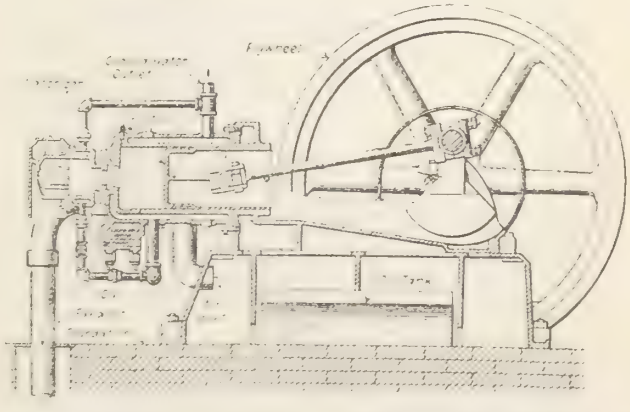


FIG. 48—SECTION THROUGH A SMALL LOW-PRESSURE OIL ENGINES OF THE "HOT BULB" OR "HOT BALL" TYPE.

An Example of a Medium Capacity Turbo-Generator Station is shown in Figs. 41 and 42, which illustrate a plant operated by the Arkansas Light and Power Company*. In this installation wood waste from a saw mill and a planing mill is used for firing the boilers, *B*1 to *B*8. The boiler house (Fig. 41) is located some distance away

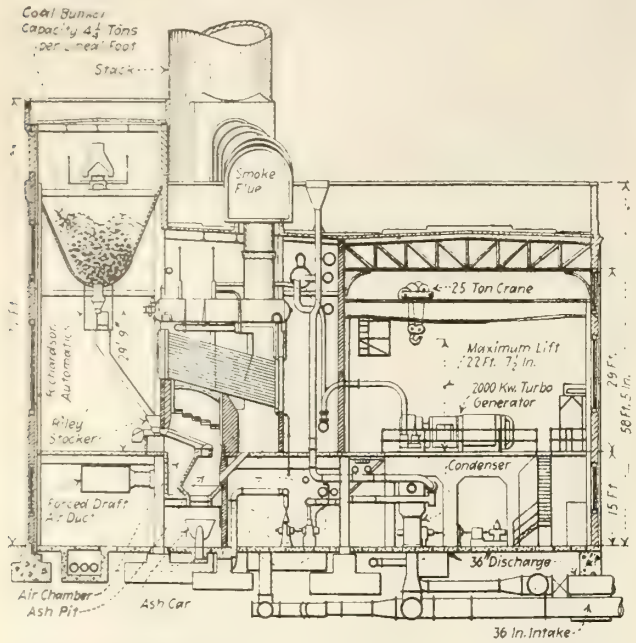


FIG. 46—BOILER HOUSE AND GENERATING STATION OF THE REMINGTON ARMS AND AMMUNITION COMPANY, BRIDGEPORT, CONN.

from the generating station (Fig. 42), the boiler house being operated by a company which owns the saw and planing mills. This company sells steam to the Light and Power Company for the operation of the turbines, *G*1 and *G*2.

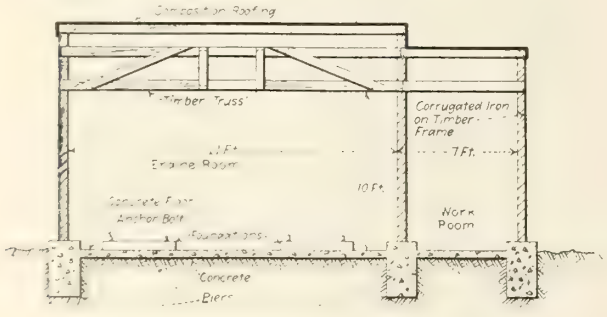


FIG. 50—TRANSVERSE SECTION OF STATION.

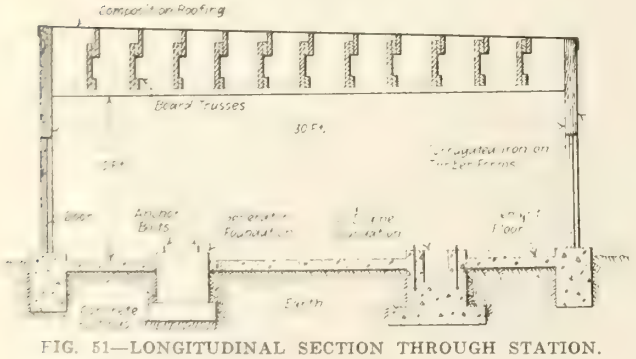


FIG. 51—LONGITUDINAL SECTION THROUGH STATION.

A Design for a Turbo Plant Having Only One Generating Unit is shown in Fig. 43. This plant is for the operation of a flour mill. A small 9 x 12 gas engine, *E*, installed in the engine room is used for pulling the load at nights, and at other times when it would be uneconomical to operate the turbine, *T*, at the small loads then existing.

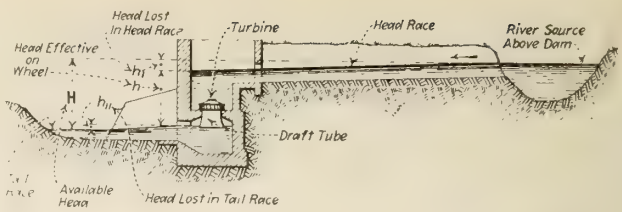


FIG. 52—GRAPHIC DEFINITION OF THE TERM "HEAD."

An Example of a Large Turbo-Generator Installation is shown in Figs. 44 and 45, which shows the Essex Station of the Public Service Company, of New Jersey. This is said to be one of the most efficient steam stations ever

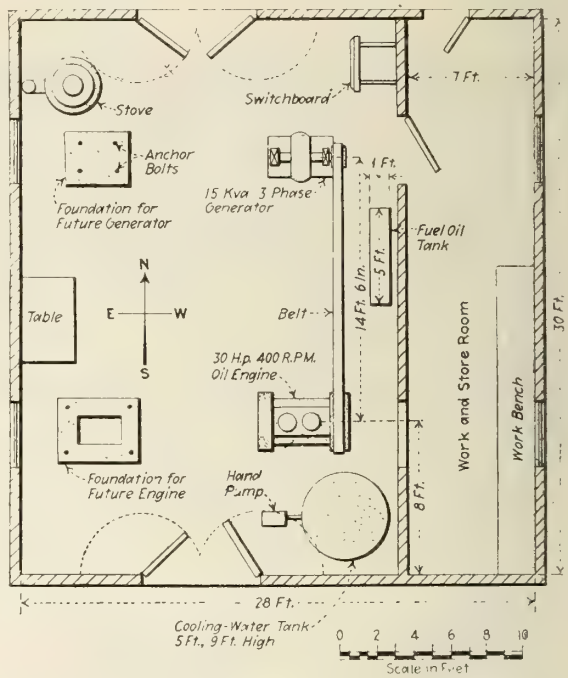
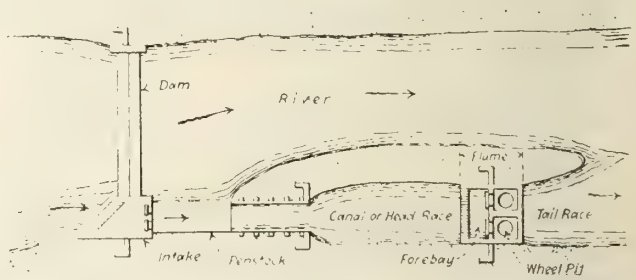


FIG. 49—GENERAL LAYOUT OF A SMALL OIL ENGINE PLANT.

constructed. The equipment comprises eight 1,373 horsepower boilers rated on a 100-lb.-per square-foot basis, and the necessary superheaters and boiler-room auxiliaries.



ILLUSTRATING THE NOMENCLATURE OF THE ESSENTIAL ELEMENTS OF A HYDRO-ELECTRIC DEVELOPMENT.

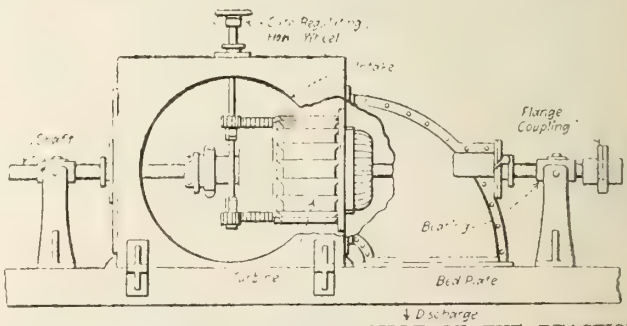


FIG. 55—ILLUSTRATING THE PRINCIPLE OF THE REACTION WHEEL. THIS SHOWS A CYLINDER KATE, HORIZONTAL TYPE TURBINE MOUNTED ON A STEEL FLUME.

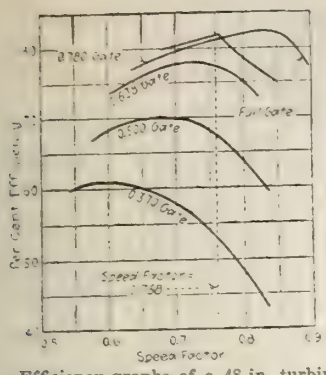


Fig. 58—Efficiency graphs of a 48-in. turbine. The wheel is designed to operate at a speed such that its ..... velocity is 75.8 per cent. of the speed or velocity of the spouting water. The governor associated with it holds it constant at this speed. But it is obvious from the above thesis when operating at partial loads, at less than 0.78 gate, the efficiency decreases rapidly.

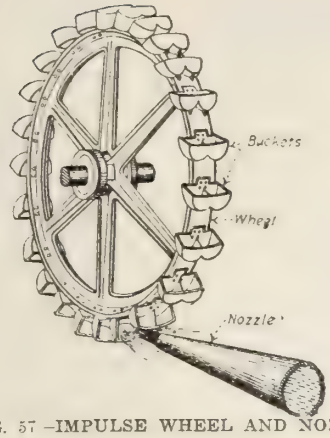


FIG. 57—IMPULSE WHEEL AND NOZZLE.

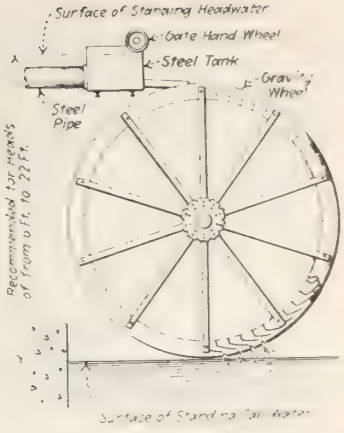


Fig. 53—Gravity type water wheel. The most efficient wheel for very low heads and small quantities of water (manufactured by the Fitz Water Wheel Company, Hanover.)

The generating equipment consists of two 25,000-kva. 13,200-volt General Electric Company turbo-generator units, *I*, in Fig 44.

A Moderate-Capacity Turbo-Generator Plant is shown in Fig. 46, which illustrates the construction and general

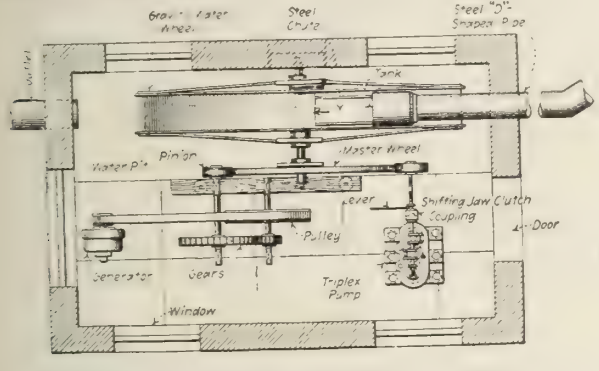


FIG. 54—A COMBINATION PUMPING AND ELECTRIC LIGHT PLANT, DRIVEN BY A GRAVITY WATER WHEEL.

arrangement of the power plant of the Remington Arms and Ammunition Company, at Bridgeport, Conn. The generating unit shown has a capacity of 2,000 kw.

Boilers for Steam Generating Stations are, in moderate and large capacity plants, always of the water-tube type, inasmuch as this is the only type which will permit of the use of high steam pressures and the ready utilization of economizers and superheaters. While in some quarters

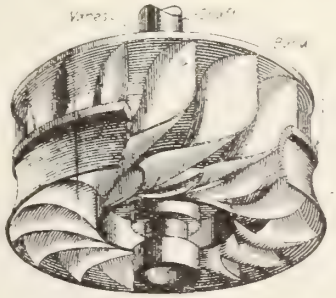


FIG. 56—RUNNER OF A MIXED FLOW TURBINE

the feeling exists that 1,200 horsepower is as great a capacity as is desirable for one unit, boilers rated at 2,400 horsepower each have been used in certain installations. In medium-capacity plants, the capacity of each boiler unit is about 500 horsepower. Fire-tube, that is, return-tubular, boilers, are now used only in the small non-condensing plants.

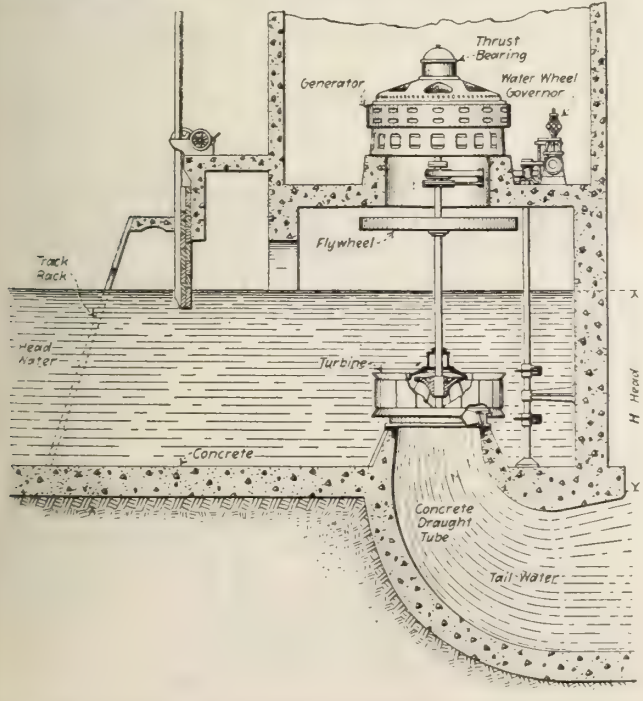


FIG. 60—LOW HEAD VERTICAL WATER WHEEL GENERATOR STATION (ELECTRICAL MACHINERY COMPANY.)

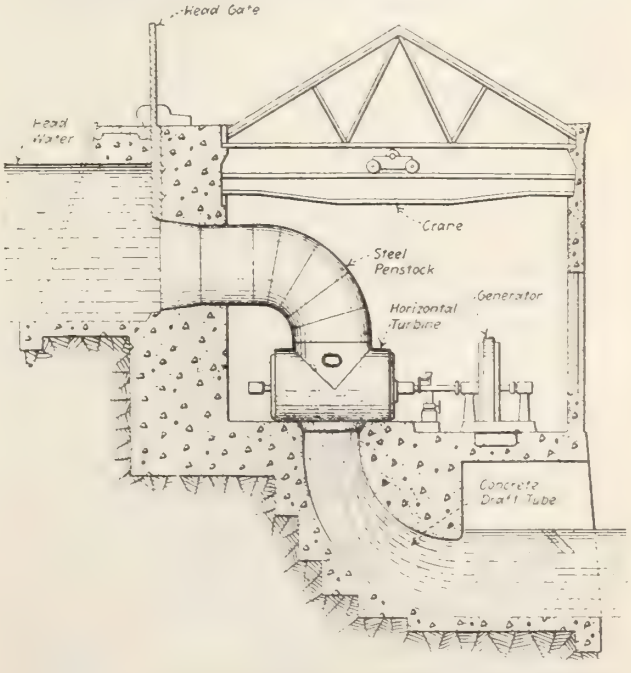


FIG. 61—A LOW HEAD HORIZONTAL-TURBINE UNIT INSTALLATION (JAMES LEFFEL & CO.)

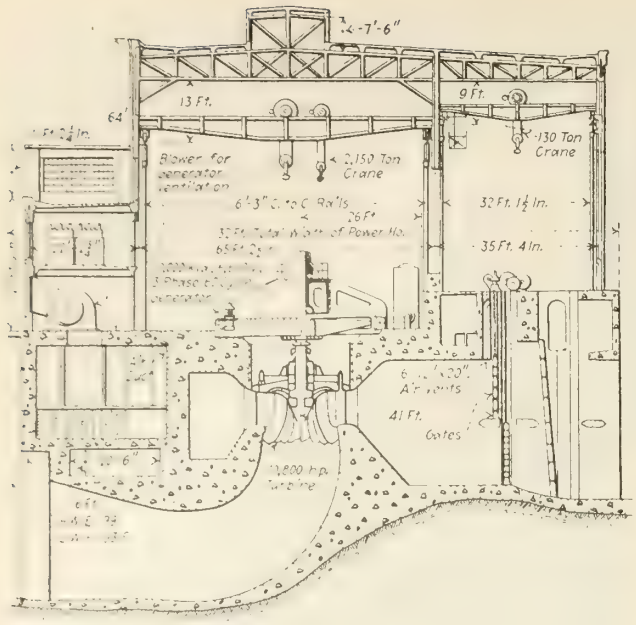


FIG. 62—HYDRO-ELECTRIC STATION OF THE CEDAR RAPIDS MANUFACTURING AND POWER COMPANY, LTD.

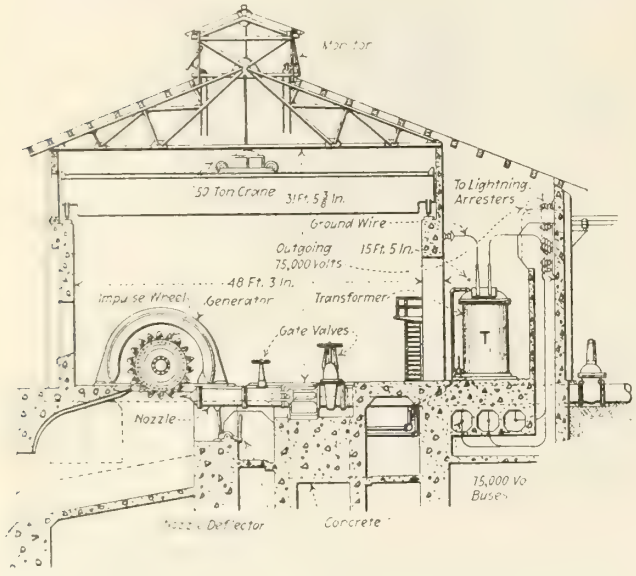


Fig. 63—Sectional elevation of the Edison Hydro-Electric Station at Kern River, California, containing four 10,750 h.p. Allis-Chalmers Impulse Wheels.

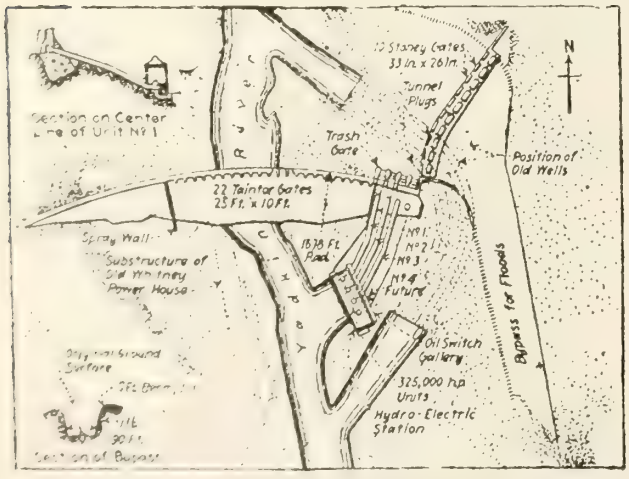


FIG. 66—THE YADKIN RIVER HYDRO-ELECTRIC DEVELOPMENT.

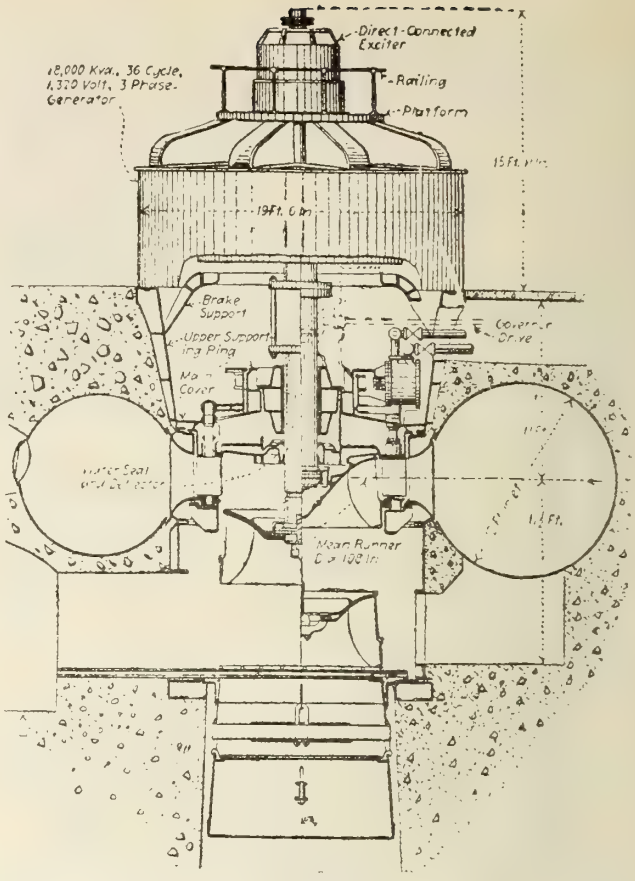


Fig. 64—Sectional elevation of the 31,000 h.p. turbo generator units used in the Yadkin River Development (in North Carolina). The illustration shows the method used in dismantling the runner.

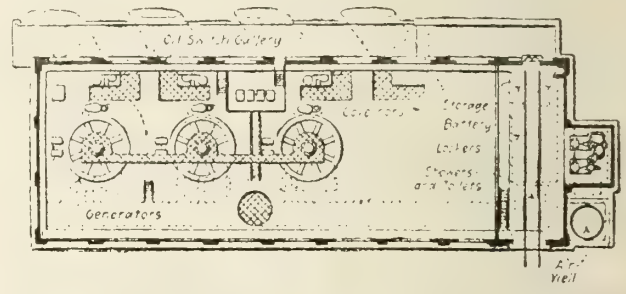


FIG. 65—PLAN VIEW OF THE YADKIN RIVER HYDRO-ELECTRIC STATION.

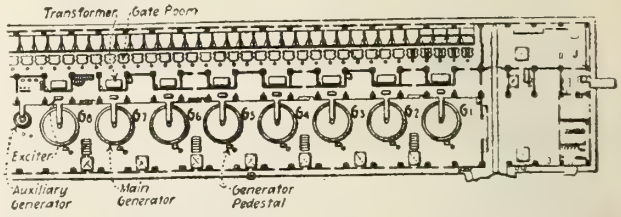


FIG. 68—PLAN VIEW OF HALF OF THE KEOKUK HYDRO-ELECTRIC.

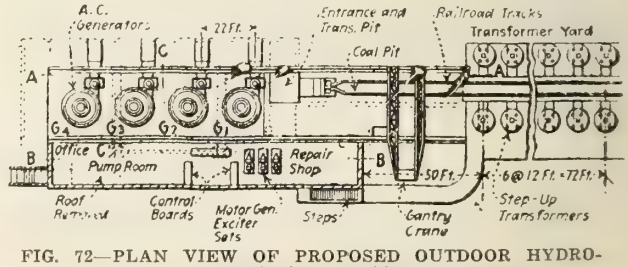


FIG. 72—PLAN VIEW OF PROPOSED OUTDOOR HYDRO-ELECTRIC STATION.

In Arranging the Boilers any one of several methods may be followed. The rows of boilers may be arranged facing an aisle running the short length of the station, or they may be laid out in either single or double rows along

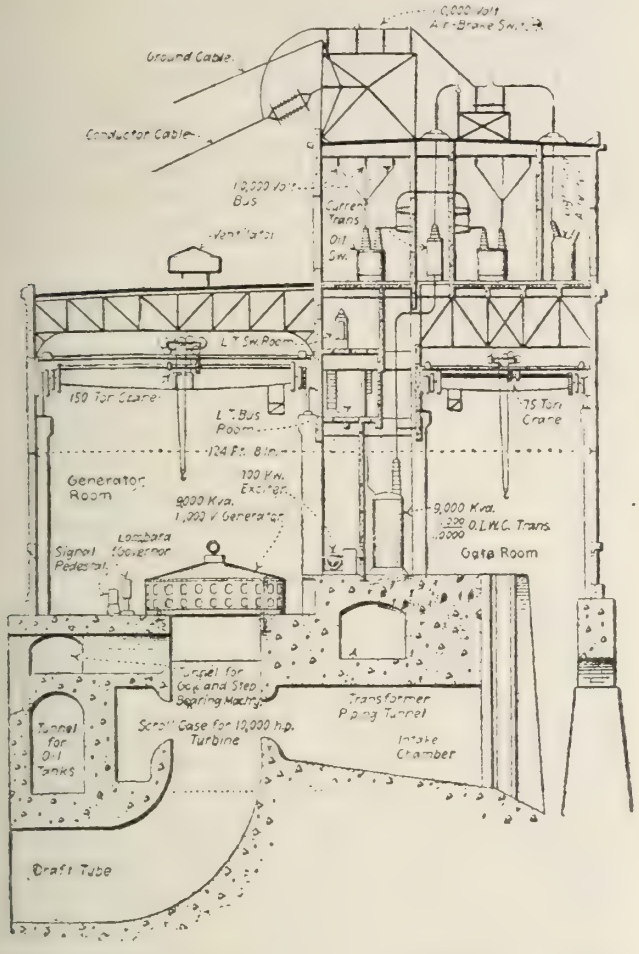


FIG. 67—SECTIONAL VIEW OF THE KEOKUK HYDRO-ELECTRIC STATION.

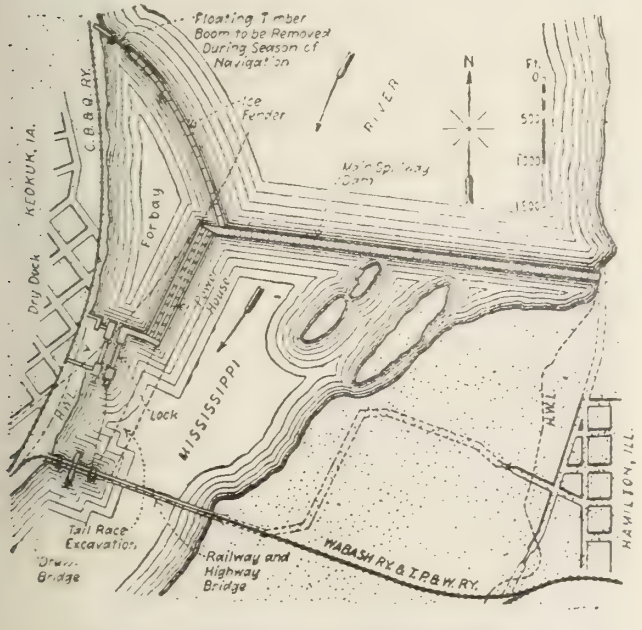


FIG. 69—THE KEOKUK (IOWA) DEVELOPMENT OF THE MISSISSIPPI RIVER POWER COMPANY.

a fire aisle. The illustrations show some of the different methods of boiler arrangement that have been utilized in practice

INTERNAL COMBUSTION ENGINE STATIONS.

IN INTERNAL-Combustion-Engine Stations, a prime mover may be either a gas engine, usually supplied with producer-gas or an oil engine. The producer-gas installations are suitable only for plants of medium or relatively-large capacities and, as above suggested, a

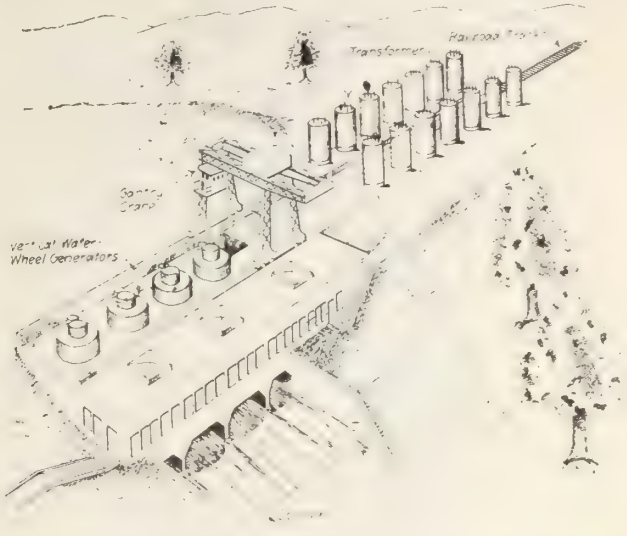


FIG. 70—SHOWING PROPOSED ARRANGEMENT OF THE PROPOSED OUTDOOR HYDRO-ELECTRIC STATION.

steam turbine is more economical in most installations of this character. The oil engines have been used to a considerable extent in medium-capacity plants in locations where the cost of oil is low. For very small plants which give service for a portion of the time, such as lighting plants operating in small towns only during the night, small oil engines are more economical than prime movers of any other type. Large gas engines have been used

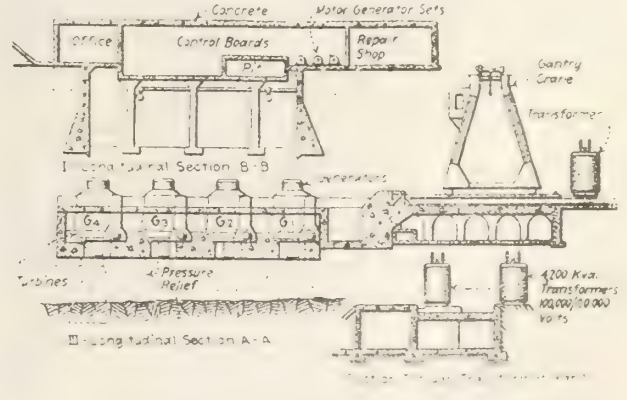


FIG. 71—SHOWING VARIOUS SECTIONS TAKEN THROUGH THE OUTDOOR HYDRO-ELECTRIC STATION.

with great success in steel plants where by-product gas for every operation is obtained from the blast furnaces. Such installations are, however, of a specific character and can hardly be classed as central station plants. Gas Engines have been built for use in these plants in capacities of 4,000 to 6,000 horsepower output each.

The Efficiency of an Internal Combustion Engine Increases With the Load (Fig. 47) so that the most efficient load for any internal combustion engine is the greatest load which that engine will carry. It follows that internal-combustion engines should be, and are, rated on the maximum basis. That is, they are not rated with overload capacities.

Oil Engines for Small Town Electric Lighting Plants are usually of the hot-bulb (Fig. 48) type. These can be operated on crude oil or kerosene. It has been found most economical in certain small plants to use kerosene rather than crude oil because, in order to obtain a low rate per

gallon, the crude oil must be purchased in tank-car quantities. In one of these small plants a considerable period elapses before a tank of oil can be consumed. Hence the charges on a container required to store the tank of oil, more than offset the difference in cost between the crude

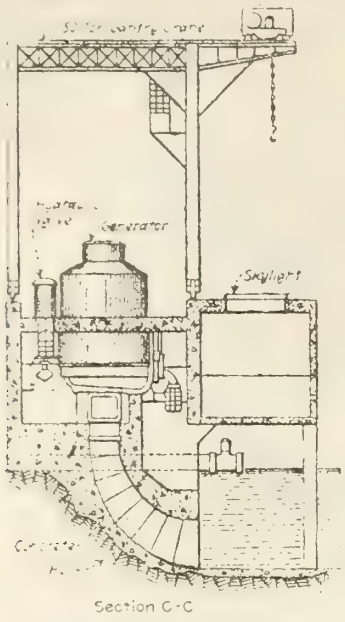


FIG. 73—SECTION C.C. THROUGH THE GENERATOR PLATFORM.

oil and the kerosene. Kerosene can be obtained in practically any locality in relatively-small drums.

The Lay-Out of a Small Oil Engine Plant is shown in Fig. 49. A plant of this type might serve its consumers through a distribution system similar to that diagrammed in Fig 5. The prime mover consists of a 30-horsepower, 400-r.p.m. Remington oil engine, which drives a 15-kva. belted generator. An economical construction for a building to house an equipment of this character is shown in Figs. 50 and 51.

HYDRO-ELECTRIC STATIONS.

Hydro-Electric Stations May be Divided Into Three General Classes: (a) *Low-Head Stations*, 4 to 25 feet; (b) *Medium-Head Stations*, 25 to 300 feet; and (c) *High-Head Stations*, 300 feet to 3,000 feet and up. Fig. 52 gives a graphic definition of the meaning of the word "head."

Water-Wheels May be Divided Into Three General Classes: (a) *Gravity;* (b) *Reaction;* and (c) *Impulse.*

A Gravity Wheel (Figs. 53 and 54) is one which develops its power by virtue of the weight of the water falling through a distance equal to the head. The falling water carries the buckets which catch it with it as it goes down and thus develops power.

A Reaction Wheel (Figs. 55 and 56), is one which develops its power by virtue of the reactive pressure of the streams of water upon the movable buckets from which the streams are forced by the head of the water above.

An Impulse Wheel (Fig. 57), is one which develops its power by virtue of the force exerted by a stream of water which issues from a nozzle or guide and impinges on buckets on the rotating wheel. The nozzles or guides are stationary and the wheel rotates.

NOTE. That the gravity wheel develops its power solely by virtue of the weight of the falling water, and that the reaction and impulse wheels develop their power by virtue of the potential energy due to the weight of the water which is first changed into kinetic energy.

The Efficiency of a Water Wheel decreases both above and below the point of maximum efficiency, as shown in Fig. 58. This fact must be recognized in selecting the generator which is to be driven by a water-wheel unit.

The Applications for the Water-Wheels of the Three Different Types may, in a general way, be given thus: Gravity wheels such as that illustrated in Fig. 53, are desirable only for very-low heads, and for the development of relatively-small power outputs. They have been used successfully in certain very-small central station installations, in which the generator is belted to the wheel shaft. The reaction wheels are best adapted to relatively-low heads and large quantities of water. In recent years, reaction wheels have been used for all ranges of head from 600 to 700 feet, for large units. The impulse wheel is best adapted to high heads and small quantities of water. Thus, for heads greater than 200 feet, and of small flow of water, the impulse wheel is the most effective prime mover. The efficiencies of water wheels may, for large units, be as great as 80 to 90 per cent.

The Names of the Elements of a Hydro-Electric Installation are given graphically in Fig. 59.

The General Tendency in Hydro-Electric Station Design has been outlined by W. R. THOMPSON*. There is a tendency to do away with the clear spillway, hence, reservoir-level-controlling devices, either in the form of Tainter gates or automatic-flash boards, are used. Frequently, the nearly-constant reservoir level has many advantages such as minimizing the investment in reserve land to that land which is ordinarily submerged. It insures the advantage of a more uniform head on the plant and facilitates the handling of the ice which forms on the reservoir.

*W. R. THOMPSON, *"Tendency in Central Station Design,"* *Electrical Review*, March 3, 1917.

This latter consideration is important on logging streams where logs are embedded in the ice. The modern tendency, specially for low-head plants, is toward units consisting of the vertical, single-runner, large-capacity turbine (Fig. 60), with a direct-connected generator. Where a set of this type is used, economy in space results, and maximum reliability is insured, due to the accessibility of the wearing parts for inspection, adjustment, lubrication and repairs. The enclosed-and-heated forebay is now being used in Northern climates to prevent the interference by ice with operation. The continued use of a submerged forebay is justified because it eliminates practically all floating materials from the rack. Where conditions affecting the choice and size of units permit, there is a tendency to reduce the number of units in the plant to say three or four, rather than to have a large number of relatively-small units.

The Typical Arrangement of a Low-Head Hydro-Electric Generating Equipment is shown in Fig. 60. This provides about as simple and effective arrangement as can be designed. The turbine and the generator are both of the vertical type and are direct connected so that there is no unnecessary friction lost in gearing or belting. The weight of the water-wheel, the pressure of the downward water thrust and the weight of the revolving part of the alternator, are carried by a thrust bearing located in the top o fthe generator. The guide bearings are self-aligning, so that cramping cannot occur. No step bearing is necessary or provided in the water-wheel.

A Low-Head Hydro-Electric Plant with a Horizontal Turbine is shown in Fig 61. With this arrangement, the generator is direct connected to the turbine shaft and the water is impounded against one of the station walls. A modern low-head relatively-large capacity hydro-electric station is illustrated in Fig. 62. In this plant ten turbines, each developing 10,800 horsepower on a 30-foot head and operating at 53 r.p.m., are installed. The generators are 6,600 volt, three-phase, 60-cycle machines, and are rated 10,000 kva.

A Typical High-Head Hydro- Electric Station is shown in Fig. 63. The impulse wheel is of the Pelton type. The governing of impulse wheels is effected by deflecting the stream away from the buckets or by throttling it. Because of the high heads under which the impulse wheels usually operate, it is dangerous to attempt to govern by throttling alone, hence a system of governing which combines throttling and stream deflection, has been adopted.

The Largest Hydraulic Single-Runner Turbine Ever Built is of 31,000-horsepower capacity (Fig. 64), and is to be installed at the aluminum plant on the Yadkin River in North Carolina. The head is 188 feet. The speed under an effective head of 188 feet, is 150 r.p.m. An efficiency exceeding 91 per cent., at full load is expected. The generators are 13,200-volt machines, rated at 18,000 kva. The turbines were built and installed by the Allis-Chalmers Company, and the generators and exciters by the General Electric. As shown in Fig. 65, the plant contains three of these 31,000-horsepower units. No transformers are required in the station, inasmuch as the energy is generated at 13,200 volts, which is also the transmission voltage. Fig. 66 gives an idea of the complete development.

The Keokuk, Iowa, Hydro-Electric Station is shown in Figs. 67, 68, and 69. The ultimate capacity of the station is 300,000-horsepower. Energy is transmitted over a distance of approximately 200 miles in certain directions of St. Louis and other cities in Missouri and Iowa. The initial installation of turbines comprises fifteen units, each having a normal rating of 10,000-horsepower, based on a head of 32 feet. The generators have a maximum continuous rating of 9,000 kva. at 11,000 volts, and operating at 80 per cent. power-factor. The normal speed is 55.7 r.p.m. This is a 25-cycle plant. For energy transmission to St. Louis, the voltage is stepped up to 110,000. For shorter distances a voltage of 66,000 is used.

Outdoor Hydro-Electric Plants* have been proposed. Figs. 70, 71, 72, and 73, show the general construction and arrangement. It is anticipated that material economics will be realized through the omission of the building (which ordinarily houses the generating equipment) in a plant of this character. Outdoor switching and transforming stations have been in successful operation for a number of years, so there appears to be no reason why an outdoor hydro-electric plant should not be successful. The plant illustrated was a tentative design proposed by R. J. McClellan, Chief Engineer of the Electric Bond and Share Company. Climatic conditions and violent winds were the determining causes for eliminating the powerhouse superstructure. The estimated cost of this development was $70 per kw. All of the generators and transformers are located outdoors. The control boards and exciters are installed in a structure over the tail-race, where a repair shop also was located.

*Electrical Review, Sept. 25, 1915, page 689.

MONEY LOST UP THE CHIMNEY

IN THE February 20th issue of POWER HOUSE there was an interesting article referring to carbon dioxide recorders and giving figures on the heat losses due to certain high and low percentages of CO_2 in the flue gas from boiler furnaces. The heat lost up the chimney represents by far the largest item of wasted fuel in the average boiler house. There is a very definite relation between the percentage of CO_2 in the flue gas and the value of the fuel that is wasted in the form of heat discharged up the chimney. This relation is shown on the accompanying chart which has been developed by the Uehling Instrument Company, 200 Empire Building, New York, to enable the engineer to determine exactly how much of his fuel, in dollars and cents, is being wasted due to low CO_2.

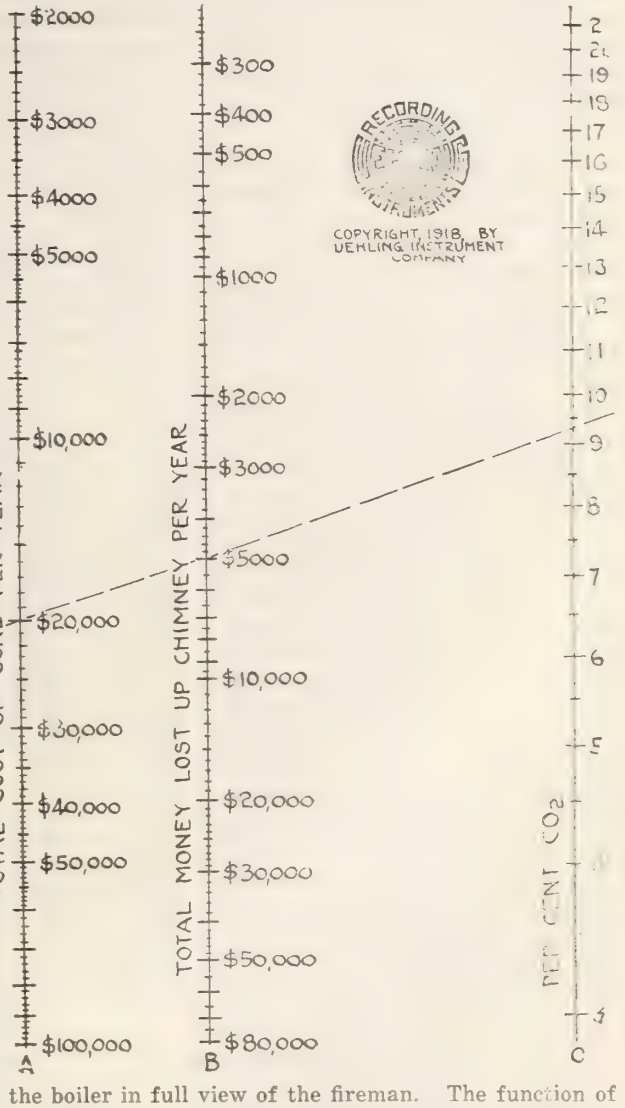
Simply connect the percentage of CO_2 (shown in Column C) with the money now being spent per year for coal (shown in Column A) and the intersection of the connecting line with Column B immediately gives the dollars rolling out of the chimney in the form of heated gases.

Example: If $20,000 is spent per year for coal burned in a furnace whose average CO_2 registers 9.3 per cent., what is the approximate money lost up the chimney per year?

Solution: Connect the $20,000 (Column A) with the 9.3 per cent. (Column C), as indicated by the dotted line drawn across this chart, and the intersection with Column B shows the approximate yearly loss to be $5,000.

The object of this chart is to show that a high percentage of CO_2 is most desirable. To be sure, even where the CO_2 is as high as 21 per cent., the theoretical maximum, there is a loss because in the average power plant the flue gases heating the boiler have a temperature as high as 500 or 600° F. Loss, therefore, is inevitable unless some sort of system is installed for either heating the feed water by means of this waste heat or preheating air and leading it under the grate.

It is significant that many of the large power plants of to-day have adopted CO_2 instruments that record automatically and continually. The reason for this is to keep constant tab on the efficiency of combustion. The recorder may be placed at any convenient distance from the boiler in the office of the chief engineer, owner, manager or superintendent, while an auxiliary CO_2 indicator is placed



on the boiler in full view of the fireman. The function of the indicator is to keep the fireman constantly informed as to the efficiency of his own work. This feature is most commendable.

Coal cannot be saved by a CO_2 machine alone. If no attention is paid to the indicator or recorder, the installation of such apparatus borders on foolishness. The records should be carefully watched and studied and adjustments should constantly be made in firing methods until the best percentage of CO_2 is obtained. After the best mark is reached, fluctuations of the CO_2 line below that mark to any great extent should not be allowed.

This chart is based on a flue gas temperature of 600° F. and an outside air temperature of 60° F. Where the flue gas temperature is higher, or the outside air temperature lower, the money loss is proportionately decreased. Further, in the construction of this chart, it has been assumed that the coal has a calorific value of 14,500 B.t.u. per pound of combustible.

The Erection of Engines and Boilers

This Article Deals With Some of the Particular Points to Watch in the Brickwork Setting of Horizontal Boilers

By T. H. Fenner

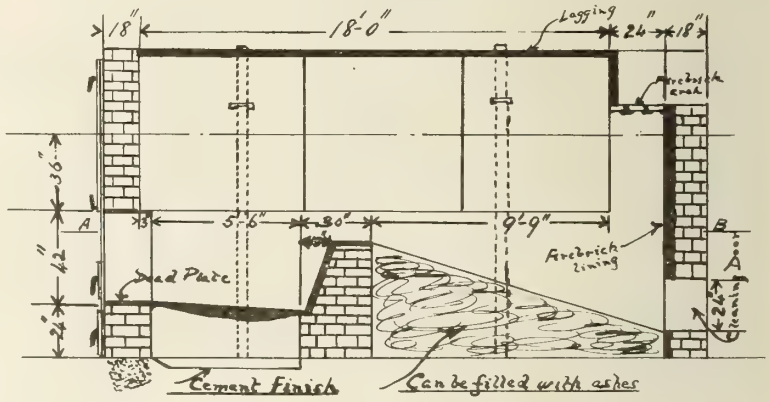
IN the previous articles on this subject we have dealt with the laying-out of foundations, excavating, making concrete forms, mixing and pouring concrete, and the handling of the boiler from the railway car to its place. Before going any further we will look into the subject of boiler settings. We need not go into the subject of water tube boiler settings here, because these boilers are almost always set up by the employees of the makers. They have a standard arrangement of setting and baffling brickwork, which is never departed from, and has been adopted as the result of much experience.

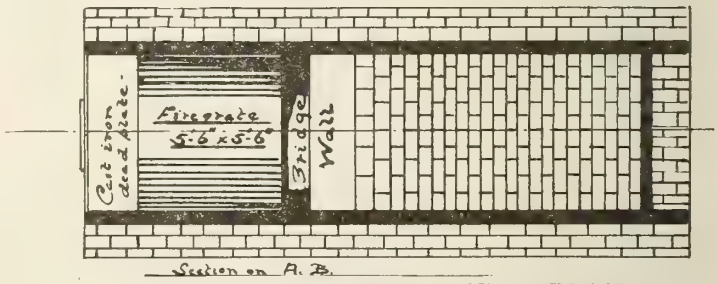
The setting of horizontal return tube boilers is also pretty well standardized, but the great trouble is that the standard is so often more honored in the breach than the observance. Horizontal boilers are so often put up in plants which are comparatively isolated, and the men on the job have the opportunity of exercising their own discretion as to the method of setting. The results are very often quite extraordinary, and the subsequent difficulty in obtaining steam is blamed on the coal, the fireman and the boiler in turn, but never on the real cause, which is the faulty setting.

In the case of the suspended boiler, the setting has no part in holding the weight of the boiler, and is therefore not subjected to any vibration, or strain from the movement of the boiler. When the boiler is supported by the walls, there is always a certain amount of racking action that tends to disintegrate the brickwork and open up sources of air leakage. The only object of a setting, when not used as a support for the boiler, is to make an enclosure which is impervious to the entry of air, excepting where openings are specially provided. An air-tight setting has not yet been made, but by close attention to the erection in the first place, and close supervision afterwards, a very fair degree of airtightness can be attained. The side, back and front walls are usually 18 inches in thickness, and where there are two boilers side by side, the thickness of the centre wall will be 24 inches and an air space of 2 inches provided in the wall above the firegrate to allow for expansion. The walls above the firebars in the furnace space, and in the combustion space, will be made with a firebrick lining. The arches and cheek plates at furnace doors, and the arch over combustion chambers, will also be composed of firebrick. It is usual nowadays to obtain specially formed blocks for these positions, which can be installed easily, without the help of a bricklayer, and usually have a long life due to the absence of joints.

The accompanying drawings show the setting of a horizontal return tube boiler, and attention is drawn to several features which require careful attention. In the first place the space above the firebars to the top of the boiler should be greater than is generally allowed in standard settings. In the accompanying sketch the height from bars to boiler shell is given as 42 inches. The usual standard boiler setting gives this height as 30 inches. Modern practice is to make this height as great as can be attained within practical limits, and some authorities claim that the furnace space should be as high as the width, or in other words, the volumetric space of the furnace should be equal to the cube of the diameter of the boiler. The reason is, of course, to prevent the cooling of the gases against the boiler shell before they are ignited, which takes place if the shell is too close to the bars. It used to be quite a common thing to find a boiler set 24 inches above the bars, and to find a very considerable deposit of non-conducting carbon deposit on the fire sheet. The bridge wall should be carried up to within 12 inches of the boiler shell at the centre of the boiler, and carried straight across. It should not be curved as, is sometimes done, to conform with the shape of the boiler.

The front of the bridge wall is lined with firebrick, as is the top, and the front should slope back as shown in the drawing. In building the bridge care should be taken to make the slope in such a way that the flame will not be thrown on to the rivets of the first circumferential seam, and in many cases the angle of the bridge will be governed by this feature. The furnace door arch may be built of brick, or as we have already mentioned, some specially made firebrick arch. In either case, care should be taken to see that the arch projects far enough under the boiler shell to protect the rivets on the head seam. This part of the boiler being comparatively cool, and a natural depositary for any scale that may be around, besides having two thicknesses of plate, requires careful protection from the heat. Otherwise, fire cracks and a leaky seam will soon develop. Another point to watch carefully is that there is no space left between the boiler shell and arch at the head, which





PLAN AND ELEVATION OF BOILER SETTING

The object of the bridge-wall is both to form a baffle for the gases going through to the combustion chamber, and at the same time, form a refractory mass which will tend to ignite any gases which might otherwise escape. From the back of the bridge-wall the floor should slope down to the cleaning door in the back wall. This floor can be faced with ordinary brick, as it will always be covered with a soot deposit which protects the face of the brick from the heat. It should be well laid to facilitate cleaning. will allow a short-circuit of the draught. It is a good plan to fill in around the edge of the shell and the arch with a plastic cement and keep this in good repair. The floor underneath the bars, in the ashpit, should be finished off smoothly with cement, and slope down slightly to the bridge wall, so that it is easy to clean out with a long shovel or rake. The dead plate should have a good bearing in the front walls. The firebrick lining should start from the level of the firebars, and carried up to the full

height of the combustion space. The brick should come in close to the boiler shell at the height of the top row of tubes. Another point to watch is the position of the arch over the combustion chamber. This should come immediately over the top row of tubes, and protect the rivet heads in the boiler head, or stay nuts as the case may be, from the hot gases. I have seen arches built so that they were 12 inches above the top row of tubes, and the rivet-heads supporting the channel iron to which the stays were secured, badly burned. There is also danger of burning the plate if the water level is not kept high, and even if the plate is not burned, the effect is bad. It can be easily understood, when it is considered that on one side of the plate there is steam or water at a temperature of about 300 degrees, while on the other there are hot gases averaging at least 1,000 degrees. With a fluctuating water level, the plate is alternately heated and cooled, setting up considerable stresses above the normal strees due to the pressure.

The junction of the combustion chamber arch and the boiler head is a difficult place to keep air-tight. Sometimes the arches are supported by a channel iron on the boiler head but this is not good practice. The arch should be supported on angle or tee irons laid in the side walls. The boiler lagging can be brought down to the top of the arch, and the joi t finished with plastic cement. However, this is one point of the setting that must be carefully watched, and kept in good repair, otherwise there will be considerable air leakage developing. Along the shell of the boiler where the fire-lining joins it is also a fruitful source of trouble from air leaking. The careful engineer will examine these daily. It is only a matter of running a lighted candle along these places, when an air leak will be clearly indicated.

Care should be taken with the fitting of the frame for the cleaning door at the back end. It should be well bedded on to the brickwork, and bolted securely in its place. It is a good idea to keep the opening inside the door filled with loose brick. This keeps the heat off the cast iron, and tends to prevent warping. In my experience as an inspector, I found leaks round the cleaning doors in 9 out of every 10 boilers I examined. Another place where there is usually a considerable leak is where the blow-down pipe comes through the setting. The hole in the wall should be bushed with a piece of pipe large enough for the blow-down pipe to come through with ample clearance and then the space around it filled in closely with asbestos. It is no use mixing the asbestos with water, in this case, for the water dries out, and the composition of course shrinks. Dry asbestos, tapped in good and tight will keep this place pretty near airtight.

Coming back to the front end of the boiler. The baffle plates on furnace doors should be kept in good repair, and the fire brick supports, or cheek blocks on which the furance arch rests, be in good condition. By taking care of these points, a long step in the prevention of warped fronts is attained, and the air leaks arising from this cause eliminated.

While the foregoing is perhaps not exactly in line with erection work, it is a subject that is closely allied with it. Further, there is so much evidence of neglect of these matters that it seems as though too much cannot be said to impress on power-plant operators the importance of these points. Looking for air leaks in a boiler setting is not as interesting as taking indicator cards, perhaps, but the right kind of attention paid to the brickwork will show more on the coal bill than a little more lead, or less compression on the indicator card.

BRIQUETTE PLANT FOR EDMONTON

Important Development to Use Tar Sand and Coal Deposits to Make Briquettes

Edmonton, Alta.—Two Chicago capitalists recently visited Edmonton to survey the field with the idea of establishing a plan to manufacture briquettes from semi-anthracite and lignite coal, which are abundant throughout the province. Part of their plan is to extract tar from the tar sands of the Athabasca River district, to be used as a binder in the briquettes.

They interviewed Premier Charles Stewart, who told them the Government would assure them aid in transporting the tar from their extraction works in the north by water route to a connection with the railway between the Peace River and Edmonton. They said they proposed to ship out from Fort McMurray, at the start, five carloads of tar daily. This output of binder would mean an immense business in briquetting. They also proposed later to supply asphalt to municipalities for road and sidewalk construction.

"There is a big future in briquetting lignite in Alberta," said Premier Stewart. "When scientifically made, lignite briquettes have a fuel value equal to anthracite. Western Canada now imports 3,000,000 tons of anthracite annually, a large part of it from the United States. With an inexhaustible supply of lignite, and with the briquetting industry established, Western Canada will be self-supporting as far as fuel is concerned and will save its present immense expenditure for imported coal."

EXPLOSION OF AN AUXILIARY STEAM TURBINE

Among the accidents reported to The Hartford Steam Boiler Inspection and Insurance Company was one of explosion of a small single stage steam turbine belonging to the Oliver Iron and Steel Company, Pittsburgh, Pa.

This little turbine stood in a sub-basement of the plant and was directly coupled to a centrifugal pump which was used for pumping water from the river. There had been some trouble with the water end of the unit due to fouling of the suction pipe, and at the time of the accident this was just thought to have been overcome and there were still a number of men standing near the little machine. The chief engineer, who was directing the starting up, stood near the water side of the machine and after it had been running for a short while he signalled to the man at the throttle to shut off the steam. At about this momtent the motor burst and the flying fragments cut an opening through the casing all the way around its circumference. One man was killed outright and four others were badly scalded by the escaping steam. One of the latter, the chief engineer, died the following day from his injuries.

The cause of this accident has been attributed to derangement of the speed governor.

STARTS NEW COMPANY

Chas. Watt, who has been associated with the Geo. F. Foss Machinery and Supply Company for the past two years, has opened an office at 212 McGill St., Montreal, and will carry on business under the name of the Watt Machinery and Equipment Company. Mr. Watt has had a wide experience in machine and engineering matters; he was born on June 15, 1877, in the town of St. Louis, Que. His early years were spent on the farm of his father, but at the age of 18 he came to Montreal and started his apprenticeship with the John McDougall Caledonia Iron Works. After five years with this firm he worked eighteen months with the Laurie Engine Company and from there he went to Dundas, working for John Bertram and Sons for two years. He then returned East to Peterborough and served with the Peter Hamilton Company for two years. In 1903 he started with the Dominion Bridge Company of Montreal, working there for ten years, the last eight as foreman. From 1913 to 1915 he was engaged in real estate activities. Early in 1915, when the demand for munitions became excessive and when executives were urgently needed, he was appointed superintendent of the shell department of the Canada Stove and Foundry Company at St. Laurent, retaining this position until 1918, when he became a salesman with the Geo. F. Foss Company, leaving there on March 15 last to open an office of his own.

Manufacturers are said to be turning their attention seriously to air cooling for the engines of small cars. "Autocar" sees in the possibilities of air cooling a chance for the British manufacturer to get ahead of foreign rivals, for in no country has more careful research work been done and more progress made in the design of air-cooled cylinders during the war.

Car Plant to Start.—The Canadian Car and Foundry Company at Fort William expect to have their plant in operation on the 3,000 cars for the Canadian Pacific Railway by June. The Company are taking on men at present to complete rush repairs on 1,500 cars for the Canadian National Railways.

The MacLean Publishing Company
LIMITED

(ESTABLISHED 1887)

JOHN BAYNE MACLEAN - - - - - - - President
H. T. HUNTER - - - - - - - Vice-President
H. V. TYRRELL - - - - - - - General Manager

PUBLISHERS OF

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESSIDER, Advertising Manager

OFFICES

Toronto (Head Office)—143-153 University Ave., Telephone Main 7324.
Montreal—Southam Building, 128 Bleury St., Telephone Main 1004.
Winnipeg—1103 Union Trust Building, Telephone Main 3449.
Vancouver—R. A. Hunter 314 Carter-Cotton Bldg., 198 Hastings W.
Ontario—S. S. Moore.
Eastern Representative—G. E. Pearson.
Toronto and Hamilton Representative—C. H. Broad.

New York—Ken Couillard, 1133 Broadway, Telephone 8971 Rector.
Chicago—A. H. Byrne, 1401 Lytton Bldg., 'Phone Harrison 9133.
Boston—C. L. Morton, 734 Old South Bldg., 'Phone Main 1024.

GREAT BRITAIN

London—The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C., E. J. Dodd, Director, Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 4d. per year; other countries, $2.50. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by notifying us at once, also advising us promptly of any change in address, being sure to give both old and new addresses.

Vol. XIII TORONTO, MAY 5, 1920 No. 9

Modern Boiler Practice 199
Electric Generating Stations—Part IV. 204
The Erection of Engines and Boilers 212
Editorial 214
Progress in New Equipment 216
Our Question Box 218
Operators' Point of View 219

W. F. Sutherland Resigns

MR. W. F. SUTHERLAND, who has been in charge of the editorial department of POWER HOUSE, is resigning his position to take up work in the industrial field. He will devote most of his time to the electrical power development side of engineering. Mr. Sutherland has agreed to ocntritueb to POWER HOUSE on electrical subjects, with which he is very well qualified to deal. The staff and readers of POWER HOUSE join in expressing good wishes for his future success.

A Personal Message

THE writer, in taking over the editorship of POWER HOUSE, does so with a deep sense of the responsibility incurred in such a step. Nevertheless the task is one which he undertakes with a great deal of pleasure, and a hope that the opportunities it opens of being of service to the stationary engineering fraternity may be fully realized. Many of the readers of POWER HOUSE are known to him through correspondence and quite a few are his personal friends. He hopes to be able eventually to include every reader in that category. The problems and difficulties that beset the path of the operating engineer are known to me through painful experience, and no one knows better the value of consultation with other men in the same profession. Every man's experience can be supplemented from that of another, and all the engineering knowledge that we have to-day is but the condensed experience and investigations of those who have gone before. The technical magazine is an open ground to which all can bring their views and experiences for the benefit of all the rest. It has sources of information that cannot be commanded by the individual, but which it makes available for every one.

There has never been a time when the technical magazine could be of greater service to its readers than the present. The work of the operating engineer calls more and more for technical knowledge, and there is no easier place for him to get it than the pages of his technical paper. It will be the earnest endeavor of the writer to maintain the high standard already set, and improve on it where possible. Criticism from our subscribers will be welcomed, and given every consideration, for the success of any journal lies with the degree of satisfaction given to the readers. On the other hand, expressions of your satisfaction are not forbidden. Having made this little editorial bow, let us all get together for the advancement of the professions.—T. H. Fenner.

The Late Olaf E. Granberg

STEAM plant owners and operators, particularly in the Province of Quebec, will learn with deep regret of the death of Mr. Olaf E. Granberg, which occurred on April 10th at his residence, Columbia Avenue, Westmount, P.Q.

Mr. Granberg's long and honorable connection with the Boiler Inspection and Insurance Co. made him widely and intimately known in steam engineering circles, and his charm of personality endeared him to all those with whom he came in contact.

He came to Canada as a boy of 7 from Norway, and settled first in the little town of Coaticook, P.Q., where he received his education. His first introduction to the engineering profession was in the Smithy of the local blacksmith, where the principal work was dressing the drills for the nearby quarries. He later entered a machine shop, and served his apprenticeship as a machinist. From there he went to the plant of the Dominion cotton mills, Coaticook, and worked up first to the position of master mechanic, and later manager.

July 1890 he joined the staff of the Boiler Inspection & Insurance Company as an inspector. As the business of the company grew he grew with it, and soon became chief inspector for Quebec district. His next appointment was that of manager of the Montreal office and later Vice-President of the company, which position he held at the time of his death. He had been in ill health for some time, and the death of his wife in January last was no doubt a contributing cause to his own demise. Mr. Granberg was 70 years of age.

His passing will be deeply felt by all his associates in the company, and by the numerous business and personal friends he had formed during his long and useful career.

Do Mergers Increase Prices?

THE matter of the big steel-shipping merger, now completed, came up in the House at Ottawa this week, and the question was put whether the Government intended to stop it.

"This new merger," said one member, "is capitalized at nearly a billion, and is almost consummated. The question is whether the Government should not take steps to stop this huge merger, which will most likely result in an increase in rates."

It would be interesting for this member of the Dominion House, seeing that the Canadian merger is primarily a steel concern, to look over the trend of prices of steel on this continent.

He might be surprised to learn that Canadians—and we depend largely on United States for steel—have bought at a much lower rate from the United States Steel Corporation than from any of the independents and smaller mills.

The United States Steel Corporation adhered to the regulated schedule of March 21, 1919, and is still very close to it.

The independents, on the other hand, are selling steel at a stiff advance over the March 21 schedule.

The U.S. Steel Corporation has been, and is yet, the one agency that has stood in the path of a runaway steel market.

There seems to be an opinion that the word "merger" implies a gouging of the people. In the steel trade the evidence does not bear this out.

There is right now a concrete example in the steel trade of this continent. In fact it is so marked as to lead to the belief that the Steel Corporation is too low or the independents and premium mills too high—and in this connection it is well to remember that the Corporation is neither passing up dividends nor going into liquidation.

Hitching His Apple-cart to a Star

PERPETUAL motion and like vagaries of the human mind have many variations, and to list them would require an ambitious volume, which, while undoubtedly large, would prove to be most fascinating reading. The modern phenomenal advance in matters electrical has, as may well be imagined, given considerable impetus to schemes intended to hitch terrestrial magnetism to some novel scheme for the furtherance of man's well-being. "Refrigerating World," of New York, has unearthed the latest of these and describes it in the following words:

"And now comes forward still another scheme to disturb the peaceful dreams of the ice and refrigeration industry. Dr. Harry Barringer Cox, whose work in the invention of the dry battery, the ground wireless and many other contrivances, has made him known throughout scientific circles, announces that he has succeeded in harnessing the magnetism of Mother Earth in such a way as to keep fruits and vegetables fresh indefinitely without the aid of the ice-man, canning, chemicals or the drying process. Dr. Cox gave this startling information to the world in New York this month upon his arrival from California with a mysterious looking suitcase which, he said, contained all the necessary paraphernalia to rob death of all of its sting for an apple, or an orange, after it is plucked from its parent stem. Ignoring Dr. Einstein and his pet theories entirely, Dr. Cox insists that he has harnessed magnetism to his purposes, and at his hotel in New York he displayed to the newspaper men alleged indorsement of his apparatus from the United States Department of Agriculture, California Fruit Growers' Association and others. At the same time the inventor claims that his process would prevent waste amounting to $1,000,000,000 a year. The only consolation afforded the ice-man is that this enormous saving will enable him to supply plenty of ice to the poor through civic committees during the dog days when ice is scarce.

"In his demonstration before the New York reporters a box about the size of a suitcase was shown containing tin cans. A copper wire was attached to the radiator and run through the bottom of the box. This wire was attached to a 'vitalizer' at the bottom of each receptacle. The doctor explained that the wire could be attached to a gas or water pipe or any metallic substance connected ultimately with the earth. In bringing the suitcase from California he drew the magnetism from the earth by attaching the wire to the steel construction of his Pullman, thereby securing the connection through the rails. Ships make a connection through the water.

"In the aforesaid tin containers the doctor exhibited oranges that were as firm and cool as if just picked in the morning when the dew was on the vine. In fact, the fruit exhibited was slightly covered with moisture. Potatoes, carrots and other vegetables several years old were also shown in the same condition. The theory of this method of preservation is, to state it in simple language, that by establishing the proper connection with the magnetism of the earth the fruit remains in exactly the same condition as when growing on the trees. In short, the magnetic connection is the tree itself.

" 'Vegetation,' he said, 'is due to the action of radioactive rays of the sun, which are produced in the earth and which through this new method may be transmitted by metal connection to any vessel and the products contained therein. The process going on in the vessel is exactly the same as that which goes on in the earth, and as long as it is undisturbed the preservation is of indefinite duration.'

"The doctor failed to explain, however, why the fruit and other products do not continue to grow as they do under natural conditions and eventually decay."

New York Gets After The Gouger

SEVERAL meetings have been held at different points to protest against the prices of potatoes, sugar, etc.

These meetings afford a good chance for people to state their case. Misery likes company, hence the sessions are well attended.

Farmers sold lots of potatoes in the fall for $2 and $2.50 per bag. That price represented the finished article. All the necessary labor had been expended. The difference between that price and the present $7 and $8 per bag represents the amount of gouging that has been going on since.

It is also a monument to the inability of the Government officials to put a crimp in the profiteers.

This week three dealers in New York City were arrested for profiteering. That is exactly what they call it.

They don't throw up a smoke screen and call it the high price made necessary by excessive production costs.

The first two arrested in New York were charged with selling 5,000 pounds of sugar at 25½ cents a pound, which they were alleged to have secured for 14 cents. The third sold at 22 cents and made 8 cents a pound. Bail is set at $1,000 each.

The jail is a mighty good place for the gouger and the financial glutton. Too bad that lenient officials admit that bail applies in all such cases.

Chance To Start Right

THE Secretary of the Navy at Washington is offering a lot of vessels for sale at bargain prices. That's what he means, although the official document puts it that they are "appraised low for immediate sale."

There seems to be a very good opportunity for some of the malcontents to start a brand new war. They could start out with buying a cruiser. There's a nice one offered for $225,000. No guns go with it, but these can easily be secured.

Then there are patrol boats, yachts, tugs, etc., in fact, everything except first-class battleships.

If you are not satisfied with present conditions, step right up and buy a fleet.

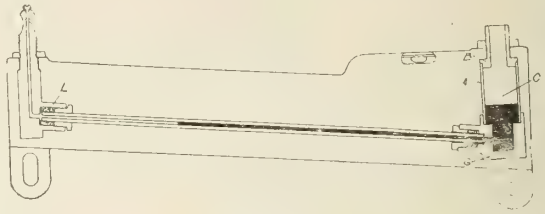
Progress in New Equipment

HAY'S DIFFERENTIAL DRAFT GAGE

The accompanying illustrations show the general arrangement and details of the Hay's Differential Draft Gage. The following description shows the various points which constitute its special features.

The oil chamber "O," is composed of a brass tube, "A," of uniform diameter, sweated to the machined parts "B" and "C." See detail 1.

The glass indicating tube is fixed in the base of the old chamber by a compression nut set against cork washers. The result is an oil tight joint, the indicating tube being held firmly but not rigidly. A similar connection is made with the machined part, "L," Fig. 8, which constitutes the air vent or pressure connection.



DETAIL 1.

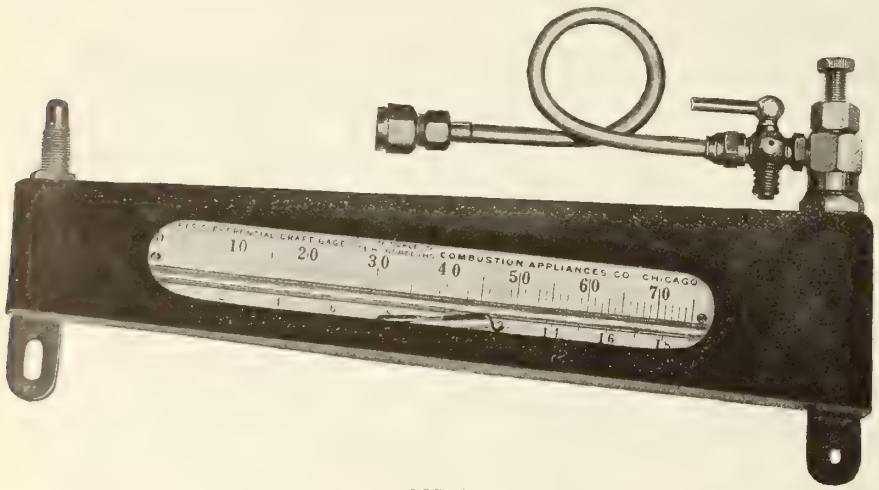
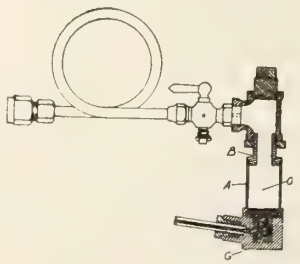


FIG. 1.

Glass tubes are never uniform bore. Furthermore it is impossible to heat a glass tube to the fusing point without affecting the walls of same. It is essential to the accuracy of a draft gage that the oil chamber be of standard and uniform bore, otherwise the indications at some point upon the scale of the gage may be inaccurate.

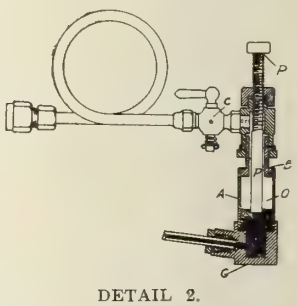
Hay's draft gages are made to stand the hard work of the boiler room. They are accurate at all points of the indicating scale. Detail 2 shows a device, patent applied for, to bring the oil quickly and accurately to the zero mark on the indicating scale. Engineers will agree with us that it is a fussy job to bring the oil to the proper point where the dropper is used. It is absolutely necessary to use a light oil as an indicating fluid. No. 300 Mineral Seal is the oil used and it will evaporate. It is therefore necessary to verify the gages occasionally for the zero indication. This is done by turning the cock "C" detail 3, and throwing the gage on air. The divide shown in detail 2 obviates the trouble with the dropper.

When the gage is first filled oil is introduced until it stands in the indicating tube at a distance of about five points from the zero mark. The plunger, "P" detail 2, is then attached and the plunger head is screwed down until the displacement causes the oil to reach zero. Thereafter when testing for zero it is necessary merely to screw the plunger down further to bring the oil quickly and positively to the zero point. When the plunger reaches the bottom of the oil chamber it is necessary to remove it and add more oil. Hay's draft gages are the only ones upon the market equipped with this device. It is an exclusive Hay's feature.



The flexible connections furnished with Hay's gages take care of all expansion and contraction that may take place between the gage and the solid iron pipe leading into the furnace. Detail 3 illustrates the flexible connection, another exclusive Hay's feature.

The furnace room is often a poorly lighted place and it is essential that the gages be clearly readable in a dim light. The scales are etched in black upon a silver plated background. The readability is further enhanced by the wide glass-covered opening of the gage front.



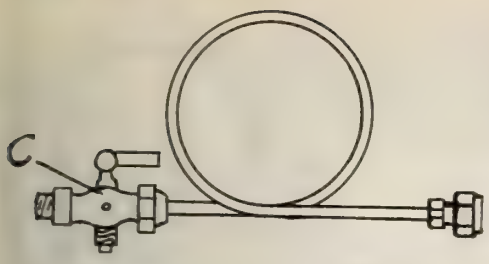
DETAIL 2.

Markers are furnished with Hay's gages arranged to ride upon the scales and may be set where desired after the gages have been erected.

THE NOKUT VALVE

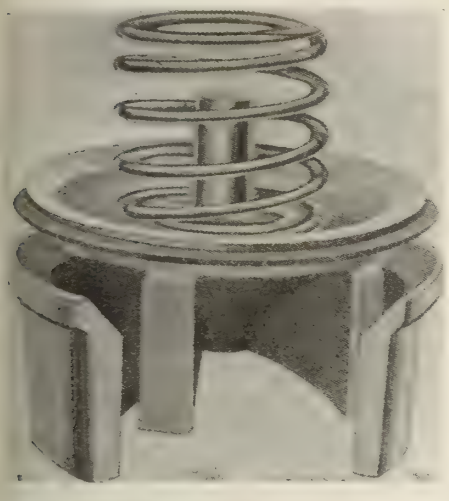
The accompanying illustrations shew two styles of valve, the NoKut standard type, and the NoKut pot type of pump valve.

These valves are claimed to be a very superior design. The valve disc is made of arpecco metal, which combines strength with light weight. A groove in the outer circumference of the valve



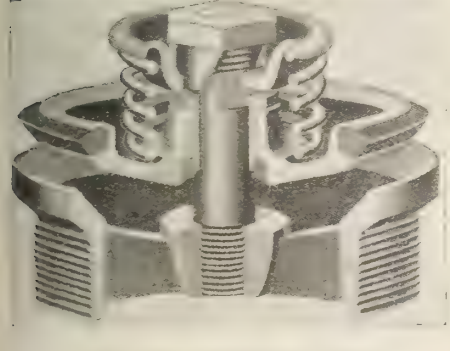
disc holds a composition ring, the function of which is to hold the disc tight against the seat when the valve closes. A similar ring is fitted on the edge of the stud hole, which prevents leakage between the valve disc and the stud.

The valve seats and discs are bevelled at the contact edges, and the water is



NO KUT POT TYPE VALVE.

not violently deflected from its course owing to the clearer passage provided the valves are not given so great a lift, and therefore work with less shock. A feature of the valve disc that will appeal to all pump users is the fitting of a brass bushing in the stud hole, which can be renewed as occasion requires. This effectually overcomes one of the



NO KUT STANDARD TYPE

most troublesome features of the ordinary pump valve operation.

It is claimed that the flexible composition sealing ring will keep the valve tight regardless of the condition of the valve seat. This has been put to an interesting test, in which the valve seat was grooved deeply with a file all round the circumference, and then subjected to a pressure of 300 lbs. for a period, without leaking. The valves are said to be very durable, with repair costs reduced to a minimum.

They are made by the Richardson Phenix Co., Milwaukee, Wisconsin, who have issued a well illustrated catalogue dealing with their product.

NEW JEFFREY CATALOGUE

The Jeffrey Manufacturing Co., Columbus, Ohio, have issued Catalogue No. 259, illustrating and describing their type "E" swing hammer shredder (ball bearing), for reducing wood chips, bark, and other fibrous materials.

Particular attention is called to the simplicity of design in the type "E" shredder, the provision made for capacity, for durability and accessibility of working parts and its easy adaptability to the handling of a variety of materials under different conditions of installation and operation. It is equipped with the highest grade radial ball bearings, which eliminate all bearing troubles and insure maximum service.

The new catalogue illustrates numerous installations and also contains engineering information, plant layouts, and other data of service to plant managers and superintendents.

The handling of coal from railway car to bunker or storage pile is an ever-present problem with many power plant executives. The latest equipment designed to meet this problem is the American Steam Conveyor Corporation, 326 West Madison Street, Chicago, Illinois.

The equipment consists of an overhead trolley, operated on either a monorail track or suspension cable. A hoist is used to lower and move a one-ton, self-dumping bucket, in which the material is carried.

One man handles the carrier in all its operations—loading, hoisting, conveying, dumping and returning the bucket. He is not obliged to leave his station at the hoist at any time. An average of thirty tons of coal can be handled an hour. Five or six cars can be emptied during the day.

The cost per ton of coal handled is extremely small—three or four cents—as contrasted with the usual eighteen or twenty cents entailed.

The equipment is completely described in a new catalogue just issued, entitled "The American Trolley Carrier." Copies will be sent to interested readers on request.

NEW PUBLICATION

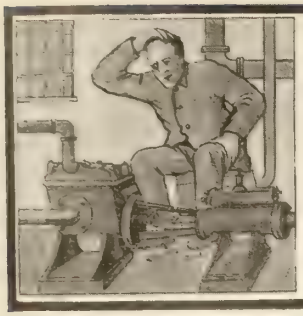
The hot-process water softener is described in a book recently issued by the H. S. B. W., Cochrane Corporation, formerly the Harrison Safety Boiler Works, of Philadelphia, Pa. The hot process softener is a modern development of the well-known lime-soda process softener, the difference being that the chemicals are added to the water only after it has been heated to 205 degrees Fahr. or higher, which results in practically instantaneous and complete chemical reactions and in more rapid settlement of the precipitate. The result is a considerable reduction in the time required for the sedimentation so that the apparatus can usually be installed within power plant buildings and without requiring special foundations or housing. The fact that the feed water heater is combined as part of the apparatus also reduces the complications and the expense of piping, etc. It is also claimed that the maximum reduction of scale and sludge-forming matter is obtained with a minimum excess of reagents and that there is no after-precipitation or troublesome deposits of scale and sludge in pumps, piping, feed water heaters and boilers, while due to the reduced solubility of the products in hot alkaline water, the minimum amount of sludge-forming solids enter the boiler and the tendency to priming and foaming is minimized. In the present publication these statements are supported by scientific data and by the results of practical operation. An improved type of a chemical feeder designed to force the water into the softener against back pressure and a chapter enumerates the impurities found in boiler feed water and describes the kinds and amounts of chemicals necessary for their removal. The book will be of value to all concerned with the operation of steam boilers.

TRADE ANNOUNCEMENT

The Harrison Safety Boiler Works (founded in 1863), which has been carried on for many years as co-partnership by Jos. S. Lovering Wharton, William S. Hallowell and John C. Jones, has been incorporated under the laws of the State of Pennsylvania, charter perpetual, as the H.S.B.W.—Cochrane Corporation with the following officers and board of directors: Jos. S. Lovering Wharton, president; John C. Jones, vice-president and general manager; William S. Hallowell, secretary and treasurer; Horace E. Sibson general sales manager; Axel B. Wallem, general works manager.

The corporation takes over, as of date January 2, 1920, the entire business of the former firm, acquiring its assets and assuming its liabilities.

The management of the business, including the engineering, manufacturing and selling organization so long identified with the Cochrane line of steam specialties, continues as before, and hereby offers its services in the solution of problems relating to the profitable utilization of exhaust steam, and the heating, metering and softening of water. The company manufacture the following lines: Cochrane feed water heaters, Cochrane steam and oil separators, Sorge-Cochrane hot process water softeners, Cochrane V-Notch meters and metering heaters, Cochrane Flow Meters, Cochrane Marine Heaters, Cochrane precision meters, Cochrane weighing meters, Cochrane multiport drainers, Cochrane multiport valves, Creasey ice breakers.



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question.—Please give some information on testing small boilers hydraulically, and what percentage of test pressure should be allowed for working pressure.

Answer.—In testing a small boiler, or any boiler hydrostatically, the safe working pressure should be known first, and the hydrostatic test pressure based on the working pressure. Before testing a boiler of which you do not know the conditions, the examination internal and external should be made. The boiler should be measured up, and the calculations for working pressure made from the measurements obtained.

The leading particulars would, of course, be strength of joints, thickness of plates, heads, reinforcements of openings, diameter area of head to be stayed, size and pitch of stays. These particulars can be obtained on any boiler, no matter how small.

The test pressure should be 1½ times the safe working pressure found by calculation, and should be applied gradually by a hand pump. Care should be taken to see that the boiler is filled with water, and all air expelled. This is done by leaving a cock open on the highest part of the boiler till water appears. When the pressure is obtained, stop the pump, close the feed valve, and make a careful examination for leaks or signs of distortion of the boiler. The pressure should be kept on for 15 or 20 minutes without any appreciable loss without using the pump, if everything is tight.

Do not fall into the error so prevalent that it is possible to put on a pressure of 250 lbs. hydraulically and then assume that the boiler is therefore good for 125 lbs. The hydraulic test is merely a checking up of workmanship, and a guide to hidden weakness. The only way to arrive at a safe working pressure is by a calculation involving every factor in the boiler.

Question.—How do you calculate the horse-power necessary to run a belt driven air compressor?

Answer.—The simplest way is to take an indicator card from the compressor, and calculate the horse-power from the mean pressure as you would a steam engine. This, of course, would only give the actual work done by the piston of the compressor, but would not include friction of moving parts. The mean pressure can be also found by tables approximately. In an air compressor diagram the curve of compression lies between the theoretical isothermal compression curves and the theoretical adiabatic compression curve. As the gauge pressure increases, the difference between these two curves becomes much greater. For instance, at 30 lbs. gauge pressure the theoretical mean pressure with adiabatic compression is 21,597 lbs. and with isothermal compression 16.345 lbs. per square inch. At 100 lbs. gauge pressure the adiabatic mean is 50,878 lbs. and the isothermal mean is 30.195. When the mean pressure is known, the work done by the piston is found by the same formula as that for the steam engine.

Area of piston $\times$ mean pressure $\times$ length of stroke in feet $\times$ number of strokes per minute $=$ st. lbs. per minute. This divided by 33,000 gives the horse-power. Suppose you have terminal pressure of 100 lbs. gauge, the mean pressure would be between 50.8 and 30.1, say 40 lbs. Then

$$\frac{40 \times A \times L \times N}{33{,}000} = \text{H. P.}$$

To this add 10 per cent. for loss by friction and slip of belt.

Question.—How would you figure out the size of a steam header for a battery of boilers containing eight boilers of 150 h.p. each? What size header should be installed?

Answer.—The amount of steam generated by each boiler would be at 100 per cent. rating 150 $\times$ 34.5 and by the eight boilers 150 $\times$ 34.5 $\times$ 8 $=$ 41,400 lbs. per hour. As no steam pressure is given, we will assume steam at 150 lbs. pressure, the volume of a one pound being at this pressure 2.533 cubic feet. This gives

$$\frac{41{,}400 \times 2{,}533}{60} = 1747.77 \text{ c.f. per min.}$$

Making an allowable velocity of 6,000 ft. per minute which is a fair average we get

$$\text{Area} = \frac{\text{Cubic Feet per Min.}}{\text{Velocity}} = \frac{1748}{6000} =$$

.291 sq. ft., say .3 square feet. This multiplied by 144 $=$ 43.2 square inches. Then diameter will be

$$\sqrt{\frac{43.2}{.7854}} = 7.4,$$

which is an odd size, so that 8 inches diameter should be about right.

The table for carrying capacity of steam pipes given in Kent's book gives the carrying capacity of an 8 inch. pipe at 150 lbs. per hour which is in fair agreement with the result obtained.

CANADIAN ICE MACHINE COMPANY'S NEW PLANT

The making of refrigerating equipment is a business demanding more or less specialized equipment and plant routine. This is particularly true of the pipe work involved. Ammonia coils, condensers, etc., have to be made of such strength as to stand comparatively high pressures and at times severe conditions. During the fall of 1919 the Canadian Ice Machine Company moved to their new factory near Ashbridges Bay, Toronto. This plant is now being used for the fabrication of all the piping entering into Canadian refrigeration plants installed by this company.

The main building is 100 by 245 feet long and together with the garage carpenter shop and storehouse occupy part of the two acres of land owned by the company. Large, well-lighted offices occupy a second floor at the front of the main building and are divided into business and engineering sections. This latter department includes the purchasing, progress traffic, drafting, departments, etc. Large private offices are also provided for the executives.

The factory building itself is of the usual brick and steel construction and is so laid out that all materials progress successively from one end to the other without interference. The factory operations include bending, electric welding, acetylene welding, etc., and in addition to departments for the carrying on of these various operations a coil shop, machine shop and blacksmith shop are provided. All manifolds are acetylene welded, while a Thompson electric welder is used for butt-welding ammonia coils. This eliminates all joints and results in a perfectly tight construction, stronger than the original pipe.

All coils and pipes before shipping are tested with air under water up to 300 pounds pressure and on occasion hydraulic pressure up to 600 pounds per square inch can be used.

For the heating of the shop and office a 75 horsepower boiler is installed. The shop is heated by Vento radiation and air ducts underneath the floor, while the office is steam heated. The heating and ventilation equipment was installed by W. J. McGuire, Toronto.

A siding runs directly into the shop with room inside for two standard freight cars. Room is also provided inside for eight carloads of pipe.

The Operators' Point of View

Re the Ontario Graded Certificate Act

Correspondence

THE Editor,—I am pleased to find as I read through the correspondence page of POWER HOUSE that I have a few kindred spirits who will help in the fight to rouse the stationary engineer out of the rut he has fallen into of late years. He will sink, if let alone, more deeply into the slime of ignorance if not roused up to see the danger of his position. This may sound very harsh to the ordinary layman, but when we think of the strides that science has made during the last five years, has the average engineer tried to keep pace with it? Has he not been able to see the handwriting on the wall and that the technical man has come to stay? Why has he not in all those years with his great amount of practical ability clinched the matter by becoming technical as well? As it stands now the younger man leaps over his head, and he will gradually fall back into the far and dim past. I still look forward to a great revival among engineers in the future, but until they can see themselves as others see them their status in the world will remain that of the skilled mechanic.

I can't say I agree with our friend Mr. Noble, although the idea is a good one, I am afraid it is not practicable, because if we had so many specialists round a plant, the green eyed monster would play a very prominent part. I know I am making a very grave assertion but if any of my fellow-engineers have had the misfortune to be in a plant where so many specialists were employed he will confirm my statement. We will take for instance some ordinary plant where a master mechanic, a chief engineer, and chief electrician is employed. Each one has his own particular duties and at some part of the game all these people's duties tie in with each other. Then the petty jealousies begin to show their snakelike heads and all is discord for a time. Of course, there are exceptions to all rules. The war was won with one head so must a power house be run with one brain and the man that shows the best brains wins out in the great race of life. I still adhere to my most religious principles, "Learn more, earn more." I don't wish to come under the category of our friend "Horatio," a sore head, but I would certainly like to see the day that our engineers will arrive at the pinnacle of perfection and be a respected and much revered body of men. But they never will be so long as they are content to remain in the indolent state they are at present. The war was fought for humanity's sake and that the poor downtrodden small man might partake of the gifts the Gods have given him. Metaphorically speaking this is extended to the engineer of to-day. Is he taking advantage of the fact? If my brother engineers would only think over the matter seriously, and the time has come when they must do so, and not only think but act and by doing so we shall rise from our present position of stagnation and obscurity.

Of course I shall be slated from one end of Canada to the other, but I have the strength of my convictions, on this matter, and will state an example of the point in question, but before I do so, please understand I am not speaking individually but collectively, of the whole of Canada. In this city of Montreal the C. A. S. E. hold an educational meeting once a month where one of its members gives a lecture on the different parts of engineering, mathematics, etc. Now I know for a positive fact that this same member spends many hours getting his data together for a two and one half hour's lecture, and the material for demonstration. The lecture should be of great advantage and benefit to the members, yet not more than one-half can attend. If spoken to about it they say "I believe it was a fine lecture, but I will be there next time." Oh, that monster, "Procrastination." These are the men who when the time comes to try and climb higher and the examination has to be passed, start running around to their fellow engineers crying what are the questions? How do you do it? What are the answers? And if a doctor put his sterthoscope to their breast the beat of their heart would almost break the drum of his ear.

I am glad to say my two former letters are doing a little good here in the province of Quebec. They are going to make the examinations a little more difficult. I was speaking to the chief examiner, who is a personal friend of mine on the matter and his version is that now all the old hands had passed through he wished to make a better class of men out of the new blood. At the same time he agreed with me in the stand I have taken and his remarks were "I hope you will shake them up for they sadly need it." I know it is very hard to hear the truth, for truth is like a keen edged sword it cuts very deep, but the sooner it is faced, the better for all concerned. I would like to call Mr. Long to account over the words, "I can't pass for a first-class examination without further study. Please Mr. Long don't use that word "can't" it should be an unknown quantity in the engineer's dictionary. If all our great engineers, before our time and since, had used that slogan, where would the world be today? "Can't" did not win the war, but "will" did. Mr. Long will have read my remarks in former letters on the slang word "Wop." If he is only an ashman he is at least a man for a' that.

I hope when we hear from Mr. Long again he will speak with more confidence, and say, "I have passed," and bear in mind after the honor is obtained and he holds the much coveted certificate he must still say excelsior, and keep on grinding. Remember, to stand still means to fall back later on, and when the good job comes along you will shake your head and say: "It's too big for me." The man who has spent his time burning the midnight oil wins out, for brains tell every time, and the man who has wasted his time falls back into obscurity.

HENRY WRIGHT

Mr. Editor,—This is my last letter on this subject, and your correspondents can scold me to their hearts content in the future. If Wm. H. Long, "Wop," and others will read my letter in February 20th POWER HOUSE in which the unlucky word "wop" was used, they will note that it is stated as certain I could

not pass the present examination for first-class papers. Mr. Long tells us he can do his work as correctly as myself; I never even hinted he could not do so, quite possibly he can do it a lot better than myself, and he would not have much to brag about even at that. He further states he only had a public school education. I only had a small part of such an education, being compelled to leave school at the early age of 10 years, therefore it is small wonder that some word or expression of mine should offend the feelings of some of those who have had greater advantages than myself along these lines.

It is to be regretted that the word "wop" was used. I tried to explain what was meant by the word in a later letter and believed the explanation would satisfy most of the readers, but apparently no attention has been given to that letter One correspondent gently hints that no gentleman will use slang; these are not his words but the impression given. If this is so there are very few gentlemen in this wicked world. A slang word such as I have used is often written to save many words. It has not proved what you could call a success this time so far as saving words is concerned, but it surely has been a success in bringing a lot of new names on to the correspondence section of POWER HOUSE.

The trap mentioned by Mr. Wright is none of my designing. It was described to me and I simply passed the description along. I tried to show this in the opening paragraph of the letter. My own opinion is that the apparatus could be converted into a fairly reliable low pressure trap by making a few inexpensive changes; closing the bottom of the float for one.

In Hawkins' "New Catechism of Electricity," 1903 edition, the practical engineer or mechanic with no book knowledge is referred to as a laborer. So I am not the only "goat" (more ungentlemanly slang). Any man who has taken and passed through a school course in engineering, or made a careful study of engineering text books, must possess considerable technical knowledge. Mr. Wright "bumps" me (more slang) rather hard. He referred to a mechanical engineer with not a particle of technical education. If he had any technical knowledge, even if he secured it by or through practical experiences in working out formulas, etc. (and he could not work out engineering formulas with no engineering printed study to his credit) is it possible for any engineer to have not a particle of technical knowledge?

In every letter I have written I have tried to show that I consider it among the wonders of the world, or words to this effect, for any operating engineer to be a finished technical man.

The opinion I have tried to state is that every engineer in charge should have considerable book knowledge about engineering.

Anything printed so far has failed to change this opinion. Will any of the correspondents who have been "calling me down" (slang again) come out in print under their own name stating they believe an engineer in charge can be a capable, safe, and reliable man and still possess not a particle of book or so-called technical education or knowledge. Do not "split hairs" (confound the slang), education and knowledge are the same thing when the term is applied to a trade. It may be secured to some extent by practical experience and greatly increased by studying the experiences and experiments of those writers, past and present, who have shown us how to solve many engineering problems, many of these problems being worked out by the use of mathematics.

Like many other questions, different people have different ideas as to what constitutes a technical man. At the present time I believe most folks will admit that it is not necessary for a man to have even a high school education, or to have passed a science school examination, or hold a degree from any university, to be a technical man. There are many free technical schools, notably in the city of Toronto, that turn out many engineers every year, who are passable technical men as well as practical engineers. Understand they are technical men in reference to stationary engineering, or sanitary engineering, or to any other branch of engineering to which their studies have been applied. In a minor degree any man can secure such technical education by faithful study of the school text books in his own home, securing help by mail from school teachers on any question he finds it impossible to answer without such help. In the technical school there is a power plant and different equipment which can be taken apart and the different parts, operation, etc., of each machine described and shown to the student. It is obvious that this cannot be done for the home study man, but text book illustrations are so well made that the man of ordinary intelligence has little difficulty in understanding them with the help of the printed description.

Another thing which I have repeatedly stated is my belief that it is impossible for any man to become an expert or even a fair technical man in all the different sciences connected with stationary engineering.

JAMES E. NOBLE,
Portsmouth, Ont.

Burnt Church,
Editor: April 26, 1920.

Dear Sir: We have been asked to give our opinion on graded certificate and any suggestions that we could make. Now I think that some have been too severe on that line, either for or against, but to my mind it is not a question of doubt but what every man operating an engine should have a certificate. Now there is nothing unfair about it. Why is it a man is required to hold a certificate of any kind? Is it not to insure life and property? Now I might apply for a position as master of a vessel. Could I get it without presenting my certificate? Not at all; too much life and property involved and that is the reason why an engineer should stand an examination, of course. I have known men who knew no more than how to turn on the water and start the engine. Good, trusty fellows, but there is more required than that now. I am living in New Brunswick and I just hold a certificate of service. Have had a large experience on engines of different makes. I mostly always effect my own repairs and I can stump the country as to the care and management of engines and boilers, but I know that I could not get a position in Ontario without first standing an examination. Perhaps I should fail but nevertheless I believe in it. Pass the good stuff along. J. R. M.

TRADE ANNOUNCEMENT

The George T. Ladd Company, of Pittsburgh Pennsylvania, manufacturers of the Ladd water tube boiler, have announced the opening of a Chicago district sales office in charge of Mr. W. M. McKinstry, the address being 528 McCormick Building. Mr. McKinstry was formerly Chicago manager of the Page Boiler Company and has had wide experience in all phases of the water tube boiler field.

During the recent cold period the barometer went unusually high (30.85 in. or 30.9 in.,) and operating companies which had an eye to turbine economy increased the vacuums on their condensers as much as possible to keep up with the rise in the barometer. At the United Electric Light & Power Co.'s 201st St. Station, New York, the unusually high vacuum of 20.35 in. was obtained on its 25,900-kva. turbo-generator. The turbine is equipped with a 40,000-sq. ft. surface condenser and a Le Blanc air pump.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE
THE E.S.MANNY Co
27 COTE ST MONTREAL, QUE

Put a Farnsworth System to Work in Your Steam Plant

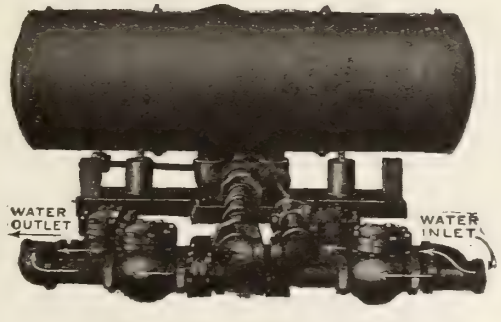
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no trunnions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE
Canadian Farnsworth Company
1-24 Hillingdon Avenue, TORONTO, Canada
W. H. ROSE, Gen. Mgr.
BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
⅛	$ 6 00	$ 8 00	$.....	$.....
¼	4 83	6 96	5 31	7 44
⅜	4 83	6 96	5 31	7 44
½	6 42	7 99	7 10	8 67
¾	8 11	10 24	9 03	11 16
1	11 99	15 13	13 35	16 49
1¼	16 22	20 47	18 06	22 31
1½	19 39	24 48	21 59	26 68
2	26 09	32 93	29 95	35 89
2½	41 24	52 07	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

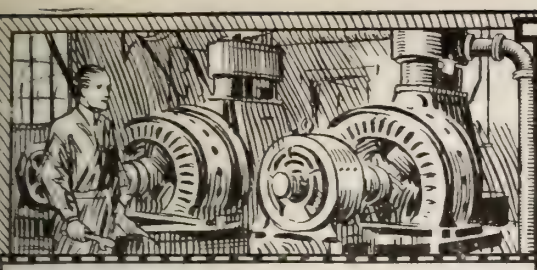
	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

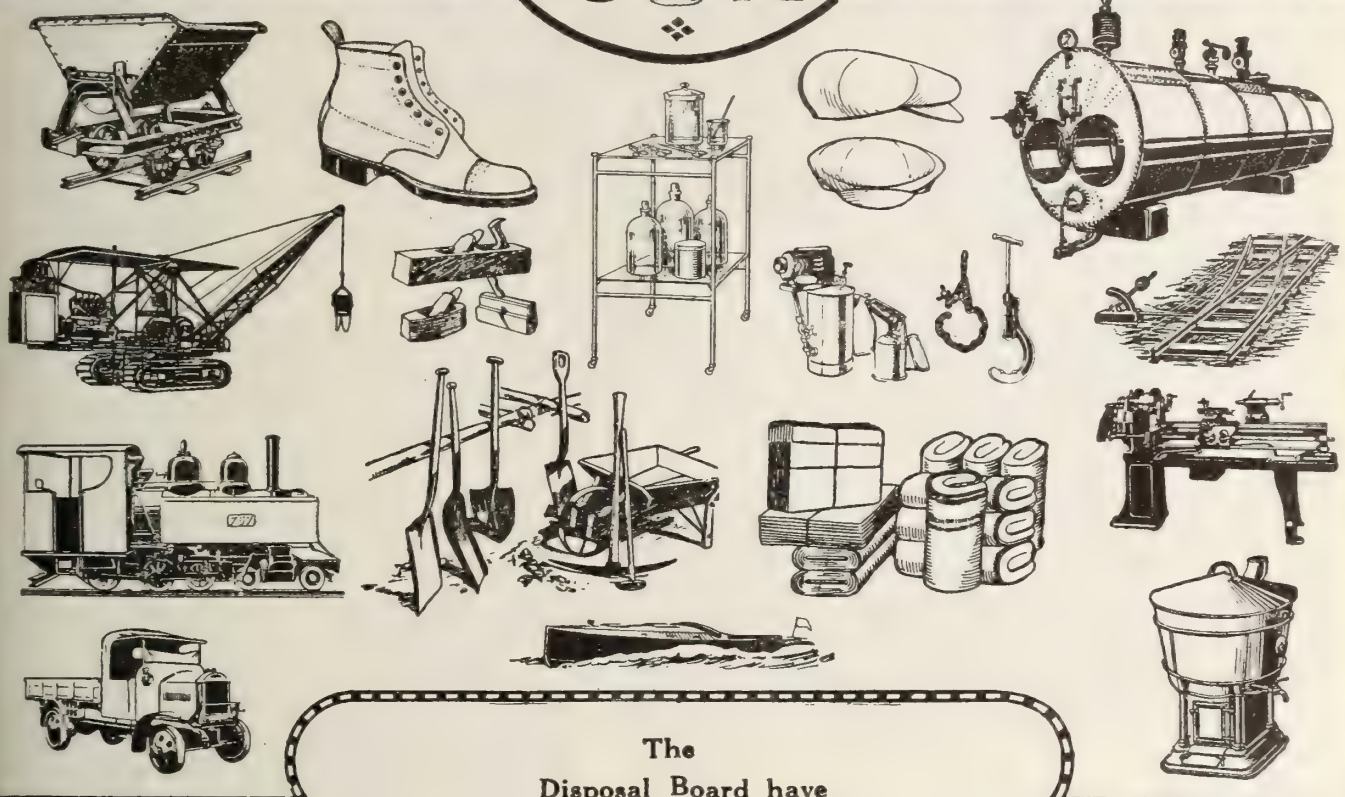
	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



MINISTRY of MUNITIONS

G R



The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, minimum charge is $1.00 per insertion for 50 words or less, set in 6 point type. Each figure counts as a word. Box number as five words. Display ads., or ads. set in border, are at the card rates.

BOOKS

on all branches of Engineering, every conceivable subject. Second-hand at half prices. New at lowest prices. State wants and send for Catalogue No. 23, post free.

WE HAVE THE BOOKS YOU WANT.

Books Bought. Best Prices Given.

121-125 Charing Cross Road, London, Eng.

Crude Oil Engine For Sale

90 H.P.—built by the Blackstone Company who are the recognized leading manufacturers of Crude Oil Engines. All in splendid condition and can be inspected set up. Complete with 60 KW, 550 Volt Generator, if so desired. This is an opportunity to get an economical power installation at attractive price to immediate purchaser.

Address:

Williams & Wilson, Limited
84 Inspector St., Montreal, P.Q.

Use The **LONG STEAM** *for* **TRAP SATISFACTION**

Automatically drains jacket kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with success. Read this letter.

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as the first in operation. We were so pleased with the working of the steam trap last winter that we ordered six more from you and have fitted them up at various points in the works where live steam is used for working purposes.

(Signed) J. Murray Wilson, Superintendent

Our trap will give you the [illegible] is required [illegible] be satisfied, too.

J. T. LONG
48 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.
4

NEW PUBLICATION

Centrifugal pumps of the single-stage and multi-stage types for various services are described in a handsomely illustrated catalogue just issued by the De Laval Steam Turbine Co., Trenton, N.J. This company makes a practice of guaranteeing each pump fully as to head, delivery and efficiency, as well as to workmanship and materials, and each pump is tested before shipment. Manufacture is on an interchangeable basis, permitting of the supplying of finished repair parts made to accurate dimensions. The present publication describes these and other details, and also explains fully the use of pump characteristic curves in adapting pumps to various services, the drives, the information required by the manufacturer in order to design a pump to suit given conditions, etc. Formulae and tables are given for calculating horsepowers, efficiencies, the readings of Venturi meters, friction in pipe lines, etc.

Mr. Irving H. Jones, who is well known in machine tool circles in the Chicago field, has become associated with the machinery department of Joseph T. Ryerson & Son, and will specialize in sales engineering work on the Ryerson line of machine tool equipment.

Mr. G. J. Armstrong, director of the McKinnon Columbus Chain, Ltd., and McKinnon Industries, Ltd., of St. Catharines, Ont., Canada, who has been visiting Australia, returned to Canada during the past month. Edwin Wood Prop., Ltd., represent these manufacturers in Australia.

U. S. Firms in Canada.—An interesting comparison of the number of outside manufacturing firms having branch factories in Canada has been compiled by the Canadian Trade Commission. This shows that while there are scarcely half a dozen British manufacturers with branch factories here, there are some 530 American manufacturers, whose products range from farm machinery and tractors to packing house products.

Short of Material. — Speaking of shortage of material, a Hamilton despatch says: The high rate of exchange is seriously affecting local industries which have to buy materials from the neighboring republic to any large extent. All importations have to be reduced to a minimum. W. B. Champ, managing director of Hamilton Bridge Works, said that their plant might have to close down owing to inability to secure materials.

FOR SALE

Enclosed liquid fuel combustion apparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented April 3, 1917. Can be inspected at and for sale by H. W. Petrie Limited, Toronto.

FOR SALE

One 300 H.P. Leonard Automatic Engine; one Closed Feed Heater; one 8 H.P. 220 v. D.C. Motor; one 15 H.P. 220 v. D.C. Crane Type Motor.

H. N. BROWN, New Glasgow, Nova Scotia.

FOR SALE

Perfected rotary engine valve, simple design, free from defects common in rotary valves. Patented Feb. 20, 1917. Can be inspected at and purchased from H. W. Petrie Limited, Toronto.

NON-CORROSIVE CYLINDER OIL MANUFACTURED ONLY BY E. H. KELLOGG & CO. NOS. 242 244 SOUTH ST. NEW YORK, U.S.A.

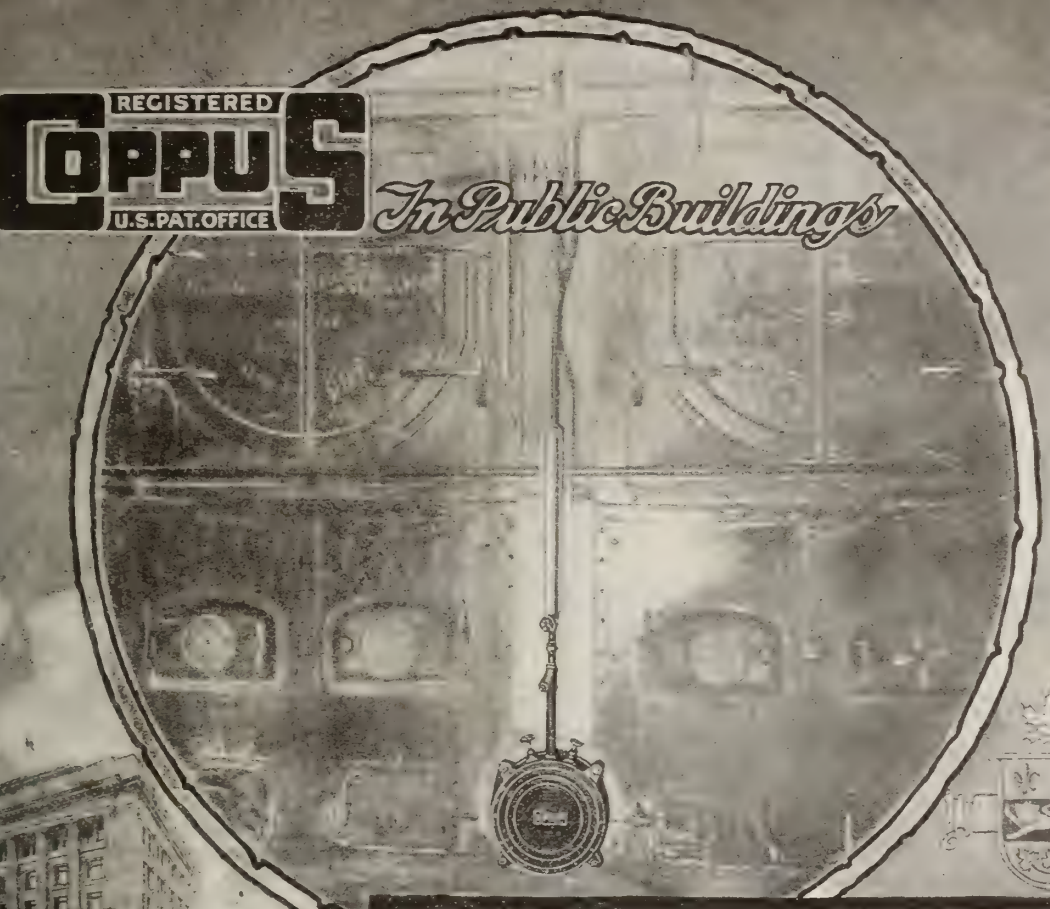
FRICTION LOSS

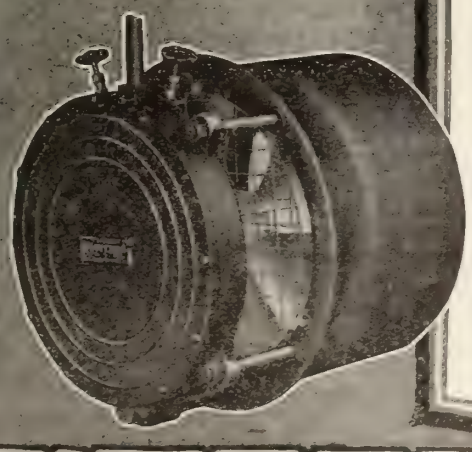
An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

REGISTERED COPPUS U.S.PAT.OFFICE

In Public Buildings





Municipal engineers **demand** efficiency—and **insist** on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the **highest** standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save you money." Write for Blower Catalog.

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mnfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave,, Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block, Calgary, Alta.

COPPUS TURBO BLOWER

"MEAD-MORRISON"

Hoisting and Conveying Machinery

Manufactured in Canada

Lifts the Load of Industry

In our years of experience we have found that the only concerns who don't get DEPENDABLE SERVICE are those who don't use "MEAD-MORRISON" Equipment.

Steam Hoists
Electric Hoists
Mine Hoists
Clam Shell and Orange Peel Buckets
Coal and Ore Handling Plants
Dredging Machinery

Engineers Manufacturers Contractors

Put Your Problem Up To Us!

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

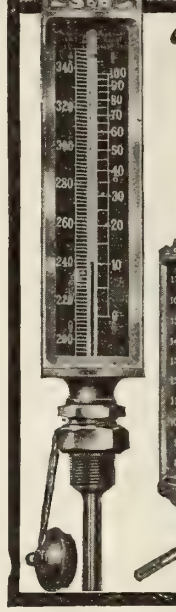
Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.
Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H. 200 to-day.



The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss,

Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recordi Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for:

Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
TORONTO

TRUE ECONOMY

Dart Union

Never Requires Attention

Never has to be Replaced

Use Again and Again—
it's always efficient

Trade DART Mark

The Joint Stays Tight. Bronze Face and Seat prevent deterioration at the connecting point. And the Heavy Iron Parts will not stretch or pull apart under strain or heavy pressure.

Manufactured by

Dart Union Co., Limited, Toronto

When you need
fuses remember that

ECONOMY renewable FUSES

—were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be ***approved in all capacities***—0 to 600 amperes in both 250 and 600 volts—by the Underwriters' Laboratories.

—bear the "Und. Lab. Inspected" label. Economy "Drop Out" Renewal Links are stamped with the "Inspected" Symbol.

—long ago won public approval—evidenced by the fact that for many years millions of them have been giving dependable protection, high efficiency and working marked economies.

—cut annual operating costs 80% as compared with the use of one-time fuses.

—are used wherever efficiency and economy are chief considerations—in steel mills, manufacturing plants of all kinds, buildings, and in every branch of industry.

—are used wherever safety is the prime consideration—in powder mills, hospitals, schools and the United States Navy.

—are absolutely accurately rated, made of the best materials and by the most skilled and careful workmen obtainable.

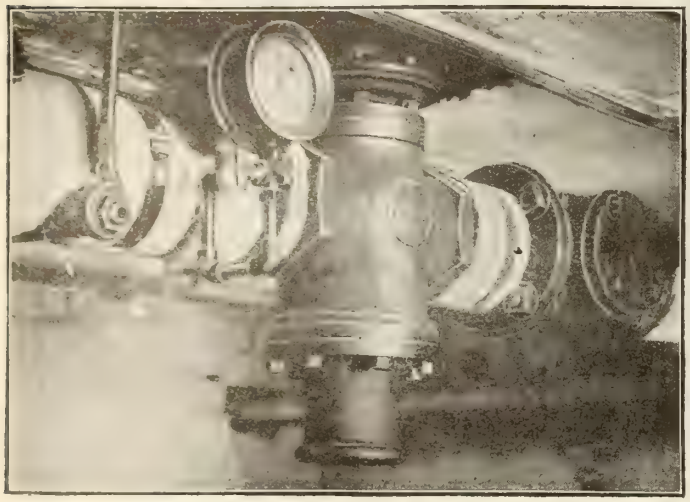
—are sold by all leading electrical jobbers and dealers.

Insist on getting Economy Renewable Fuses.

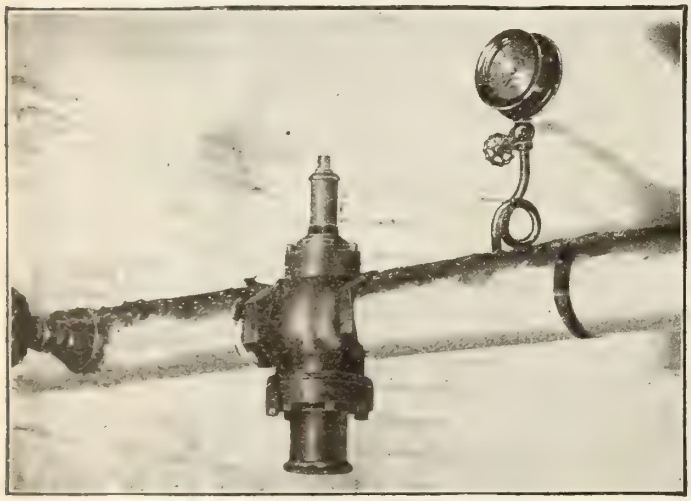
Economy Fuse & Manufacturing Co. of Canada, Ltd.

Unity Building Montreal, Canada

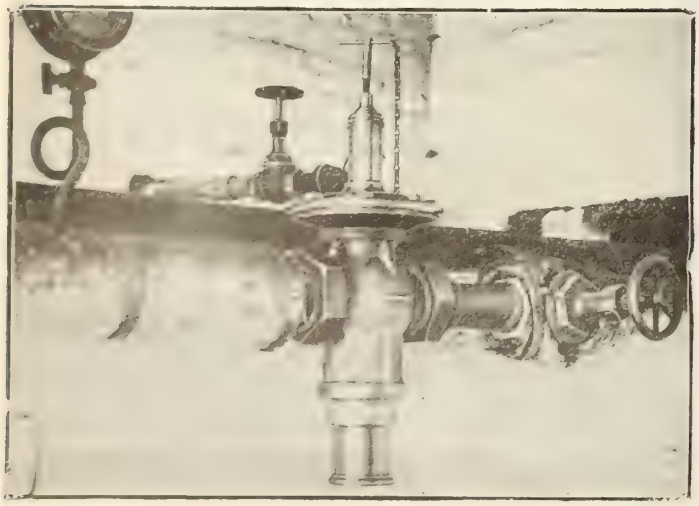
MASON'S



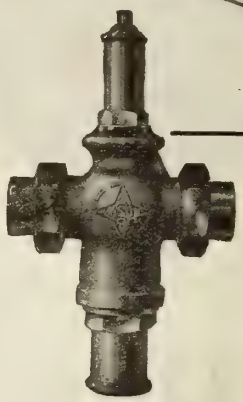
No. 1—3″ Mason Standard Reducing Valve.



No. 2—Mason 2½″ Standard Reducing Valve.



No. 3—Mason 2″ Standard Reducing Valve.



Mason Reducing Valve

What Do You Think of This Record of Service?

Twenty-four years ago (1896) two **Mason** Reducing Valves (No. 1 and No. 2 as shown in the accompanying illustrations) were installed in the heating system of the Protestant Hospital for Insane, at Verdun, Montreal. No. 3 was installed three years later.

No. 3 has never been taken out, has never been repaired and is giving the best of service to this day. Nos. 1 and 2 were given a new lease of life in September, 1919, when they were repaired with new main valves and auxiliary valves, and judging by their appearance and action they are good for many more years of satisfactory operation. Can you beat this for efficient, economical service?

The **quality** that is embodied in **Mason** Reducing Valves is seen in all **Mason** power house specialties —else they would not be associated with the Mason Regulator & Engineering Company.

The Mason Line Includes :-

"Mason" Reducing Valves (genuine); "Mason" Pump Governors; "Mason" Pressure Controllers; Bundy Steam Traps for every service; Coppus Turbine-driven Blowers; Coppus Turbine-driven Boiler Feed Pumps; Sims Hot Water Generators; Sims Storage Heaters; Sims Open Feed Water Heaters; Bundy Oil Separators; Ashton Gauges and Safety Valves; Everlasting Blow-off Valves; Babbitt Sprocket Rims; Stratton Steam Separators; Reilly Feed Water Heaters; Reilly Evaporators and Distillers; Reilly Feed Water Filters.

Remember, Mason for Service—our salesmen are practical engineers.

Mason Regulator & Engineering Co.

Formerly H. L. PEILER & Co. Limited

MONTREAL: Office and Factory, 135-153 Dagenais Street

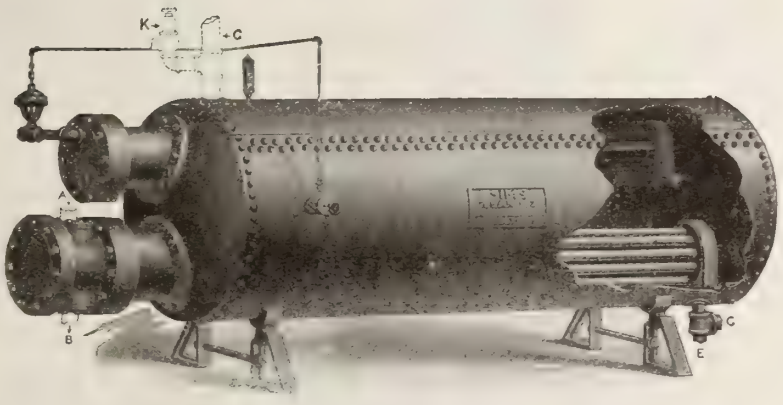
Toronto Branch

145 Wellington Street

Room 5

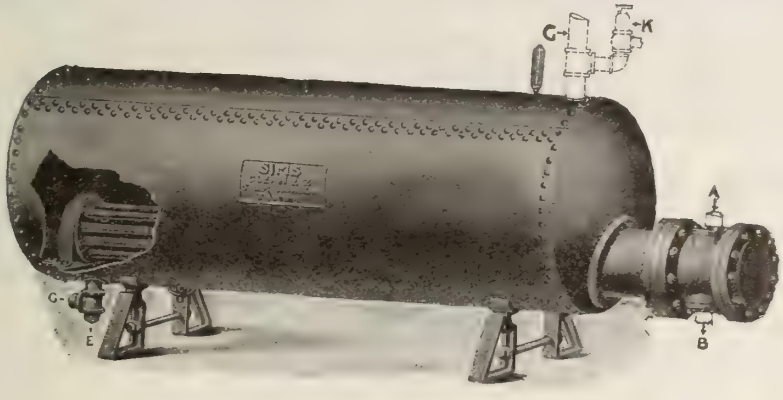
SIMS

CLEAN E-Z STEAM TUBE HEATERS



Style D, B-H

Showing clean E-Z Heater designed for using both live and exhaust steam — in separate tube structures.



Style B-H

Showing the construction used on all sizes larger than number four. Tubes may be cleaned without breaking steam connections.

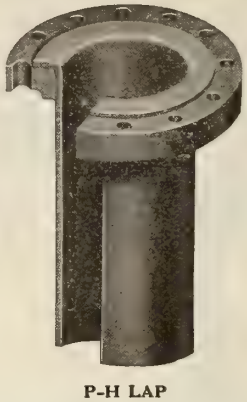
Sims B-H Clean E-Z Storage Heaters are adapted for practical use in any plant or building requiring hot water, with either high or low pressure steam available as the heating medium. Sims Steam Tube Storage Heaters when installed in any plant effect great economy in operation. Send for bulletin, giving many interesting facts about Storage heaters.

THE ARTHUR S. LEITCH CO

1001-2 Kent Bldg., Toronto, Ont.

P&H FLANGED PIPE JOINTS

SCREWED



P-H LAP

P&H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

Made in Canada by

PAGE-HERSEY IRON, TUBE & LEAD CO. LIMITED

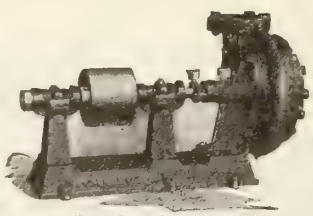
Head Office: 100 CHURCH STREET, TORONTO, ONTARIO

AMERICAN-MARSH PUMPS

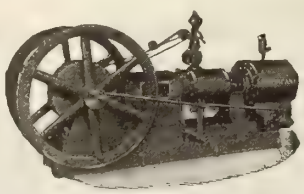
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

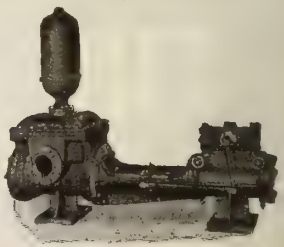


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

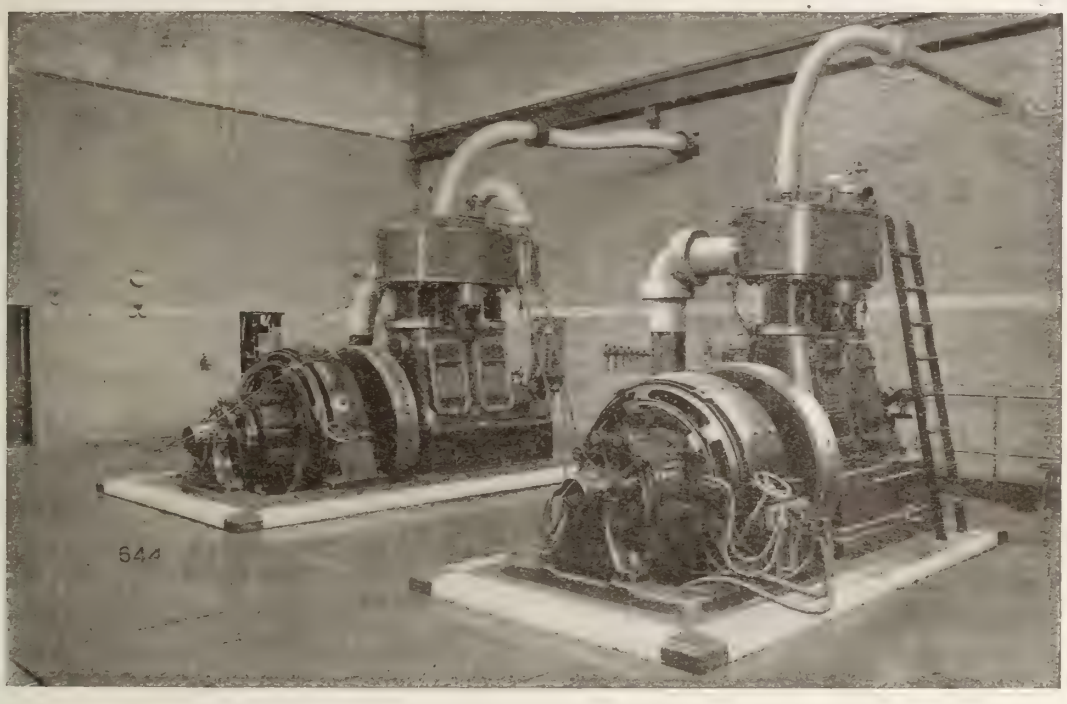
AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

WE handle only quality equipment. It is selected and approved by our engineers and backed by years of service.

We design and erect power plants for every service, no matter how large or small. If you have any knotty power plant problems, put them up to our engineers. Their services are at your disposal without obligation.

We Can Make Immediate Shipments and Installations
—ON—

Steam Engines	Condensing Plants	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

All enquiries cheerfully answered

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. MONTREAL

If You Distribute Steam for Any Purpose You Can Use "Adsco" Equipment

LET us quote on your requirements for all materials for Underground Steam Main Construction. We make a complete line of everything used in the distribution of Steam; Expansion Joints, Insulation, Variators, Valves, Manhole Curbs, Companion Flanges, Separators, Angle Joints, Steam Traps, Meters, Regulators, Heaters. We have a big stock of W. I. Pipe; Flanged Fittings, a complete line, all made from sweep-angle patterns to standard dimensions; also "Adsco" Specialties for the "Adsco" System of Atmospheric Heating.

STANDARD STEAM PIPE CASING

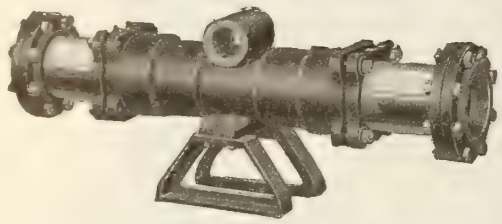
In central station heating the degree of efficiency of insulation is considered to be the percentage of heat transmitted to the consumer as compared to the total amount of heat delivered into the pipe line, and in order to secure the greatest economy in the distribution of steam through underground mains the most competent engineers have, after exceedingly thorough investigation and tests, adopted what is commercially known as "Standard" Steam Pipe Casing for insulating such mains.

GATE VALVES

A line of extra heavy gate valves for underground and interior work. Superiority of design and excellence of construction characterize these valves. See our Catalog for full details.

EXPANSION JOINTS

This company has specialized on Expansion Joints for many years. Many of these in our regular line have been developed especially for our own Central Station Heating work. We make Expansion Joints large or small, single or double, heavy or light—of every necessary type to meet every condition found in steam distribution.



Write for Complete Catalog

of Adsco equipment mentioning the particular apparatus in which you are most interested. If you are interested in heating a group of buildings or industrial homes; ask for Catalog PW on "Central Station Heating."

AMERICAN DISTRICT STEAM COMPANY

General Office and Works: NORTH TONAWANDA, N.Y.

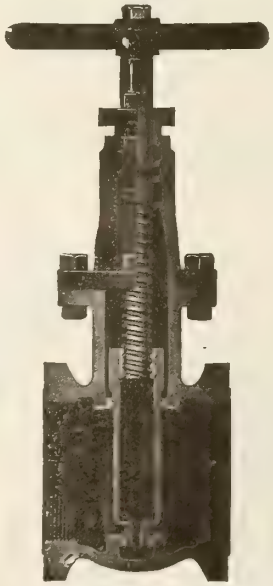
Representatives:

A. R. Williams Machinery Company, Ltd., Toronto, Ont., and Branches

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

MORSE
CHAIN
In a Big Railroad Shop
Where Every Ounce of Power and Inch of Space Count
This Morse Chain is delivering power to a 180" boring mill from a 15 H.P. G.E. Motor running at 1200 R.P.M. The chain is exposed to all the grit and dust of the shop. It is 4" wide and connects a 17 tooth pinion with a 120 tooth wheel directly below—a distance of only 33" between centers.
No record has been kept of the age of this particular Morse Drive, but the boring mill is known to be one of the oldest in the shop and one of the first to be individually driven, so it is safe to state that this Morse Chain has been many years in service of the most exacting nature.
MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD Ithaca, N. Y.
Morse Engineering Service
Write for 1920 Vest Pocket Memo and Diary
Assistance Without Obligation
Address Nearest Office
BOSTON, MASS. 141 Milk Street
CHICAGO, ILL. Merchants L. & T. Bldg.
CLEVELAND, OHIO. Engineers Bldg.
DETROIT, MICH. 1008 Woodward Ave.
GREENSBORO, N. C. 805 Ashboro Street
NEW YORK CITY 50 Church St.
PITTSBURGH, PA. Westinghouse Bldg.
SAN FRANCISCO, CAL. Monadnock Bldg.
ATLANTA, GA., Candler Bldg. Earl F. Scott, M. E.
CANADA Jones & Glasco, Regie'd
MONTREAL, St Nicholas Bldg Toronto, Traders' Bank Bldg.
KANSAS CITY, MO. Long Bldg. Morse Engineering Co.
MINNEAPOLIS, MINN., 413 3rd St., S. Strong Scott Mfg. Co.
ST. LOUIS, MO., Chemical Bldg. Morse Engineering Co.
"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

The Most Modern Power Plant May Waste 25% of its Coal

Unless—

proper steps are taken to prevent the waste. Innumerable results have shown that 25% of the fuel burned under steam boilers is wasted by preventable losses in the boiler furnace alone.

Modern equipment alone will not eliminate these losses. Equipment is just as efficient as its operation allows.

To save that 25% you need accurate information of the furnace at all times—then the necessary knowledge to apply that information.

"When you buy HAYS APPARATUS you buy HAYS SERVICE"

The Hays Automatic CO_2 and Draft Regulator shows an accurate and continuous record of the two essential furnace conditions. Our book, "How to Build Up Furnace Efficiency" helps you interpret and apply this information.

A copy of this interesting book will prove invaluable to you. It is in no sense a catalogue — and it has gone through 14 editions.

The Jos. W. Hays Corporation

MICHIGAN CITY INDIANA, U.S.A.

General Representative for Canada:
Stephen H. Payne, 30 Church St., New York.

Representatives in Canada:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto. Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal. Wm. Goold, 701 Merchants Bank Building, Winnipeg.

VULCABESTON

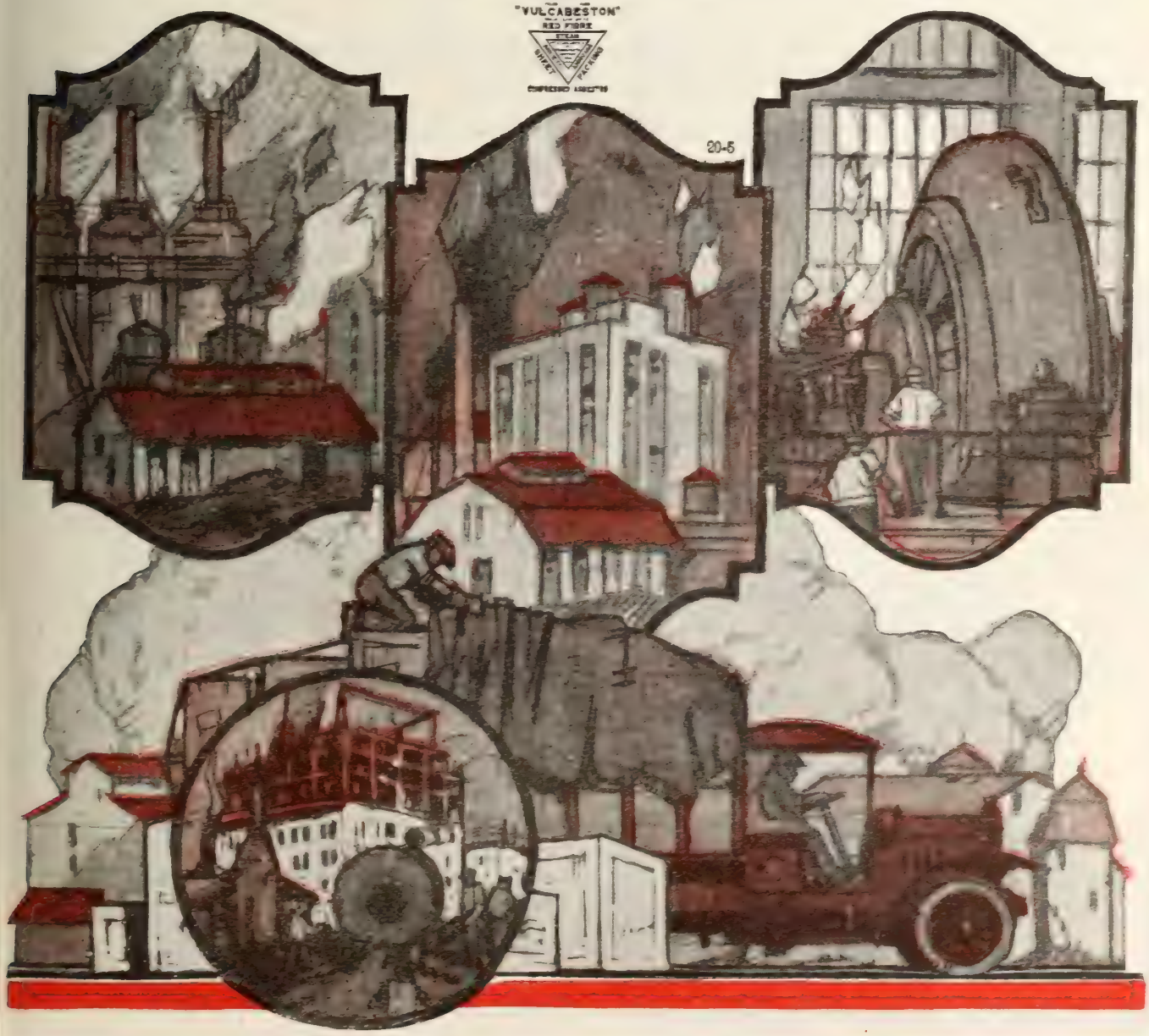
Under All Conditions

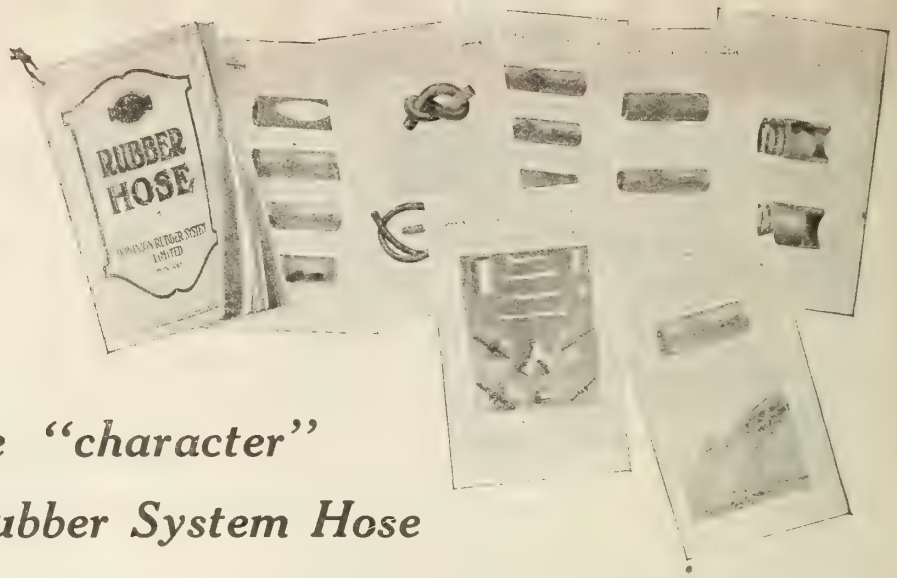
Today, a wet steam joint under low or high pressure—tomorrow a superheat cylinder or pipe line under high pressure, or perhaps an ammonia, gas, or air compressor—no matter what the purpose, there you can use dependable, long-lasting Vulcabeston that holds tight year after year of the most racking service. The long-fibre asbestos body of Vulcabeston forms a full-fitting gasket that stands up under the extremes of pressure, temperature, moisture and corrosion.

Standardize on Vulcabeston. Stock your storeroom with "The Universal Packing." We would be pleased to furnish samples upon request.

THE JOHNS-PRATT COMPANY **Hartford, Conn., U. S. A.**

Dealers in all large cities





The dependable "character"
of Dominion Rubber System Hose
results from its ability to meet exacting conditions.

INDUSTRY is the stern parent of improvement. Twenty years ago the making of rubber hose was in its infancy; to-day it has become an art with us.

Two reasons account for the selection of Dominion Rubber System Hose by most Canadian industries: first, because its performance is a tangible buying guide; and second, because our manufacturing department keeps abreast of industry's most exacting demands.

Dominion Rubber System Hose for Industrial Use

Is designed for every requirement, whether it be for conveying liquids, gases, oils, acids or steam at any practical temperature, or pressure. When new conditions crop up, we produce special types to meet them. The fact that we do create new types for the Canadian market is evidence that Dominion Rubber System Hose measures up to the requirements of Canada's largest hose users.

Our catalog is a useful and convenient reference in selecting the exact type of hose for your requirements. It pictures and describes the complete line and gives the service conditions for which each type is designed. A copy will be sent on request from our nearest service branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION
RUBBER
SYSTEM
AND ASSOCIATED COMPANIES

Dominion Rubber System

Service Branches

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

Opening is Larger than Corresponding Pipe

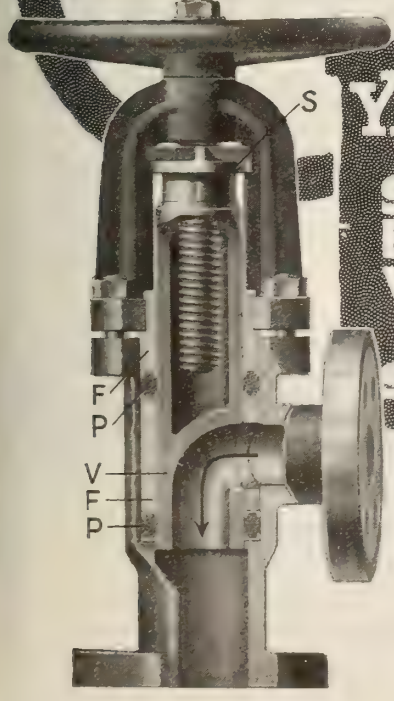
There is nothing to interfere with the unrestricted flow of passing blow-off sediment when your boilers are equipped with the Yarway (formerly the Simplex) Seatless Blow-Off Valve. The absence of seats and discs, together with the large, smooth port, not only provides smooth passage for the blow-down, but also eliminates troubles met in other valves by the cutting and scoring of scale and grit.
Try one for 60 days, subject to return. When writing, state size of line and whether screw or flange, angle or straightway.

Learn the Good Points of Other Yarway Products

Yarway-Lea V-Notch Meter
Yarway Pipe-Joint Clamp (formerly the Simplex)
Yarway Adjustable Spray Head (C. C. Thomas Patents)
Yarway Boiler Skimmer
Yarway Hydraulic Valve (Caskey Patents)
Yarway Starting and Pressure Unloader (Richards Patents)

YARNALL-WARING CO.
7604-20 Queen Street
Chestnut Hill, Philadelphia

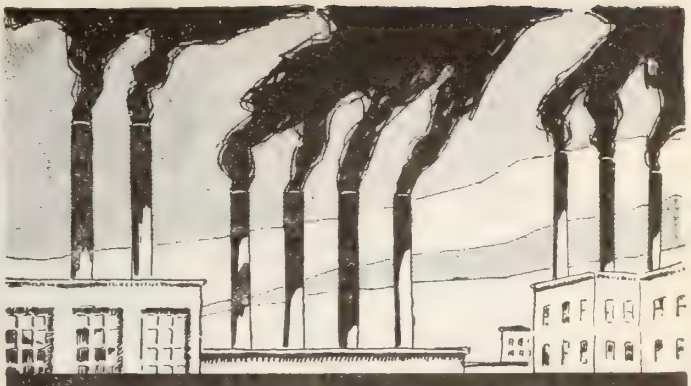
A. McLELLAN
103 St. Francis-Xavier St.
MONTREAL, QUE., CANADA



YARWAY
SEATLESS BLOW OFF VALVE
formerly the SIMPLEX

Operation

In closing valve, shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.



GET THE MAXIMUM POWER FROM THE FUEL YOU USE

The fundamental purpose of the boiler setting and the refractory lining is to keep the furnace heat in and the cold air out. Cold air inleakage checks the fire, cools the gases before combustion is complete and sends a large percentage of the heat units of your coal up the chimney.

Separate fire bricks are little more than in place with fire clay when the heat begins to move them.

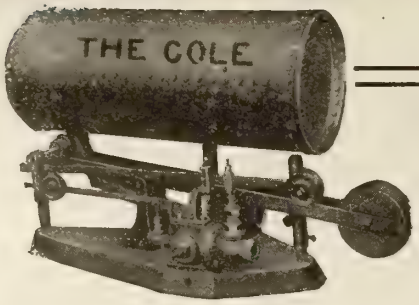
BETSON'S
REG U S TRADE MARK PAT OFF
PLASTIC FIRE BRICK

should be used to form in place a one-piece, jointless, monolithic furnace lining, including front arch and walls, side walls, bridge walls, combustion chamber and back arch, if any. Also, gas tight baffles should be formed of these same materials. Then you will not only be getting the most out of your fuel, but you will cut your repair bills to the minimum and will avoid the delays and shut downs too often necessary with other types of boiler furnace linings and baffles.

We have an interesting and instructive pamphlet dealing with the uses for Betson's Plastic Fire Brick. Write for it.

Betson Plastic Fire Brick Co., Inc.,
P.O. Box 386-6 Rome, N.Y.

Canadian Distributor:
INTERNATIONAL CHEMICAL CO.
44-H Lombard Street
TORONTO, ONT., CANADA



THIS IS A "COLE" YEAR

BOOST FOR THE "COLE" SYSTEM

Five cents a day wasted in a power plant represents a loss of 6% interest on a capital investment of $300.00.

How much interest at this rate is wasted in your plant through old-fashioned methods of draining condensation?

We have some very interesting literature. May we send you some?

GEO. W. COLE, LIMITED

2002-4 DUNDAS STREET, W., TORONTO

WESTERN REPRESENTATIVE:
Geo. A. Young, 203 Scott Block, Winnipeg

EASTERN SALES OFFICE:
76 St. Gabriel St., Montreal

EXIT *the* LADDER

with its delays, dangers, nuisances and out-of-dateness.

ENTER *the* Babbitt —*Adjustable*— SPROCKET RIM *with Chain Guide*

—a simple, safe, economical, convenient and time-saving device, which makes easy the operation and control of all out-of-reach valves from the floor, without the need of ladders or other props.

The Babbitt Rim is easy to adjust and to apply—takes only 5 minutes. It has no complicated parts to give trouble or get out of order and is the most practical and economical device of its kind on the market. Request pamphlet.

BABBITT STEAM SPECIALTY COMPANY
NEW BEDFORD, MASS.

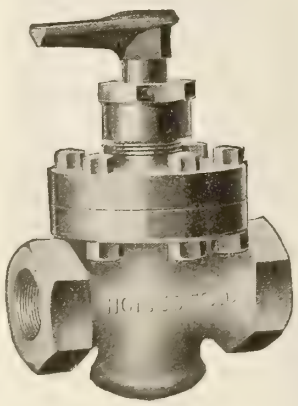
Western Distributers:
Jenkins Bros., 300 W. Lake St., Chicago, Ill

Canadian Agents:
Engineering Specialties Co., Ltd. Toronto, Ont., Can.

Prevent Breakdowns and Costly Repairs with

HOMESTEAD

QUARTER-TURN VALVES

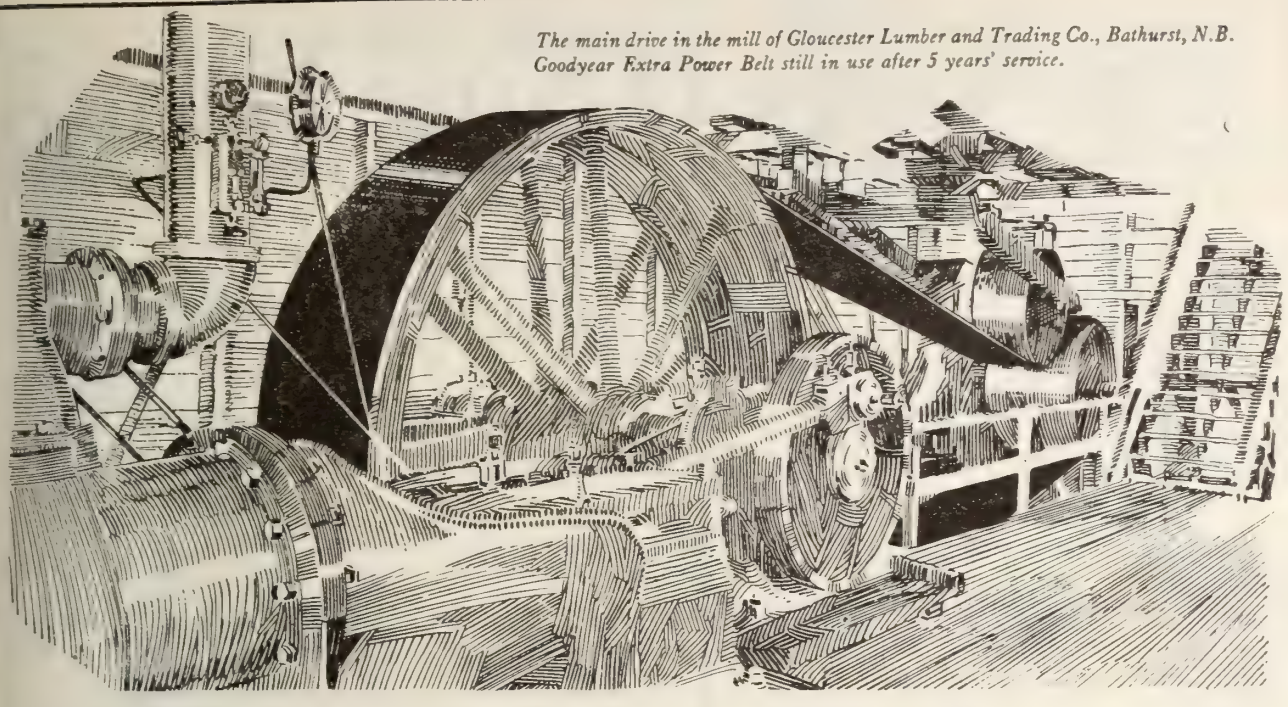


"Homesteads" for all classes of severe service. They are all constructed with the patent homestead process which makes them seatless while the pressure is passing through and which permits their being operated easily and safely.

Homestead Valves embody the highest quality of workmanship and material and will stay tight under any specified pressure up to 5,000 lb.

Order Your Requirements Now.

Homestead Valve Mfg. Company
Pittsburg, Pa. Works: Homestead



The main drive in the mill of Gloucester Lumber and Trading Co., Bathurst, N.B. Goodyear Extra Power Belt still in use after 5 years' service.

Master Belts of Industry

Goodyear has solved the problem of belting the great main drives of industry—the backbone of production.

Experience, in a thousand Canadian plants, says Goodyear Extra Power Belts.

Because these belts are *strong*—with the strength of properly selected fabric, every thread perfect.

Yet *flexible*, hugging pulleys, taking advantage of every inch of pulley surface. Flexible because in Goodyear Extra Power Belting high-grade rubber is forced through and through the fabric in generous quantities. Every strand is cushioned in it. No stitching to stiffen or weaken the belt. No separation of plies.

Its *friction* surface grips, even through dampness or dust. No slipping with Extra Power. No need for extra tight belts, pulling pulleys out of line. No need for belt dressing. No lost power.

The testimony for Goodyear Extra Power on main drives is very complete. For instance:—

The Norfolk Milling Company, of Simcoe, writing about their main drive belt, purchased a year ago, say:—

> *"Has been in continuous operation for one year, and has not stretched nor given us the slightest bit of trouble."*

There are many others—some selected at random are:—

Swedish Crucible Steel Company, Ltd., Windsor, Ont.
Dominion Sugar Company, Ltd., Chatham, Ont.
Dominion Forge and Stamping Co., Ltd., Walkerville, Ont.
Page Wire Fence Company of Canada, Ltd., Walkerville, Ont
Echo Flour Mills, Ltd., Gladstone, Man.
P. Burns Company, Ltd., Edmonton, Alta.
Hollinger Consolidated Gold Mines Co, Ltd., Timmins, Ont.
Dome Mines Company, Ltd., South Porcupine, Ont.
Burrard Saw Mills, Ltd., Vancouver, B.C.
Silverton Lumber and Power Company, Ltd., Silverton, B.C.
Woodstock Electric Railway Light and Power Company Ltd., Woodstock, N.B.
Gloucester Lumbering and Trading Company, Bathurst, N.B.
Amherst Foundry Company, Ltd., Amherst, N.S.
Hull Iron and Steel Foundries, Ltd., Hull, Que.
Quebec Graphite Co., Ltd., Buckingham, Que.

The complete story of Goodyear Extra Power Belts on main drives is interesting. There are facts about other types of drives just as important to you. Let a Goodyear belting man call and talk to you. No obligation. Just phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches:—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in smaller cities.

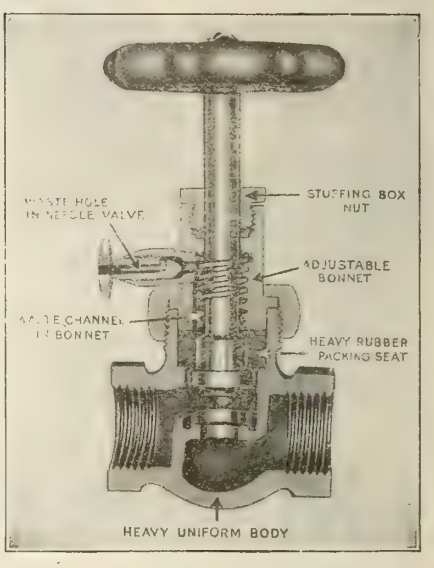
GOODYEAR

MADE IN CANADA

EXTRA POWER BELTING

"The Valve O'Nine Points"

THERE are nine outstanding features of the "EMCO" Composition Disc Valve — plainly shown in the accompanying illustration — which in themselves are sufficient reasons why this valve is superior to any other.



Cross Section "EMCO" A840 Composition Disc Valve

Combined with these

there is superiority of strength, durability and workmanship which is the outstanding quality of every "EMCO" product.

Registered in the following Provinces as follows:

Globe Valve A840

British Columbia	**No. 2590**
Alberta	**" 1102**
Saskatchewan	**" 2365**
Ontario	**" 1755**

The design is approved and registered in the Provinces of the Dominion by Inspectors of Steam Boilers for a pressure of 175 pounds.

Made of the best Bronze Metal, each Valve is subjected to a thorough hydraulic test before it leaves the factory.

We can make prompt deliveries. Write for prices, etc.

Empire Manufacturing Company, Limited

London and Toronto, Canada

LINCOLN ARC WELDING

Every Factory Can Use Lincoln Electric Welding

Special Equipment for Hurried Calls

A LEAKY boiler is not a common occurrence in most plants. Sometimes a batch of castings turn out defective—but not often. Shaftings and other pieces of equipment break and become worn—but only occasionally.

But When Such Things Do Happen

Isn't it rather comforting to know just where to turn—so that you won't have to face a prolonged shut-down—or lose valuable production—or waste valuable equipment.

Lincoln Electric Welding is faithful in such cases. It repairs boilers quickly and permanently—just as it joins together steel sheets, plates, bars, angles, tubes, etc.

You can have a special portable outfit come to your door—install your own Lincoln Welder or send your work to our welding plant.

But there is one sure way to find out exactly what you can do and save with Lincoln Electric Welding.

Get in touch with us. Phone, write or wire for particulars.

"Link Up With Lincoln"

The Lincoln Electric Co. of Canada, Limited

1111 Temple Bldg., Toronto, Canada
Phone Main 3768

Welding Plant Foot of Jarvis Street
Phone Main 7430

Montreal Branch: Coristine Bldg.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

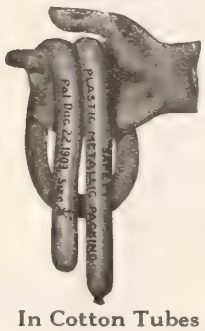
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

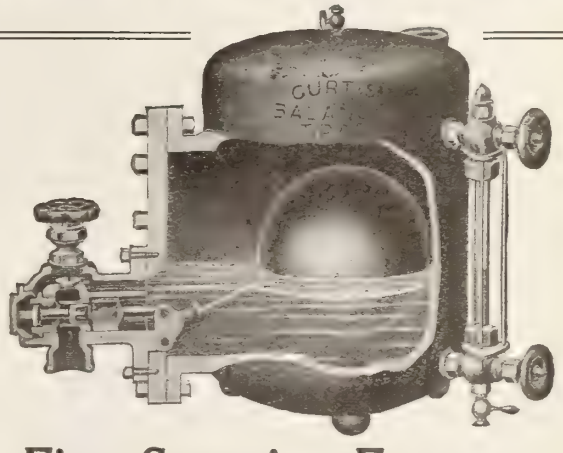
Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties. Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14 Mass.

Agencies: 83 Barclay St., New York City
174 N. Market St., Chicago, Ill.

McAvity
BRASS AND IRON PRODUCTS

This Name On A Valve Means

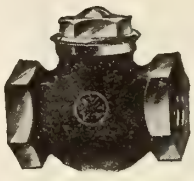
1 Absolute dependability based upon engineering experience extending over half a century.

2 A product manufactured with scrupulous care from the best materials obtainable.

3 That the reputation of the manufacturer will not be jeopardized by any unworthy product.

THREE "McAVITY" VALVES

"McAvity" Brass Globe Valve



"McAvity" Brass Check Valve

"McAvity" Brass Angle Valve

T. McAvity & Sons

St. John, N.B.
Montreal Winnipeg

Toronto
Harvard Turnbull & Company
207 Excelsior Life Building

Make it Easier--

ALL-WAY
Flexible Spout Grease and Oil Guns

Make it easy to refill the most out-of-the-way gear cases or transmission as the flexible spout can be bent to any desired angle. The Cleaning Device at the end of the **"ALL-WAY"** spout reduces cleaning time and oil wastage to a minimum. The **"ALL-WAY"** gun is especially useful and handy in filling lineshaft hanger reservoirs.

If your dealer cannot supply you, write us.

We also manufacture the well-known "ALL-WAY" Oil Can. Saves you 50% of your oil bill.

The Allway Oiler Mfg. Co.
196 KING STREET WEST
TORONTO, ONT.

TRIMO
THE WORD TRIMO

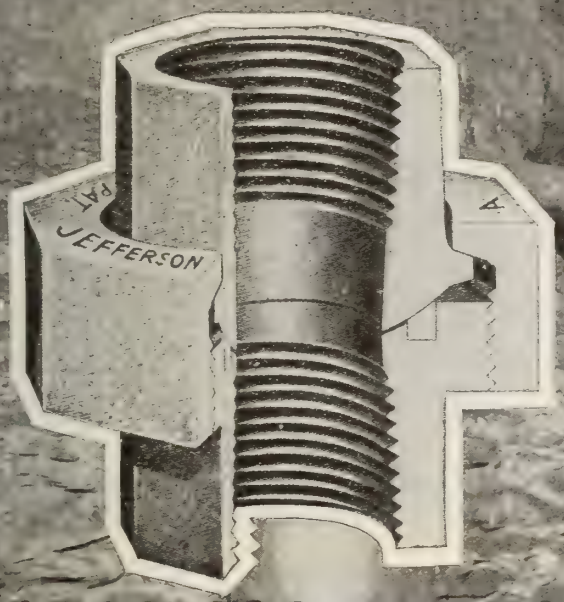
Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston,) Mass., U.S.A.

JEFFERSON



"LOOK FOR THE NAME ON THE NUT"

The Importance of Dependable Unions

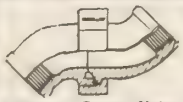
The importance of dependable unions is emphasized in underground service—here the failure of a single union might mean serious loss of life and heavy damages.

Insure against breakdowns with JEFEFRSON UNIONS. You can tell them by "The name on the nut," it is your protection against substitute "just as good" variety.

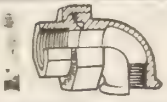
Your Jobber has JEFFERSONS in stock and can tell you why they always make good. Talk unions over with him.

Our catalogue "UNIONS" shows the complete JEFFERSON LINE. Write for it to-day.

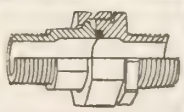
Jefferson Union Co.
Lexington, Mass.



Jefferson Swing Union allows connections ranging from a slight off-set up to 90 degrees and many angle connections.



Union Elbow, all female. Takes the place of a straight union, nipple and an elbow. Also made male and female.



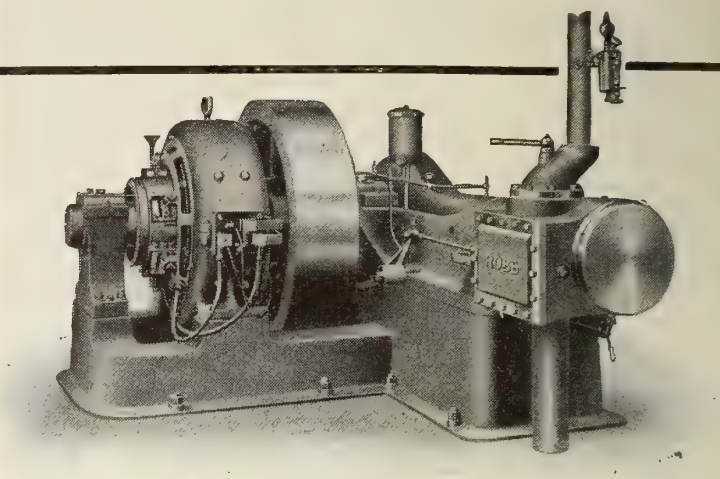
All Male Union. Saves two pipe joints between two female threaded parts.

ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
Phone
Westmount 6800

Toronto Office:
20 Victoria
Street

WILLIAMS' SUPERIOR DROP-FORGED CLAMPS

THERE'S a Williams' Clamp for every purpose.

If it's extreme strength and heavy service—Williams' "Vulcan" line provides both.

11 sizes, 3/4 to 12½ inches capacities.

If it's general utility—without need for maximum strength—Williams' "Light Service" line will fit the case, 8 sizes, 2 to 12 inches capacities.

If it's stability and utility—medium service—Williams' "Agrippa" line offers the solution. 7 sizes, 4 to 18 inches capacities.

If it's Tool Room work requiring comparatively small openings of jaws — Williams' "Vulcan" Tool Makers' line should be chosen. 4 sizes, 1 to 4 inches capacities.

All are made of a special, high-grade steel. After forging they are submitted to a refining process, or "heat treatment," which increases their stiffness and strength and reduces the liability of springing.

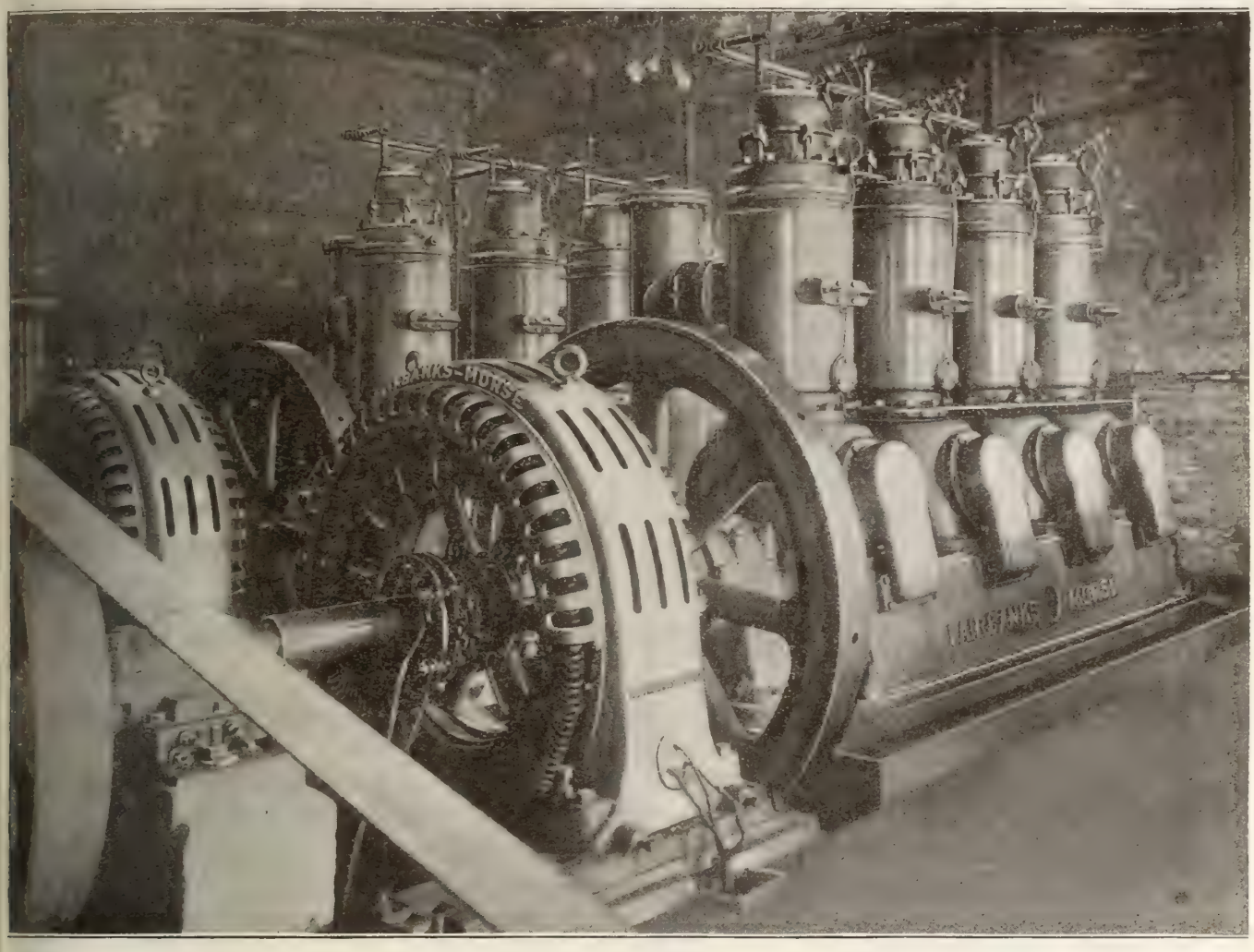
Engineers' Tools Book on Request.

J. H. WILLIAMS & CO.

"The Drop-Forging People"

78 So. Clinton St., Chicago, Ill. 78 Vulcan St., Buffalo, N.Y. 78 Richards St., Brooklyn, N.Y.

W. BRUCE CAMPBELL,
78 Confederation Life Building, Winnipeg, Canada



FAIRBANKS-MORSE
ELECTRIC POWER MACHINERY

Each of the units shown above consists of a 200 H.P. Semi-Diesel Oil Engine and a 170 K.V.A. Generator.

Our smallest plant is a 1½ H.P. 9 K.W. Automatic Suburban Lighting Outfit.

Fairbanks-Morse Electrical Machinery covers the entire range between the above sizes.

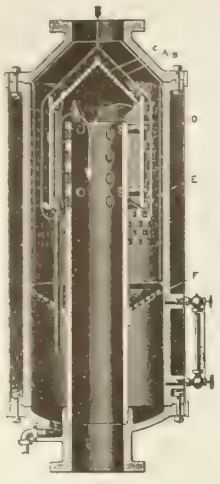
Our experience is at your service.

The Canadian Fairbanks-Morse Co. Limited

"CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS"

ST. JOHN QUEBEC MONTREAL OTTAWA TORONTO HAMILTON
WINDSOR WINNIPEG SASKATOON CALGARY
VANCOUVER VICTORIA

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SAPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y.

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

SAVE
TROUBLE and EXPENSE

by using the packing that gives the longest service under hard conditions, —
"PALMETTO."

ASK ANY ENGINEER WHO USES

TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

and you will find him enthusiastic over its great lasting qualities and because the quality can be depended upon to be always the same.

If you don't know "Palmetto," let us send you a working sample to test under your own conditions.

TWIST for valves.
BRAIDED for rods.

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St., New York

Do You Throw Away a Faucet When the Washer is Worn Out?

Of course you don't—you simply put in a new washer, costing but a few cents.

It is the same with a Pratt & Cady Renewable Asbestos Disc Globe Valve. When the disc wears out you simply put in a new one at about 10% of the price of an entire new valve.

That saves buying a new valve, also the time and cost of tearing the valve out of the line. Without removing a P. & C. Renewable Valve from the pipe line, a new disc can be inserted in a few minutes.

Try a few Pratt & Cady Renewable Disc Globe, or Renewable Seat Gate Valves and prove to yourself that they will reduce your valve maintenance cost to a mere fraction of your present cost.

Made in Iron and Bronze in all standard sizes for every service.

Write for Valve Book To-day.

PRATT & CADY CO., Inc.

BOSTON CHICAGO CLEVELAND DETROIT HARTFORD MINNEAPOLIS NEW YORK PHILADELPHIA PITTSBURGH SAN FRANCISCO

Representatives in all large cities

Pratt & Cady
Renewable Disc GLOBE VALVES

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

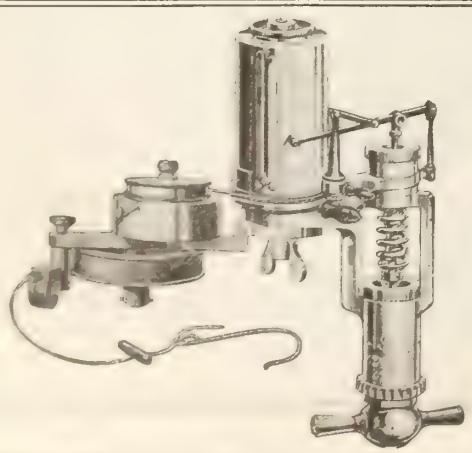
BUSCH-SULZER
DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.



LEARN AND EARN
START TO-DAY! DON'T WAIT!

Learn the exact condition of the engine in your charge.

Find out all about it by using an

American-Thompson Improved Indicator

Then correct any troubles you may find and report to your employer.

He will appreciate your efficiency and reward you accordingly.

Send for catalog to-day.

Canadian Agents: Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, St. John, Calgary.

American Steam Gauge & Valve Mfg. Company

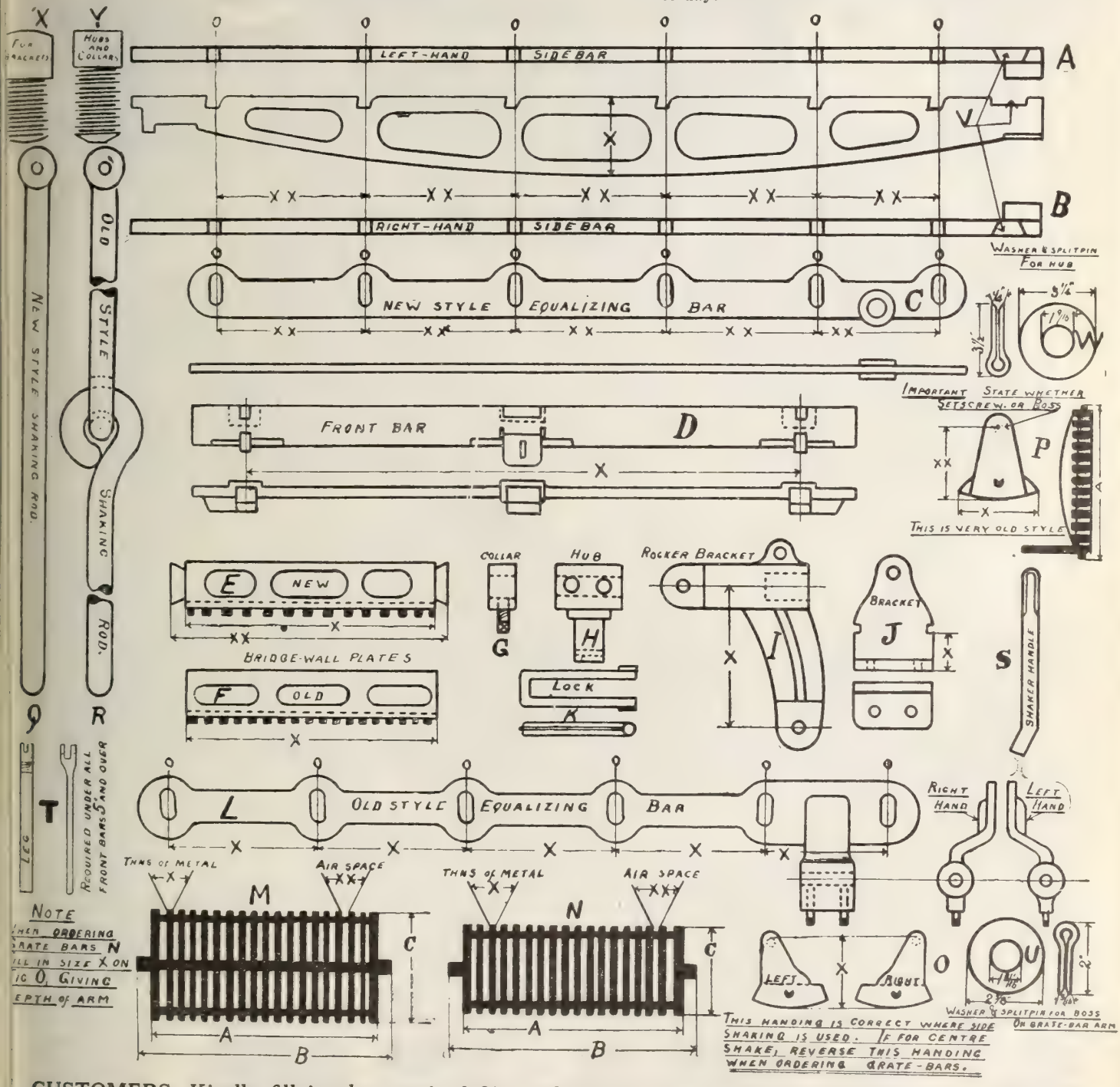
New York Chicago BOSTON Atlanta Pittsburgh

Mount this Chart of "Cyclone" Grate Bar Parts

On Cardboard

You should find this chart helpful when ordering piece parts of our famous "Cyclone" Shaking and Dumping Grates. Keep it handy.

Engineers and plant owners unacquainted with the "Cyclone" Grate and the service we give, **write us to-day.**



NOTE
WHEN ORDERING GRATE BARS N FILL IN SIZE X ON FIG O, GIVING DEPTH of ARM

THIS HANDING IS CORRECT WHERE SIDE SHAKING IS USED. IF FOR CENTRE SHAKE, REVERSE THIS HANDING WHEN ORDERING GRATE-BARS.

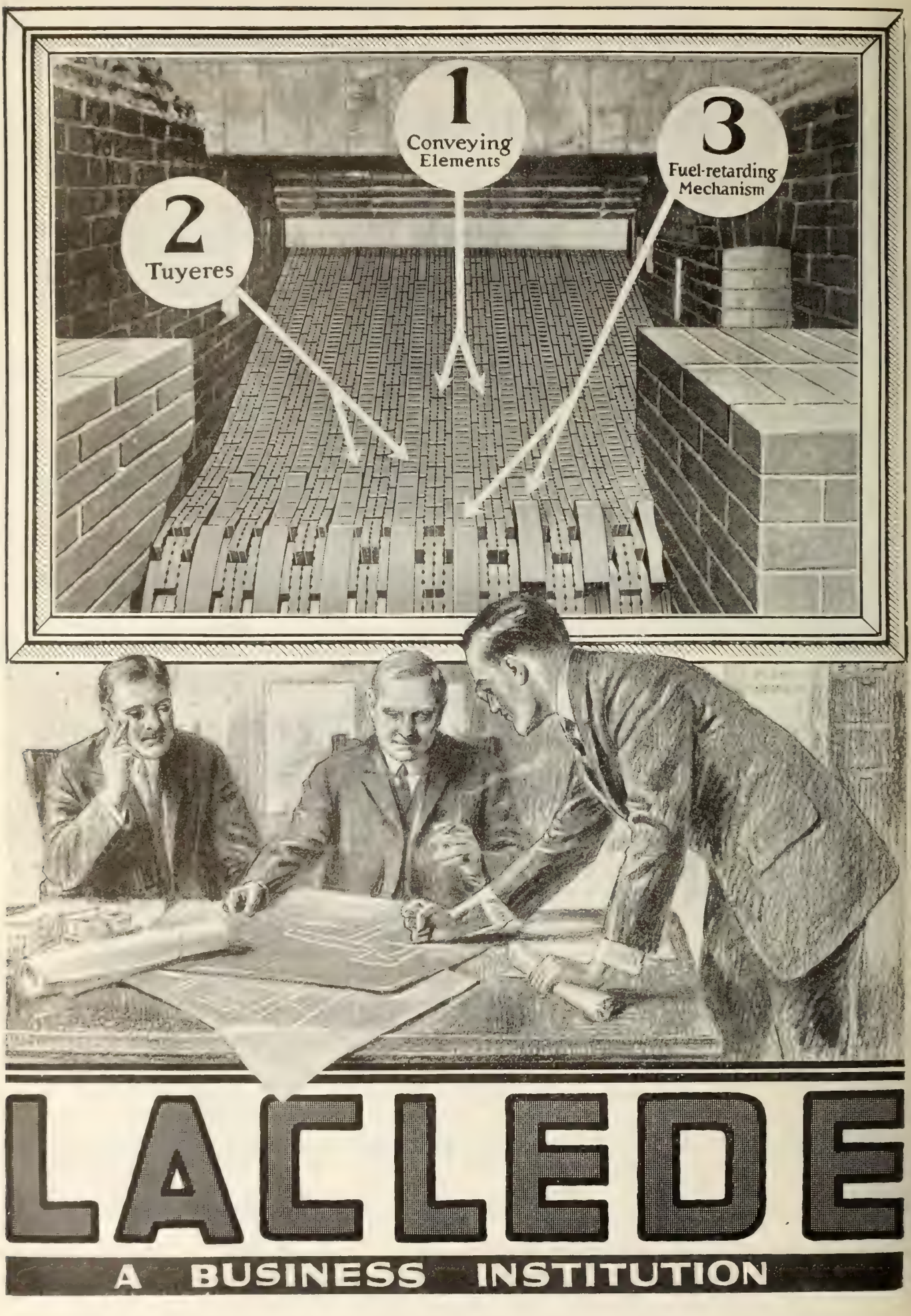
CUSTOMERS: Kindly fill in the required Sizes when ordering Parts and it will greatly facilitate the dispatch of same. When ordering Parts for grates N, which is the old style 8" centres, and all sizes under, kindly order as far ahead of date required as possible, as we do not carry large stock of 8" centres and under.

Cut out this chart and keep for reference, or write us and we will send you a copy free.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G 3660 Toronto, Ontario


1
Conveying Elements
2
Tuyeres
3
Fuel-retarding Mechanism
LACLEDE
A BUSINESS INSTITUTION

THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

One feature of the Stowe Stoker is the provision which brings about

Low Combustible in the Ash

The stationary tuyeres (2) terminate at their lower end in the retarding bars (3). These bars are automatically raised and lowered. In their lower positions the ash is positively carried onward toward the ash-pit by the conveyor grate elements (1), and in their raised position the ash is just as positively held back in the furnace.

The relative duration of these two alternating influences can be controlled from the front of the stoker, to produce any desired thickness of fire at the ash discharge end of the stoker, and to accommodate either high or low ash coals.

These retarding bars hold the nearly spent fuel in the furnace, subjecting the last traces of combustible for a considerable period to the influence of the furnace temperatures, and to the moderate air allowance supplied by the full blast pressure of the wind box.

The result: *A new standard for low combustible in the ash.*

We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices: CHICAGO, 1366 Peoples Gas Bldg.—PITTSBURGH, 901 Oliver Bldg.—NEW YORK, 504, Fifty E. 42nd St.

Distributors:

PHILADELPHIA
A. C. Warner Co.,
Bulletin Bldg.

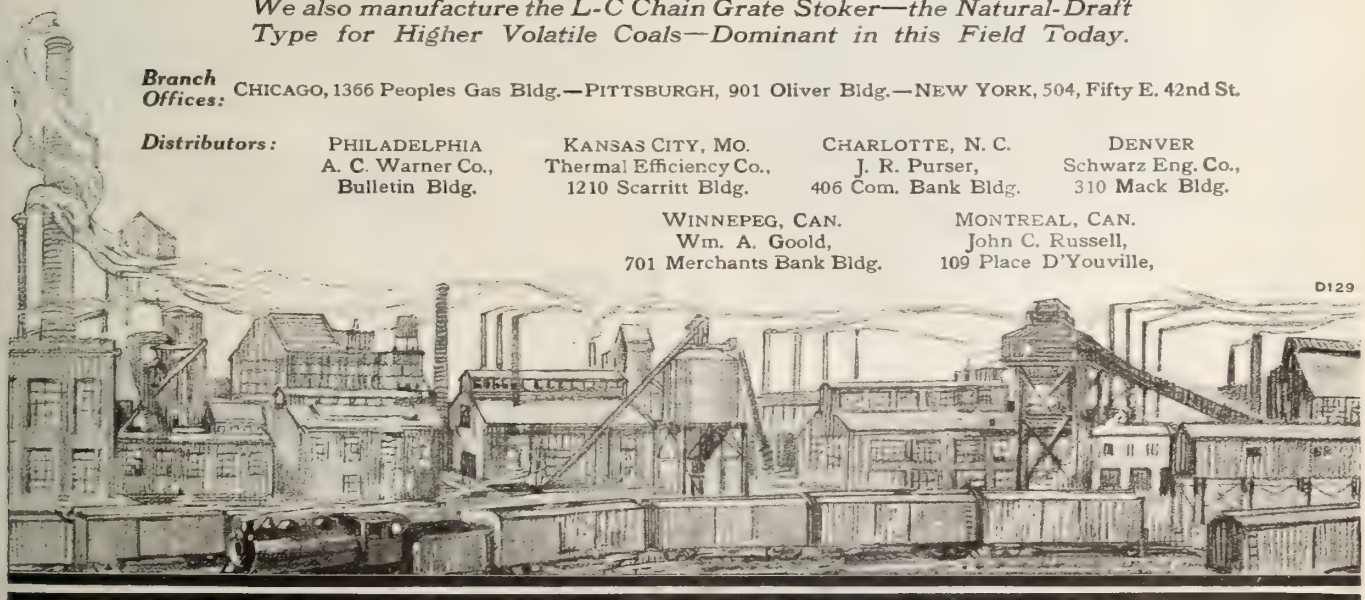
KANSAS CITY, MO.
Thermal Efficiency Co.,
1210 Scarritt Bldg.

CHARLOTTE, N. C.
J. R. Purser,
406 Com. Bank Bldg.

DENVER
Schwarz Eng. Co.,
310 Mack Bldg.

WINNEPEG, CAN.
Wm. A. Goold,
701 Merchants Bank Bldg.

MONTREAL, CAN.
John C. Russell,
109 Place D'Youville,



D129

CHRISTY

FOUNDED 1844 ST. LOUIS

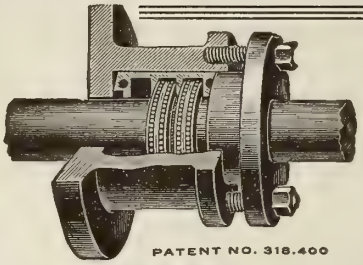
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



PATENT NO. 318,400

PAT. NO.	600,899		PAT. NO.	829,116
" "	634,104		" "	830,530
" "	602,328		" "	856,103
" "	654,541		" "	878,238
" "	654,542		" "	894,537
" "	725,368		" "	895,791
" "	774,490		" "	898,068
" "	775,193		" "	905,108
" "	776,194		" "	934,629
" "	791,300		" "	979,206
" "	805,669		" "	1000,76

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

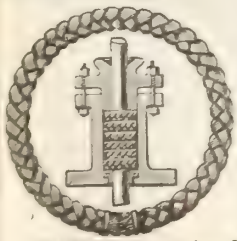
27 COTE ST MONTREAL, CAN.

CUT GEARS

In Grey Iron, Steel, Semi-Steel and Bronze.
On a Gleason Gear Planer Bevels cut up to 8 inches diameter.
Spurs cut up to 110 inches diameter.
Any pitch and width of face desired.
We employ three Gleason Gear Dividing Heads in our Plant, and cut wooden cogs in mortise gears with Gleason Attachments.
Largest range of Gear Patterns in Canada.
Our Pattern Shop, Foundry and Enginering Plant at your service.
Send in your inquiries and orders for immediate attention.

THE J. C. WILSON MFG. CO., LIMITED

BELLEVILLE, ONTARIO



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon. W. R. Rollo — Deputy Minister: W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

MONCRIEFFS "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotlan

Canadian Representative:

W. J. WALL, 134-136 Bleury St., Montreal

CRANE FLANGED FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST PATRICK ST

MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

ECONOMIC Carling BLOWERS SUPERIOR

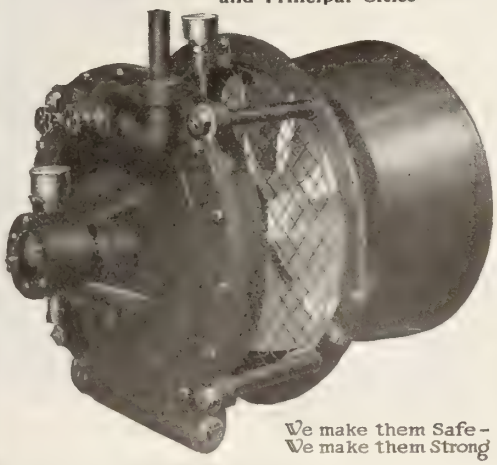
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

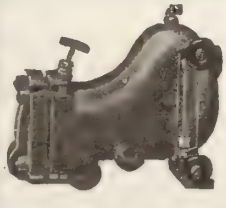
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe –
We make them Strong



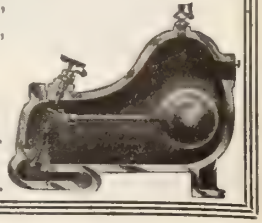
McDANIEL IMPROVED **STEAM TRAP**
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

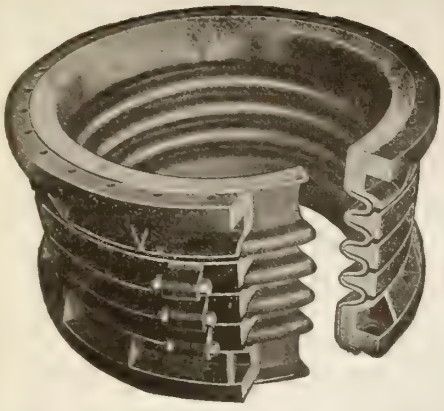
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



THE Badger Self-Equalizing Expansion Joint is a one-piece joint made from seamless copper tube and fitted with cast iron or steel equalizing rings to control the expansion and equally distribute it on each corrugation

Write for our new book today

E. B. BADGER & SONS CO.

81 PITTS STREET, BOSTON, MASS.

Canadian Agents:

FRASER & CHALMERS OF CANADA, LIMITED

Beaver Hall Hill, Montreal, Canada

Let Us Solve Your Water Problems

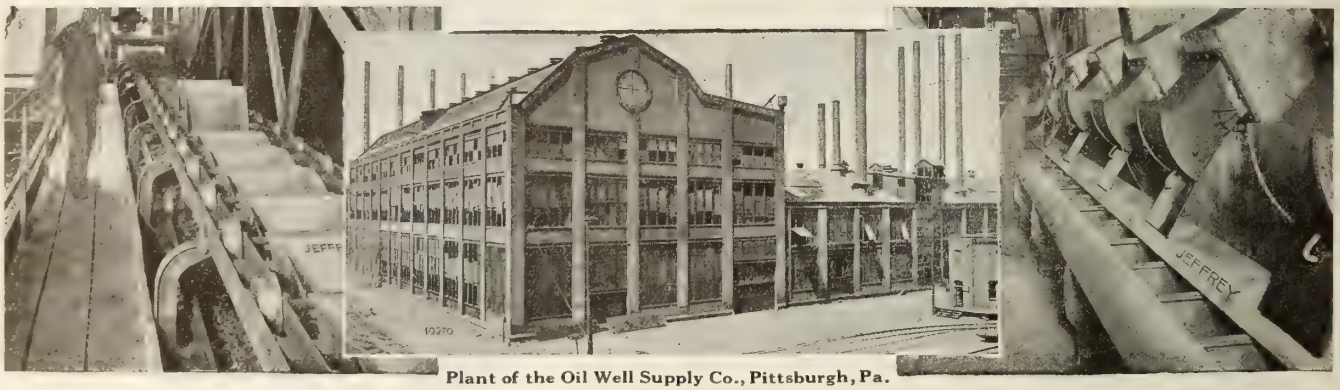
We have an up-to-date organization which will efficiently take care of your water problems—whether industrial, municipal or residential. Prompt service.

YOUR ENQUIRIES ARE SOLICITED ON:—

Steel Tanks - tacks - Plate Work
Return Tubular Boilers - Connelly Water Tube Boilers

MANUFACTURED BY
E. LEONARD & SONS, LONDON, ONT.

E. J. PHILIP & SONS, 57 Queen St. West, TORONTO



Plant of the Oil Well Supply Co., Pittsburgh, Pa.

Upper Run Over Bunkers

Handling Ashes on Lower Run

Saving Labor And Expense With A Jeffrey Pivoted Bucket Carrier

At the plant shown above, an 18" x 24" Jeffrey Pivoted Bucket Carrier completes the cycle of automatically handling coal from bottom dump cars to stokers with a minimum of labor.

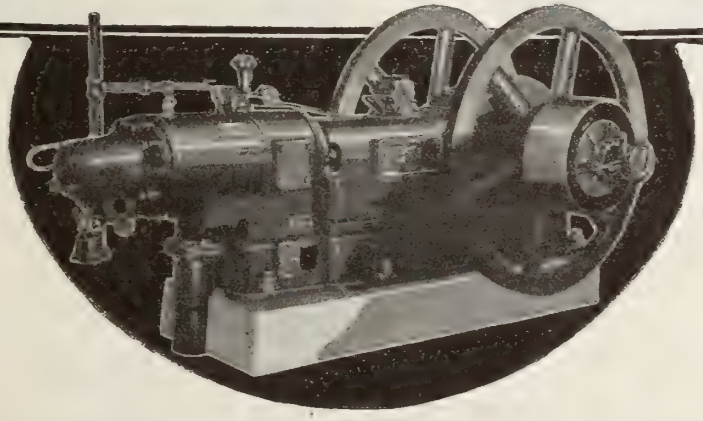
This Jeffrey Carrier has a 57 foot lift and a horizontal run of 68 feet. Handles both coal and ashes, coal being received from a roll crusher.

Catalog No. 210-3 fully illustrates and describes the Jeffrey Pivoted Bucket Carrier. Write for Catalog.

The Jeffrey Mfg. Co., *Canadian Branch and Warerooms,* **MONTREAL**

The Fuel for Economical Power

Performance records are available showing the dependability and operating economy of Giant Oil Engines under service conditions similar to yours.



Giant Semi-Diesel Oil Engines are built in capacities from 12 to 200 H. P., both single and duplex types.

OIL is readily procurable and its cost for fuel is low. And low-cost fuel oils are utilized most successfully by Giant Semi-Diesel Oil Engines —because:

Giant Oil Engines are of advanced, highly standardized design—simple and rugged in construction. They have no valves, magnetos, carburetors, wiring or other complicated devices to render dependability uncertain.

Their automatic regulation prevents waste of fuel and power, and largely eliminates the human factor in engine operation.

Power costs of ½ to ¾ cent per horsepower hour are common amongst "Giant" users.

Oil as your standard fuel and Giant Semi-Diesel Oil Engines utilizing it will economize power in your plant. Write for bulletins.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street EN-26-H

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton and Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Graton & Knight Mfg. Co., Montreal
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
McDonough, J., 323 Markham St., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDENER AND WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
Leitch Co., A. S., Toronto.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

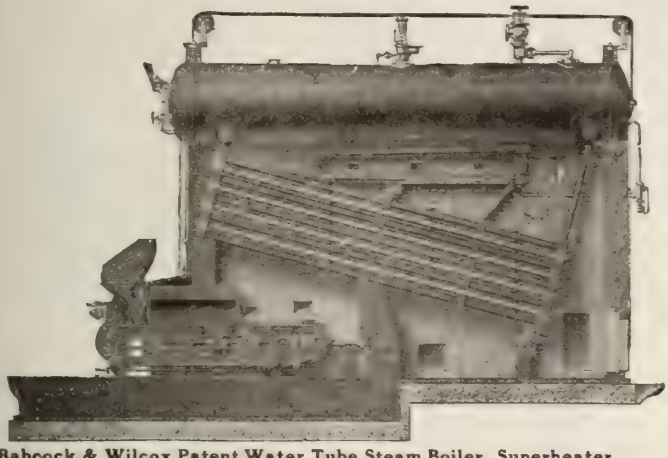
CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Beveridge Paper Co., Montreal, Que
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

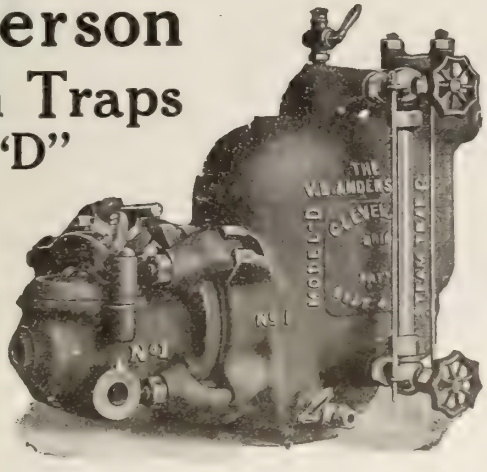
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

Anderson
Steam Traps
Model "D"



Stays Tight

The Anderson Model D Steam Trap is positive proof against break-downs due to accumulated moisture in engine cylinders and turbine castings. The Anderson can be counted upon to deliver **dry steam** under all operating conditions.

From the day you install an Anderson Model D steam Trap it will remain tight.

Every part is machined to solid gauge. Self-contained strainer and self-contained by-pass are Anderson features. The simple design gives complete accessibility to every part.

You can't afford to tolerate a trap that doesn't drain, or lets live steam through.

Our catalog contains a full description of the Anderson—Write for it to-day.

THE V. D. ANDERSON COMPANY

1935 W. 96th. St., Cleveland, Ohio

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL HOLE COVERS

Can. Allis-Chalmers, Ltd., Toronto, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Royles, Ltd., Irlam, Manchester, Eng.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
Williams Machinery Co., A. R., Toronto.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Escher, Wyss Co., Montreal.

CONDENSERS

Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSED AND SMOKESTACK PAINTS

Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES

Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton, Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Can. Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER

Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY

Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER

Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Green's Economiser, Ltd., Toronto.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.
Green's Economizer, Ltd., Toronto.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRICAL SUPPLIES

Can. General Electric Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS

Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Williams Machinery Co., A. R., Toronto
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY

Can. Allis-Chalmers, Ltd., Toronto, Ont.
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUSTERS

Green's Economiser, Ltd., Toronto.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Garth Co, The, Montreal, Can
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

Alberger Heater Co., Buffalo, N.Y.
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.
Williams Machinery Co., A. R., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green's Economiser Ltd., Toronto, Ont.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Green's Economiser, Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS

Ministry of Munitions, London, England.

FIBRE, VULCANIZED

Beveridge Paper Co., Montreal, Que.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR

Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

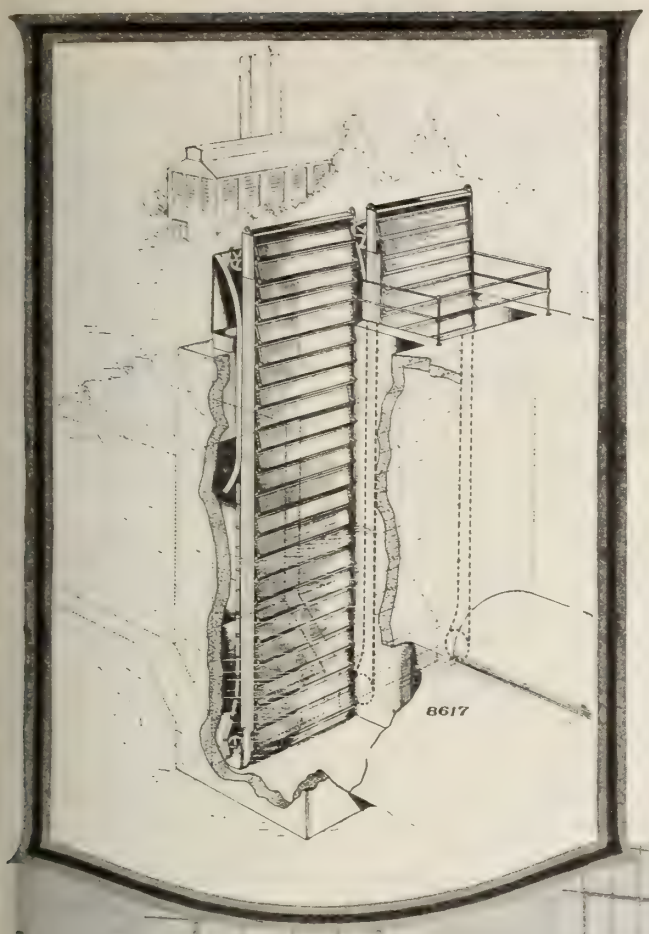
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk, Con.



Get Clean Water for Your Condenser Intakes

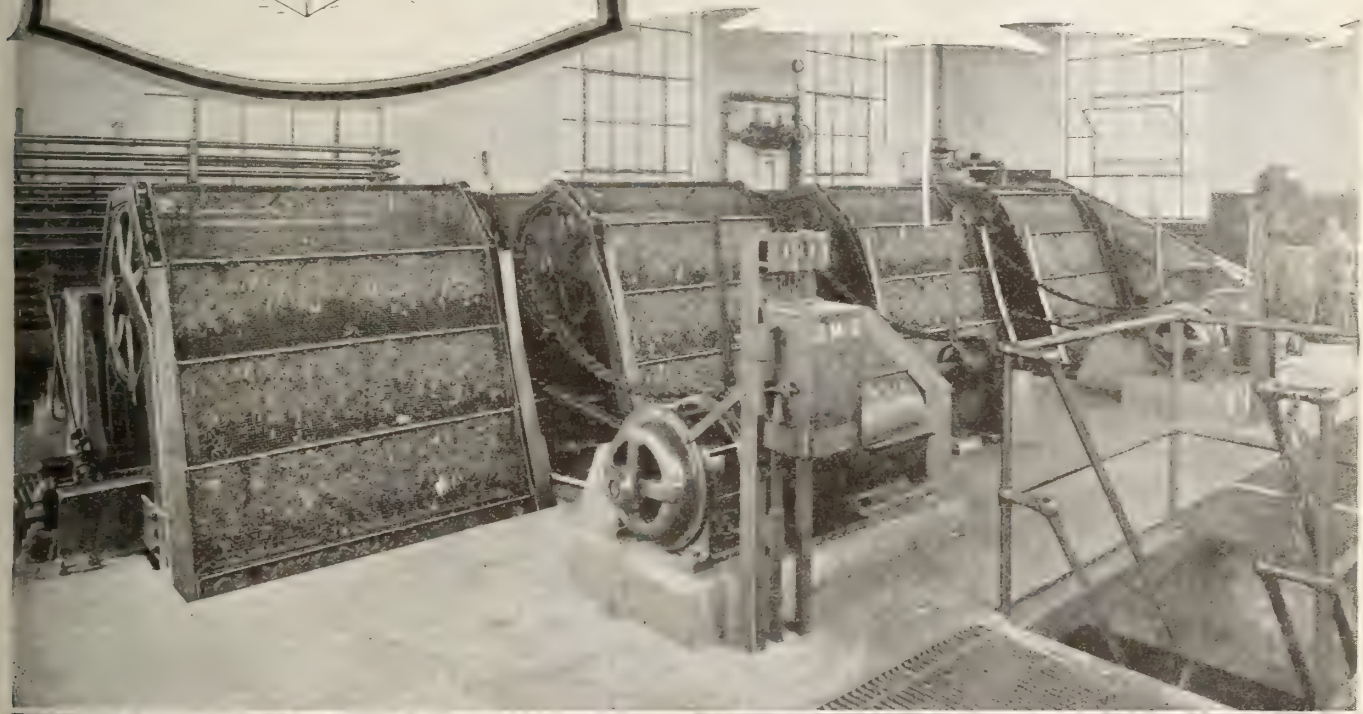
by installing

Link-Belt Water Screens

LINK-BELT Traveling Water Screens automatically remove the debris from the water and insure a steady supply of clean water to the condensers at all times. They are self-cleaning, require little attention and can easily be adapted to almost any intake system.

Let our experienced engineers investigate your system and make recommendations. Write for catalog.

CANADIAN
LINK-BELT Co., LIMITED
WELLINGTON AND PETER STREETS
TORONTO



We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets

Write for Catalogs
Place X in Square

LINK-BELT
WATER INTAKE SCREENS

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMEL-WARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox Ltd., Montreal
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Parce Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Beveridge Paper Co., Montreal, Que.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

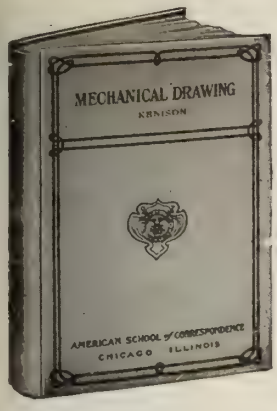
LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.



Clearance Sale of High Grade Technical Books

FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

Title of Book.	Name of Author.	Binding	Number of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	....
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	275	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Audels Answers on Practical Engineering	Harris & Associates	Cloth	254	Yes	.75
Gas and Oil Engines	L. E. Brookes	Cloth	192	Yes	.85
Ford Car	V. W. Page	Cloth	288	Yes	....
New Catcehism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Setting Valves of Canadian-made Engines	G. C. Keith	Paper	31	Yes	.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
How to Run Gasoline Engines	C. Von Culin	Paper	144	Yes	.50
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkin's Indicator .	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Aids to Engineers Examinations	N. Hawkins	Cloth	222	No	1.50
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy of $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

153 UNIVERSITY AVENUE, TORONTO, ONT.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Phillip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Lea & Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, VALVE STEM
Crane, Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. R. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

Plibrico is molded into place; needs no forms and H requires minimum time and labor.

PLIBRICO Makes Air Tight Furnace Linings

Air leaks in furnace lining joints, boiler settings and baffles are the greatest preventable losses in a boiler plant. No argument should be necessary to establish the fact that **An Air Tight Furnace Lining** is a great fuel economizer.

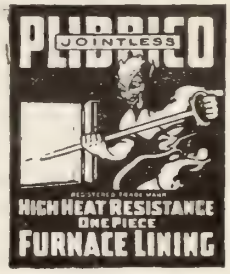
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Send for book on furnace building.

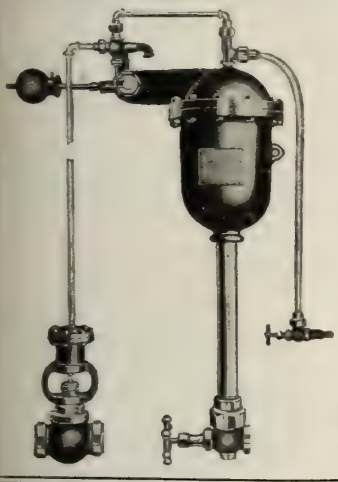
JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.



They Never "Forget"

VIGILANT FEED WATER REGULATORS

are always on the job every minute of the day, constantly making sure that the exact amount of water is being fed into the boiler to keep the gauge at middle point. And this saves coal—don't forget that very important point. Let us explain how.

Write for full information to-day.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Pa.

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300

MACGOVERN & COMPANY UNITED POWER MACHINERY

ROTARY CONVERTORS

25 Cycles.

K.W.	Make	A.C. Volts	D.C. Volts	Phase	R.P.M.
100	CHAPMAN & WALKER	400	550	6	750
150	GENERAL ELECTRIC		600	3	750
200	WESTINGHOUSE		600	3	750
250	GENERAL ELECTRIC	350	550	3	750
250	WESTINGHOUSE		600	3	750
300	NATIONAL	330	550	3	500
300	WESTINGHOUSE		600	6	750
300	GENERAL ELECTRIC		600	3	750
300	GENERAL ELECTRIC		600	3	750
300	WESTINGHOUSE		650	3	500
360	GENERAL ELECTRIC	370	600	3	500
400	GENERAL ELECTRIC		600	3	500
400	WESTINGHOUSE	370	600	6	750
400	WESTINGHOUSE		600	6	750
500	WESTINGHOUSE		600	3	750
500	WESTINGHOUSE		600	6	750
500	GENERAL ELECTRIC		370	3	750
600	GENERAL ELECTRIC		160		188
1500	GENERAL ELECTRIC		263	6	214
2000	GENERAL ELECTRIC		250	6	300

60 Cycles

K.W.	Make	A.C. Volts	D.C. Volts	Phase	R.P.M.
100	GENERAL ELECTRIC	220	340		1200
100	WESTINGHOUSE		550	2	900
150	GENERAL ELECTRIC		575	3	1200
150	WESTINGHOUSE	177	250	6	1200
200	WESTINGHOUSE		125/250	2	1200
250	WESTINGHOUSE	370	550		600
300	WESTINGHOUSE		600	3	600
300	WESTINGHOUSE	350	600	3	600
300	WESTINGHOUSE		600	3	600
300	WESTINGHOUSE	350	600	3	600
400	WESTINGHOUSE		236/275	2	450
400	WESTINGHOUSE		500/600	3	720
500	GENERAL ELECTRIC	92	120		720
500	GENERAL ELECTRIC	430	600	6	500
500	WESTINGHOUSE		250	6	1200
500	WESTINGHOUSE		550	3	600
1000	WESTINGHOUSE	156	220	6	514
1500	WESTINGHOUSE	178	250	6	450

MacGOVERN & COMPANY, Inc.

Offices: New York, Pittsburgh, 285 Beaver Hall Hill, Montreal Plants: Lincoln, N.Y., and Linden, N.J.

BUYERS AND SELLERS OF NEW MACHINERY A CONTINENT-WIDE SERVICE

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester. N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York. N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

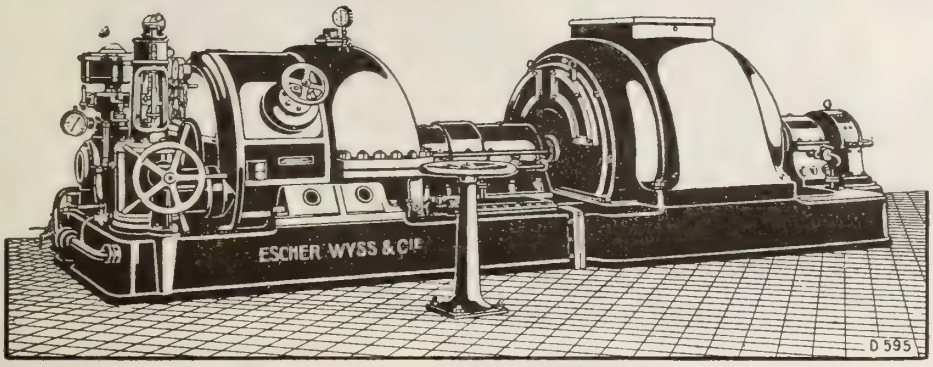
UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER

Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

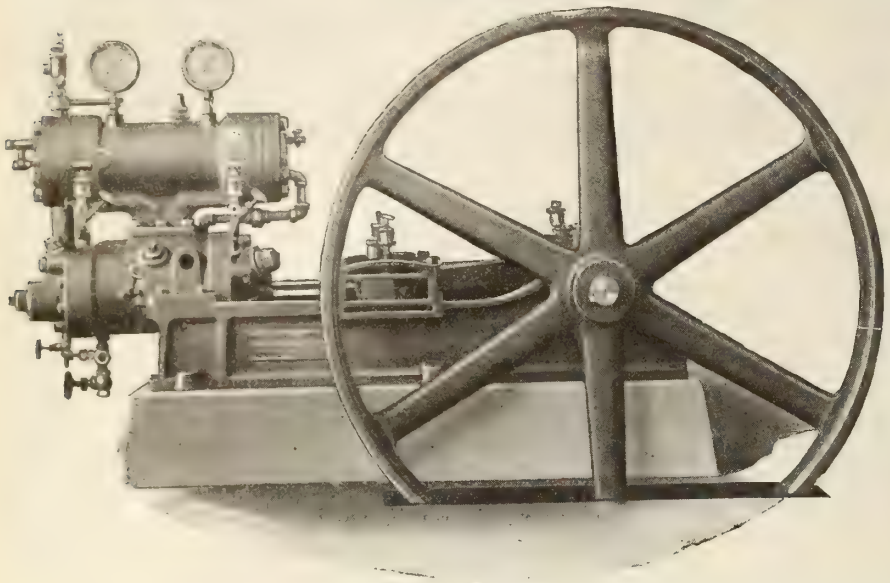
WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

NORWALK
AIR & GAS · COMPRESSORS



A Norwalk 150 lb. Air Compressor

Years of Satisfaction

Norwalk compressors give the completely satisfactory service for which they are known in every state in the union because they are built to give **continuous and dependable** service. They are long lived.

Investigate Norwalks before you install a compressor for any purpose. It will save you trouble and money.

Bulletins on air, oxygen, hydrogen, acetylene or carbonic acid gas sent upon request.

The Norwalk Iron Works Company
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

INDEX TO ADVERTISERS

All-Way Oiler Co. 60
Anderson Co., V. D. 75
American District Steam Co.... 50
American Steam Gauge & Valve Mfg. Co. 66
American Steam Pump 48
Armstrong Cork & Insulation Co. 11

Babbitt Steam Specialty Co..... 56
Babcock & Wilcox 75
Badger & Sons, E. B. 72
Betson Plastic Fire Brick Co... 55
Boving Hydraulic Eng. Co.... 70
Bowser & Co., S. F. 15
Brown, H. N. 42
Busch-Sulzer Bros.—Diesel Engine Co. 66
Buyers' Directory..... 74, 76, 78, 80, 82, 83

Can. Consolidated Rubber Co... 54
Can. Fairbanks-Morse Co. ... 63
Can. Farnsworth Co., The.... 39
Can. Link-Belt Co. 77
Can. Johns-Manville Co. 9
Can. Mead-Morrison, Ltd. 11
Can. Steam Boiler Equipment.. 67
Carling Turbine Blower Co.... 71
Chaplin-Fulton Mfg. Co..... 81
Classified Ads. 42
Coppus Engr. & Equip. Co.... 43
Cole, Geo. W., Ltd. 56
Crane Limited 71

Darling Bros. 70
Dart Union Co. 59
D'Este Co., Julian 45
Department of Labor 71
Diamond Specialty Co. 7
Direct Separator Co. 64
Dominion Coal Co. 70
Dunham & Co., C. A. 4
Durabla Mfg. Co. 64

Economy Fuse Co. of Can, Ltd. 45
Electric Welding Co. 81
Empire Mfg. Co. 58
Engr. & Mach. Works of Can. 14
Escher, Wyss & Co. 83

Foyle, W. & G. 42
Frick Co. 12

Garlock Packing Co. 13
Goodyear Tire & Rubber Co... 57
Goldie & McCulloch Co. 16
Greene, Tweed & Co. 65
Green's Economizer, Ltd. 44
Gutta Percha & Rubber Co.... 8

Hays Corporation, Jos. W..... 52
Holden Co., Ltd., The 73
Holmes Metallic Packing Co... 70
Homestead Valve Mfg. Co..... 56

Inglis Co., John..Inside back cover

Jamison Cold Storage Door Co. 12
Jeffrey Mfg. Co. 72
Jefferson Union Co. 61
Jenkins Bros. 3
Johns-Pratt Co., The 53
Jointless Fire Brick Co. 81

Kellogg & Co., E. H. 42
Kerr Engine Co. 88

La Clede Christy Clay Products Co. 68, 69
Laurie & Lamb 49, 70
Leitch Co., The Arthur S..... 47
Leonard & Sons, Ltd., E..... 53
Linde Can. Refrig. Co..... 10
Lincoln Electric Co. 59
Long, J. T. 42
Lunkenheimer Co..Inside front cover

MacGovern & Co. 81
Magnolia Metal Co..... 4
Manny Co., E. S. 42, 70
Mason Regulator & Eng. Co... 46
McAvity & Sons, T. A..... 60
Ministry of Munitions 41
Morrison Brass Mfg. Co., Jas. Outside back cover
Morse Chain Co. 51
Mueller Mfg. Co., H. 2
Murphy Iron Works 5

Norwalk Iron Works Co..... 94

Page-Hersey Iron and Lead Co., Ltd. 48
Penberthy Injector Co...Front cover
Philip & Sons, E. J..... 72
Pilley Packing & Flue Brush Mfg. Co. 71
Pratt & Cady Co., Inc..... 66

Robb Engineering Co. 62

Sanford Riley Stoker Co..... 5
Scaife & Sons Co., Wm. B..... 87
Schaeffer & Budenberg Mfg. Co. 44
School of Engineering 48
Starrett Co., The L. S..... 5
Sturtevant & Co., B. F. 66
Steel Mill Packing Co..... 45

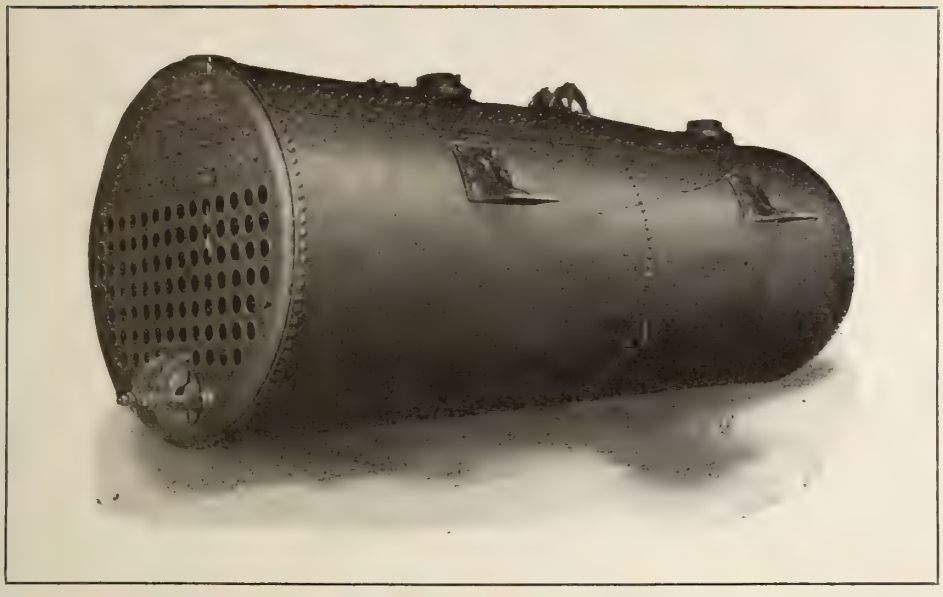
Technical Books 79
Trimont Instrument Co. 60

Uehling Instrument Co..... 5

Victoria Foundry Co. 70
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd. 64

Wall, W. J. 71
Waterous Engine Works Co.... 1
Watson & McDaniel Co. 71
Williams & Wilson 42
Williams & Co., J. H. 62
Wilson Mfg. Co., J. C. 70
Worthing Pump & Machine Co. 6

Yarnall-Waring Co. 56
York Mfg. Co. 11



INGLIS BOILERS

TANKS AND ENGINES

Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and service in Canada for over a half-a-century. Always reliable!

Write us for prices and specifications

The John Inglis Company

LIMITED

ENGINEERS AND BOILER MAKERS

14 Strachan Avenue — **Toronto, Canada**

Representatives in Eastern Canada:
JAMES W. PYKE & CO., LIMITED
232 St. James St., Montreal

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

MORRISON

Even, Low Pressure Maintained by J.M.T. Reducing Valves

A sudden change in the low pressure demand, or variations in flow and pressure on the high pressure side have no effect on the constant low pressure maintained.

The J. M. T. does all that a pressure-reducing valve can do. Since its introduction there has been no "problem" of pressure reduction of air and steam.

Method of Operation

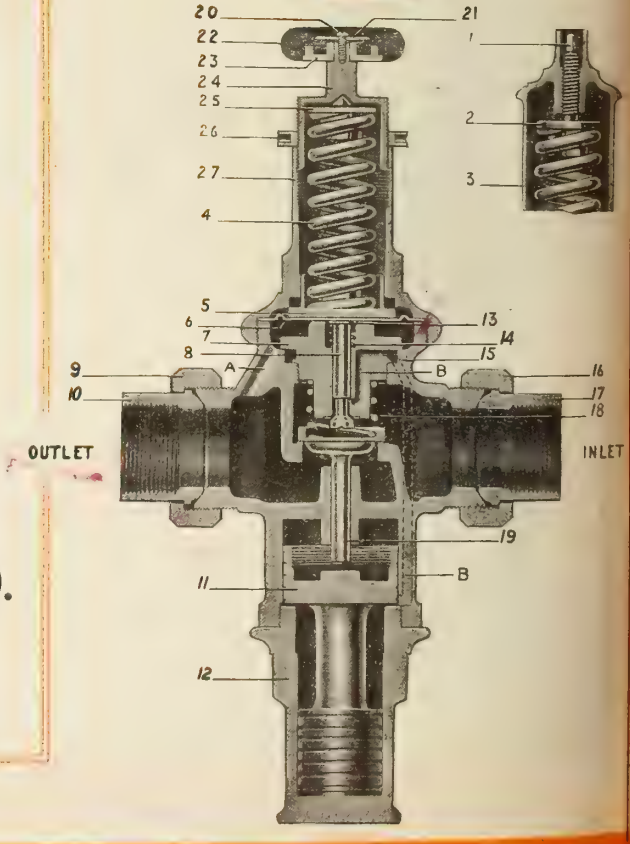
J. M. T. Reducing Valves are controlled by the variation of the reduced pressure acting through the port A, (shown in the cross-section) on the diaphragm 6. This diaphragm is resisted by the spring 4, which is adjusted to the desired pressure. This construction allows the diaphragm to be raised by an increase of the reduced pressure and forced down by the spring 4, when the reduced pressure is decreased.

The auxiliary valve 8 is held in contact with the diaphragm by the auxiliary valve spring 14, and moves up and down freely with the diaphragm. As soon as valve 8 is open steam passes through into port B and under piston 11. By raising piston 11 main valve 19 opens against the initial pressure, because the area of valve 19 is less than the area of piston 11, steam is thus admitted to the system. When the pressure on the low pressure side reaches the required point, which is determined by the spring 4, the diaphragm is forced upward by the low pressure steam which passes up through the port A to the under side of the diaphragm 6, allowing valve 8 to close, shutting off steam from piston 11. Main valve 19 is now forced to its seat by the initial pressure, shutting off steam from the system and pushing piston 11 down to the bottom of its stroke. Steam beneath piston 11 exhausts freely around the piston and passes off into the low pressure side.

In practice the main valve does not open or close entirely with each slight variation of pressure, but assumes a position which furnishes just sufficient steam to maintain the desired pressure. Piston 11 is fitted with dash pot 12, which prevents chattering or pounding.

These valves can be furnished for ranges of reduced pressure as follows: 5 to 50 lbs., 50 to 140 lbs., 140 to 300 lbs.

Full particulars of these or any other steam specialties will gladly be forwarded upon request.



JAMES MORRISON BRASS MFG. CO.
93-96 Adelaide St. W.
TORONTO ONTARIO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 10. Publication Office, Toronto—May 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

HANS RENOLD OF CANADA LIMITED

announce
their recent appointment
by
Hans Renold Ltd., of Manchester, England
as
SOLE CANADIAN REPRESENTATIVES
for

RENOLD STEEL DRIVING CHAINS.

THIS APPOINTMENT TO BE EFFECTIVE FROM JUNE 1st, 1920, AFTER WHICH DATE ALL ENQUIRIES SHOULD BE ADDRESSED TO

11 St. Sacrament Street,

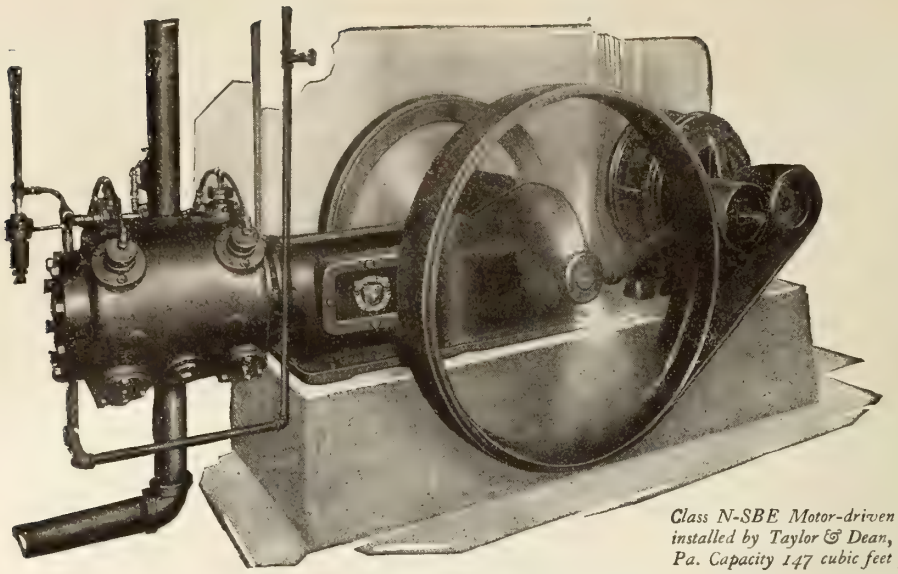
MONTREAL.

President,
CHAS. G. RENOLD.

Vice-President,
J. MURRAY CLARK, K.C.

Managing Director,
H. GEORGE.

Telephone
Main 6247



Class N-SBE Motor-driven Compressor installed by Taylor & Dean, Pittsburgh, Pa. Capacity 147 cubic feet per minute.

An ideal unit for moderate air power needs

CHICAGO Pneumatic Short-Belt Motor-Driven Air Compressors are ideal units for the small air power plant. Their compact construction economizes space. The short-belt drive with idler pulley prevents belt troubles

These units embody the same advanced principles of design and construction as the larger Chicago Pneumatics—Simplate Indestructible Flat Disc Valves, automatic regulation and lubrication, great rigidity, liberal bearing surfaces—all insuring more power with less waste; longer service with less upkeep.

Electric motor, steam and belt-driven types of these units are usually available from stock at the Company's branches listed below. Capacities 69 to 1197 cubic feet per minute.

Ask for Bulletin.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

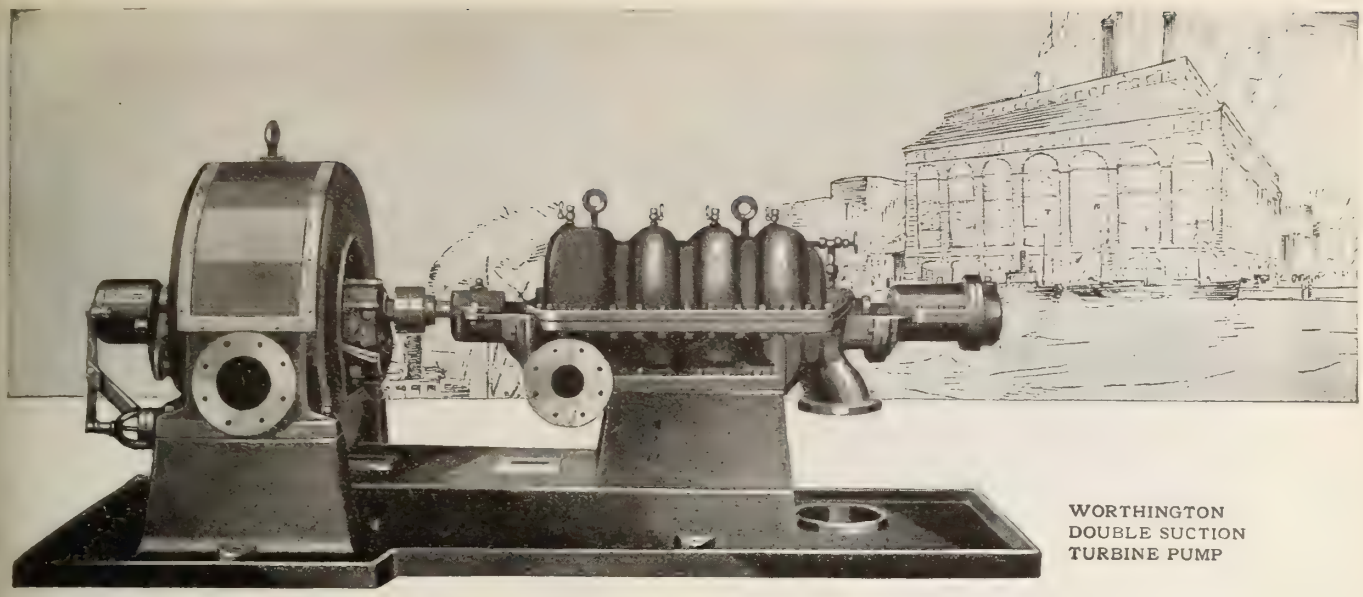
Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-52-H

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*



WORTHINGTON
DOUBLE SUCTION
TURBINE PUMP

Worthington Centrifugal Boiler Feed

TO satisfy the need for a centrifugal boiler feed pump that is free from end thrust, Worthington offers their Double Suction Turbine Pump for boiler feed.

Worthington has designed and built into this centrifugal type pump a distinctive hydraulic balance port which inhibits end thrust even when the pump becomes old. And this continuously good, long service has made Worthington Double Suction Turbine Pump leader in its field and worthy representative of the engineering skill and constructive ability of the 80 years old Worthington organization.

This pump is one of the varied Worthington line of power plant apparatus that has successfully satisfied over 200,000,000 boiler horse power since 1840.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

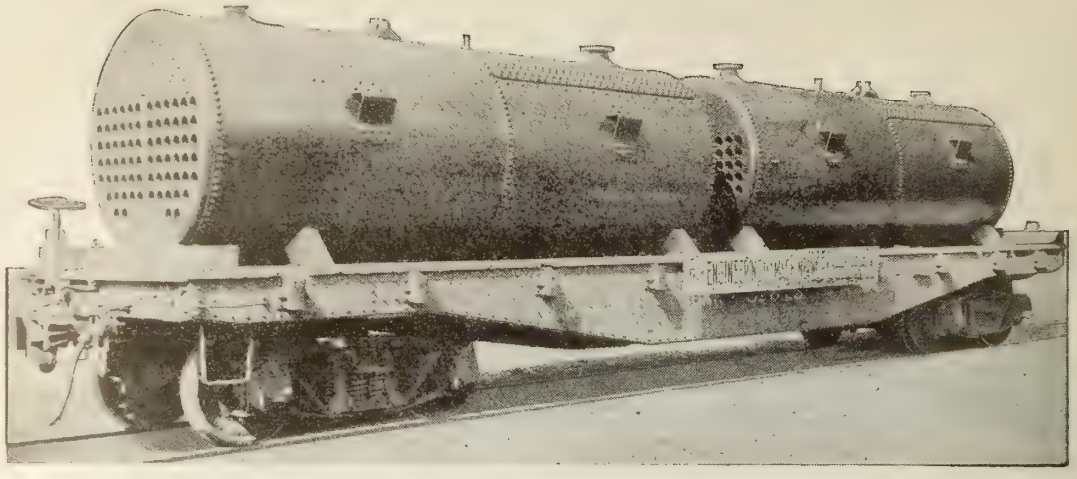
Other Worthington Products:
Steam, Power and Centrifugal Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, and Vacuum Pumps

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Epping-Carpenter, *Pittsburgh, Pa.*
Laidlaw Works, *Cincinnati, Ohio.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*

OWER HOUSE, May 20, 1920, Vol. XIII., No. 10. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in anada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter uly 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



You will like our Workmanship

We are ready now for your order for any type of Boiler—Vertical, Horizontal and Locomotive

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

DYNAMO GENUINE

The Best Babbitt for High Speed Motor Bearings

HOYT'S Dynamo Genuine is made to take care of one need only—and take care of that one **efficiently** and **economically.**

IT is the only alloy which will give real service on street car or other motors which have to withstand severe strains for long periods.

This babbitt is an extremely high copper alloy. It is made as pure a bronze as a babbit can be made with success.

Hoyt Metal Co.

TORONTO
MONTREAL
WINNIPEG

PROPERLY SIZED COAL IS ESSENTIAL FOR INDUSTRIAL AND RAILWAY OPERATION

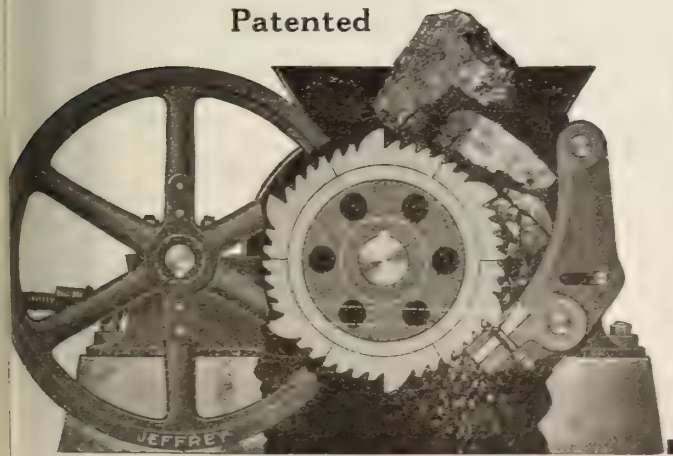
IN old days fuel problems were not given the attention demanded at present. With the installation of automatic stokers in Boiler Houses and on Railway Locomotives and limitations of size of lumps for hand firing, it is necessary that Industrial Power Houses and Railroad Coaling Stations be prepared to supply the proper sizes of coal. A Jeffrey Single Roll Crusher with its easy adjustability to give various products meets this condition.

What a

Jeffrey

Single Roll Crusher Installation Means to You

Patented



Makes you independent of the regular supply of screenings.

Permits the use of Run-of-Mine or Lump Coal in your stokers.

Enables you to buy lump coal of proper quality in place of inferior screenings.

Produces the most efficient sizes of coal for stoker use.

Saves money—proper fuel means economical operation.

SHIPMENTS FROM STOCK

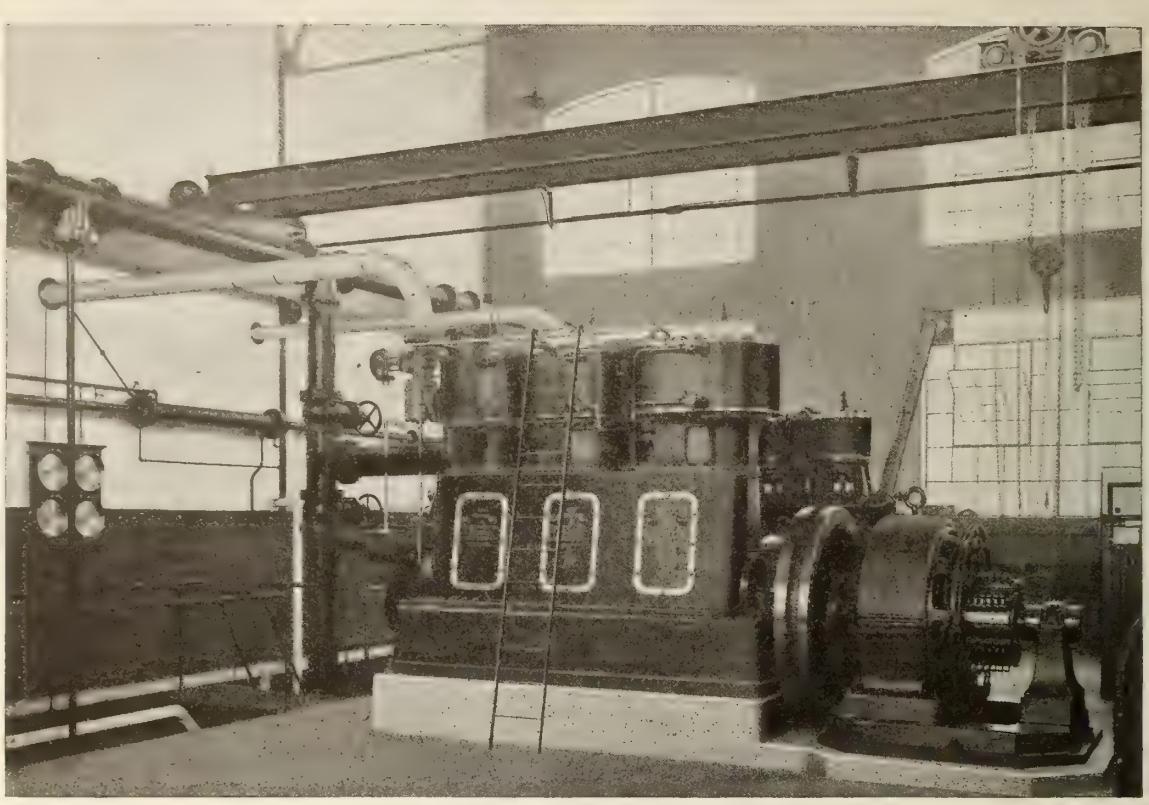
Write for Catalog No. 141-4, fully illustrating and describing the Jeffrey Single Roll Crusher.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

DEPENDABLE POWER EQUIPMENT



Vertical Enclosed Forced Lubrication
Steam Engines

Single, Twin, Compound, Triple Expansion and Three Cylinder Compound

The G. & McC. Co. Vertical Enclosed Forced Lubrication Steam Engine is designed to give long and satisfactory service under modern, high-speed conditions, to require the least possible attention, give perfect regulation and have all parts simple and easy of access.

To make a Steam Engine, durable, quiet running, dust and dirt proof, simple in design, which will give maximum power in the minimum of space was our desire. **This G. & McC. Co. Engine is a distinctly successful Made-in-Canada model.**

Our catalogue explains the engine in detail. May we send you a copy?

The Goldie & McCulloch Co., Limited

Head Office and Works : GALT, Ontario, Can.

Toronto Office: Suite 1101-2, Traders Bank Bldg.

Western Branch: 248 McDermott Ave., Winnipeg, Man.

British Columbia Agents: Robt. Hamilton & Co., Vancouver, B.C.

Quebec Agents. Ross & Greig, 400 St. James St., Montreal, Que.

Capacity Production

EVERY manufacturer wants capacity production; he wants every ounce of power and work from his machinery. Volume of production is largely a matter of steady, uninterrupted work, which means that the machinery must be maintained at maximum efficiency.

To give this continuous, efficient service, machinery must be properly lubricated. Correct lubrication is inseparable from the economical operation of machines and power equipment; it is a big factor in profitable manufacturing and *you cannot afford to use any but the best lubricants in expensive machinery.*

Imperial Lubricants are well known for their high, uniform quality. They are graded for every type of machine and every moving part. They have been tested and proved under actual service conditions to be of superior fitness for the work for which each is designed.

If you have lubrication problems or difficulties, write to our Imperial Lubrication Engineers. They will gladly study your problems and submit recommendations free of charge or obligation.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Arlo Compressor Oil

Write to 56 Church Street, Toronto, or to any of our branches for an appointment or for information or advice on your lubrication problems.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

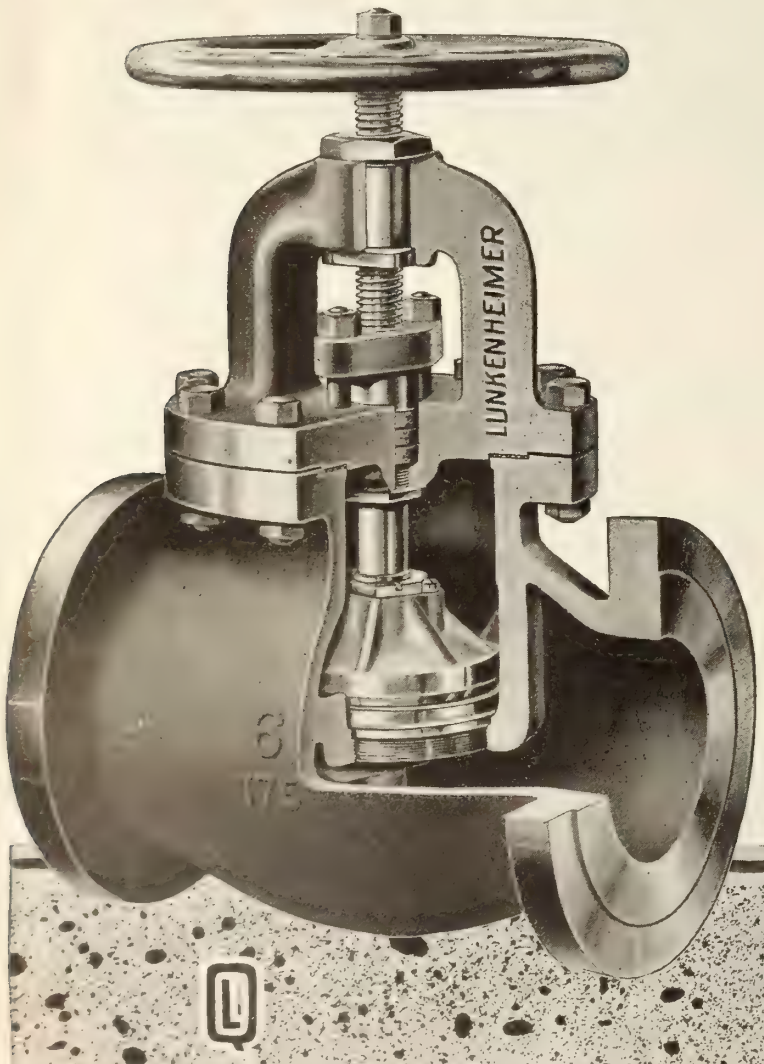
BRANCHES IN ALL CITIES

-lasting satisfaction-

LUNKENHEIMER

IRON BODY BRONZE MOUNTED

GLOBE, ANGLE, CROSS & CHECK VALVES



give lasting satisfaction in service. Their design, extreme strength and durability due to the high quality materials used, and the Lunkenheimer system of test and inspection which they undergo, insure safety and maximum valve service.

Lunkenheimer "Valve-iron" is close grained and has a tensile strength far in excess of the iron used in the average valve. The trimmings are made of Lunkenheimer "Valve-bronze," a material possessing extreme wear resisting qualities.

The spring seat, peculiar to Lunkenheimer valves, will compensate for any slight distortion which may be caused by temperature change or pipe strains. The seating surfaces are re-grindable and all the parts renewable.

For high temperature service these valves can be supplied with trimmings made of Lunkenheimer "Valve-nickel"

All standard sizes, in three weights, for working steam pressures up to 125, 175 and 250 pounds.

Specify LUNKENHEIMER Iron Body Valves and insist on their installation.

Distributors of Lunkenheimer Products situated in every commercial centre.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

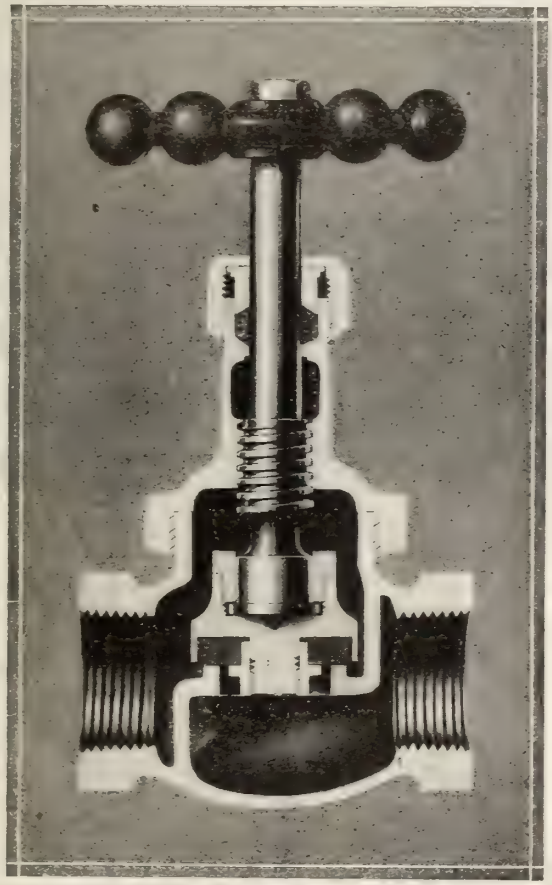
CINCINNATI

New York Chicago Boston London.

AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862

TRADE PENBERTHY MARK.

BE SURE THIS NAME is on the Valve you buy



SECTIONAL VIEW OF PENBERTHY COMPODISK VALVE
Registered and Approved for 175-lbs. Steam Pressure

Then you get "The valve with the outside bonnet construction."

The first progressive improvement made in brass valve construction in generations.

Think of the advantages!

Valve always accessible.

No straining or stripping of threads when assembling or taking apart.

Impossible to spread or enlarge body of valve when screwing down bonnet to place.

No corrosion of threads, for they are on the outside, away from the action of steam and water

Are You Responsible
For the Efficiency of Your Power Plant?

THEN SPECIFY "PENBERTHY" VALVES
THE BEST BY EVERY TEST

STOCKED BY LEADING JOBBERS AND MILL SUPPLY HOUSES IN CANADA

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

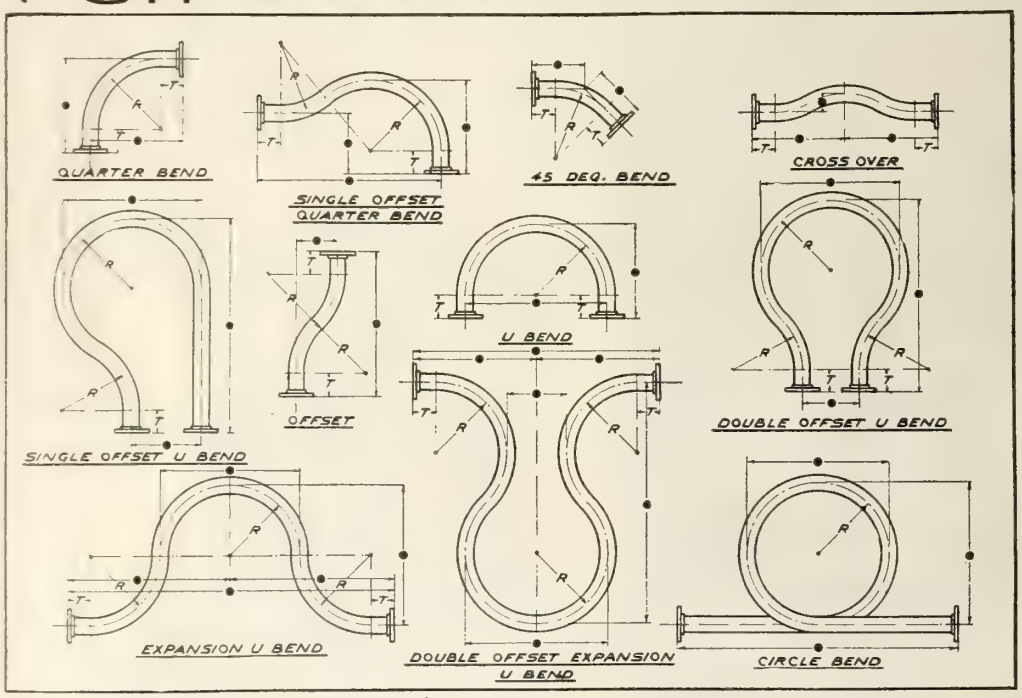
AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

PH WROUGHT PIPE BENDS



All Kinds and Sizes Up To 10-inch Diameter

MADE IN CANADA BY

PAGE-HERSEY IRON, TUBE & LEAD Co LIMITED

100 CHURCH STREET, TORONTO, ONT.

GATES

Furnace Linings--High Temperature Cements--Special Shaped Firebricks

CONTRACTORS FOR

All Kinds of Power Plant Brickwork. Estimates on all Jobs.

Gates Refractories Limited

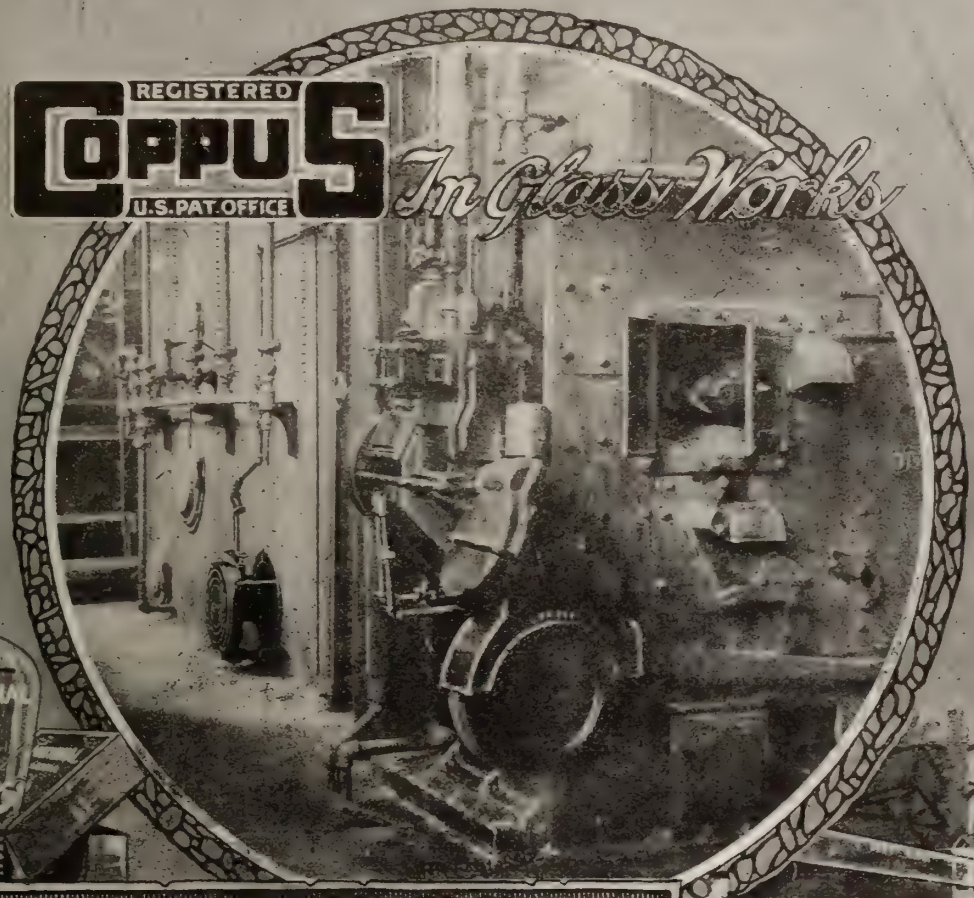
Head Office : St. James St., MONTREAL

Toronto Office : St. James Chambers, Church and Adelaide Sts.

EXPERTS ON REPAIR JOBS

REGISTERED COPPUS U.S. PAT. OFFICE

In Glass Works



In the Glass Division Power Plant of the National Lamp Works out in Cleveland, Ohio, they burn gas coal screenings and producer tar—difficult fuel to burn economically. Yet with the 4-18" COPPUS Turbo Blowers which they operate, full steam pressure is maintained in their 4-250 H.P. Stirling Boilers—and cheap fuel is efficiently furned. Without these Blowers, one of which is shown above, additional boilers would have been necessary last fall. With their aid, however, the heavy plant load is easily handled.

Before the National Lamp Works installed COPPUS Blowers a careful investigation satisfied them that for efficient operation, low steam consumption, and sturdy dependability, COPPUS Blowers stand in a class by themselves. And after practical proof that COPPUS Blowers are all that is claimed for them, Mr. Bretz, Plant Superintendent, expresses himself as "highly pleased with them." In the National Lamp Works, as in thousands of plants in every industry, COPPUS Blowers have proved profitable investments.

Why not find out exactly how and why "COPPUS EQUIPMENT CAN SAVE YOU MONEY." Write us and our engineers will help you solve your combustion problems. If you haven't a copy of Blower Catalog write for one to-day.

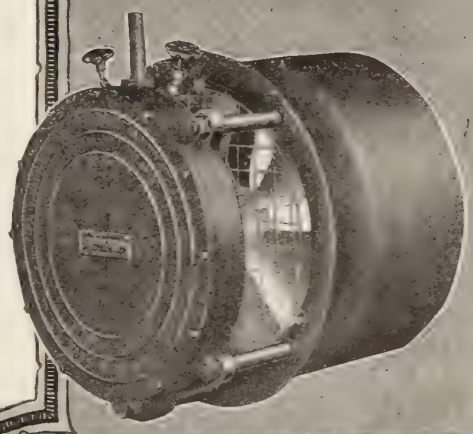
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

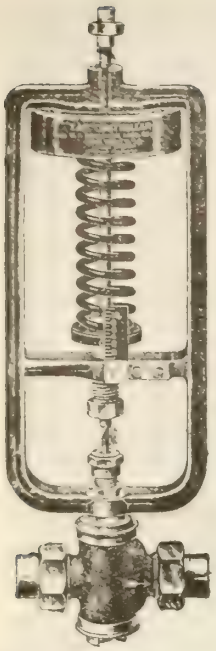
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng. Co., 125 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.



COPPUS TURBO BLOWER



TAG TAG TAG TAG

Maximum and Minimum
the Same
Under TAG Control

The best way to conserve coal is to supply the power needed and no more.

It's no economy to supply too little power, and the balance between too much and too little is hard to strike by hand valve manipulation.

The TAG Self-Operating Pressure Controller does it for you. Set it and forget it; it works automatically; it needs no care or attention.

On your steam, oil, air and water lines there is never so much as a half-pound of pressure difference between maximum and minimum with a TAG Controller on the job.

Bulletin PP-388

C. J. TAGLIABUE MFG. CO.
TEMPERATURE ENGINEERS
16-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark Reg. U.S. Pat. Off.

TAG TAG TAG TAG TAG TAG TAG

"MEAD-MORRISON"
CANADIAN MM CANADIAN MM

ELECTRIC CAR PULLER

How long does it take you to spot that car?

How do you get the empties back on the other siding?

This CAR PULLER requires only ONE MAN.

The capacity of the puller is a rope pull of 3,500 pounds at a rope speed of 60 feet a minute.

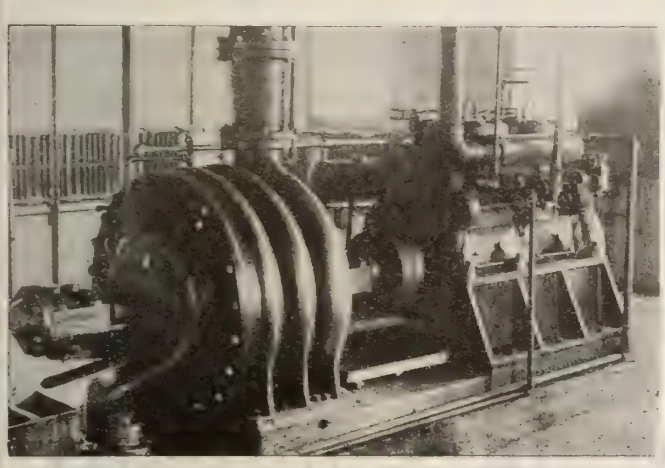
Furnishes Dependable Service Under All Conditions

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Sterling

THE ENGINE of REFINEMENT
For the finest boats that float

EMERGENCY POWER at any speed up to 1,500 R.P.M. for centrifugal pumps and electric generators. 12 to 600 H.P.



Sterling Model F, 4-cylinder, 75 B.H.P. engine direct connected to Worthington 3 stage fire pump at Berthierville, Quebec, suction 6", discharge 6", capacity 900 Gals. per min., Speed 900 R.P.M.

Catalog on request.

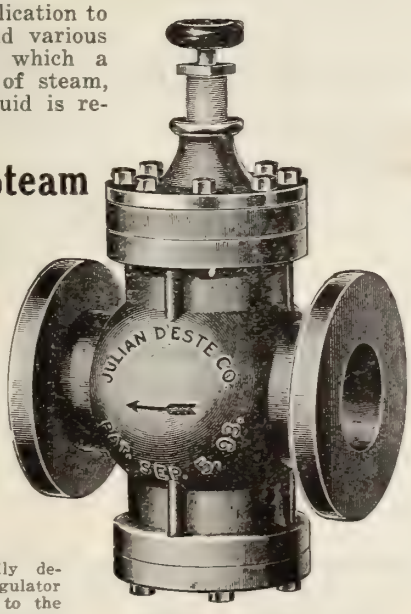
Sterling Engine Co., Dept. C-4, Buffalo, N.Y. U.S.A.

CURTIS Engineering Specialties

Universal City!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

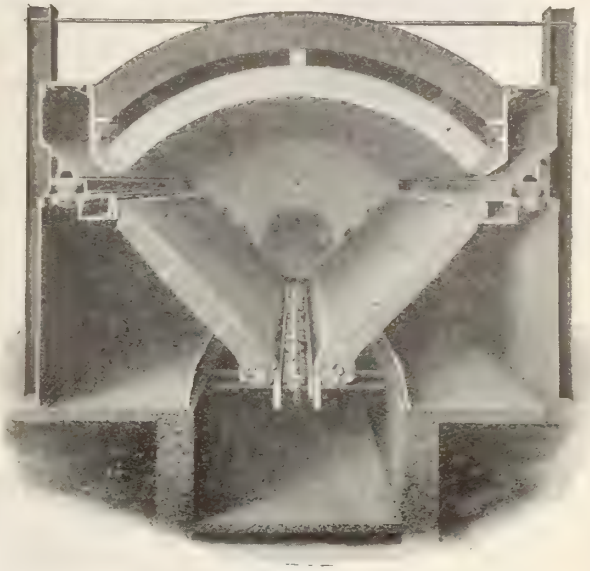
MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: {83 BARCLAY ST., NEW YORK CITY
{174 N. MARKET ST., CHICAGO, ILL.

MURPHY AUTOMATIC FURNACES



STOOD the Test of Time

The Murphy Furnace is the pioneer among stokers. It is one of the oldest—and one of the best; 37 years of successful operation—and still going strong. To-day over 6,000 boilers are fired by Murphy Furnaces.

Remember that during that time a great many manufacturers have sprung up and died. Time tells—the principle must be sound—the operation successful.

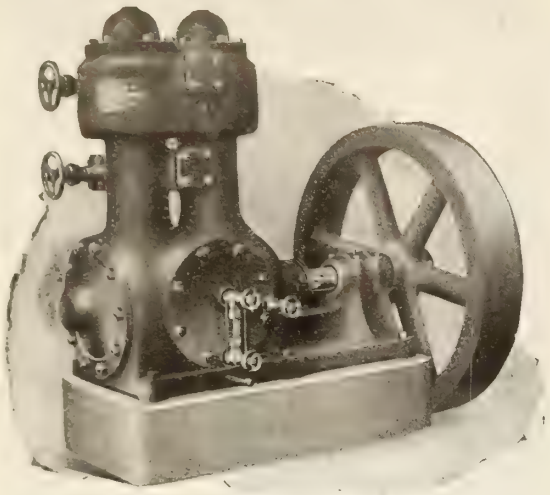
Our engineers have gathered a store of useful information. The Catalog HM-5 is yours for the asking.

For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalog "HR-5."

MURPHY IRON WORKS

DETROIT MICH. U. S. A.

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to your business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

For Better Commutation

on Motors, Generators and Rotary Transformers

USE

"Le Carbone" Carbon Brushes

Losses through faulty commutation are among the most troublesome with which operators of electrical equipment have to contend—and are often far more serious than is realized. For thirty years the growing use of "Le Carbone" Brushes has been reducing this loss.

The quality of "Le Carbone" Brushes is not only extraordinarily high, but absolutely uniform in each and every grade. Dimensions are accurate, ensuring perfect fit in the brush holders. Composition does not vary from the standard for the grade, so that exactly the same conductivity and co-efficient of friction can be relied upon year after year, so long as "Le Carbone" Brushes are in use.

When the right grade of "Le Carbone" brush is selected (and when we know the characteristics of the machine we undertake to do this) sparking is practically eliminated, and pitting, flash-overs, burnt-out brush holders and commutator wear are unknown. Commutation is perfect, efficiency of the machine is raised, and service is uninterrupted.

If you have a troublesome machine, give us full particulars—try out the "Le Carbone" Brushes we recommend—and return them if they don't give satisfaction.

"Handy" Commutator Stones

Keep commutators in A-1 condition with less trouble and lost time than any other device. They quickly reduce flat spots, high mica, high bars, ridges or other rough spots, removing far less copper than when the commutator is turned, and leaving a smoother surface than can be obtained by fine sandpaper.

Use No. 6 Cutting Stone for preliminary work and No. 25 Finishing Stone for polishing. *Both can be used with machine running at full load.*

Supplied in any size up to 12″ x 12″ x 10″, with handles to suit.

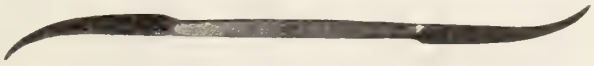
"Handy" Commutator Slotting Files

The part which undercut mica plays in aiding perfect commutation is now generally recognized—and one of the quickest, easiest, cheapest ways to slot a commutator and to keep the mica down is with the "Handy" Commutator Slotting File.

It is tempered to cut mica readily, but to drag as soon as it gets down to the copper, so that even an inexperienced workman can easily tell when he has gone just far enough. The "V" slot leaves the sides protected against short circuits from accumulation of oil and dirt.

Neither brush holder nor armature need be removed. A commutator can be slotted at night or in odd moments of rest, *without any loss of operating time.*

"Handy" Files are both single and double ended.



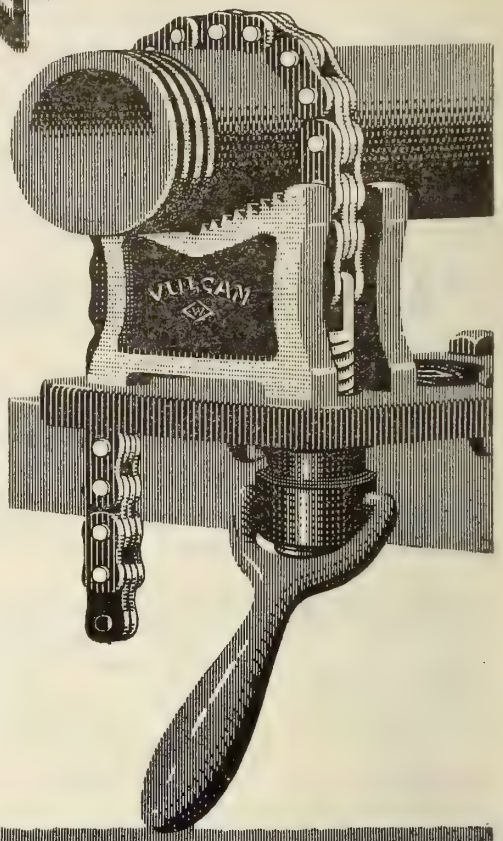
For extensive commutator slotting we recommend the Aurand Portable Electric Commutator Slotter and for general commutator repairing the Peerless Universal Armature Machine.

CANADIAN DISTRIBUTORS

LYMAN TUBE & SUPPLY CO., Limited

MONTREAL TORONTO WINNIPEG NEW YORK

WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE



A PIPE vise, like any tool intended for rough usage, should be so designed and constructed that the severe strains and stresses of hard, continuous service cannot cause breakage or failure in operation.

Williams' "Vulcan" Chain Pipe Vises have no weak parts to fail through faulty design. Though they are far lighter and cost less than the conventional cast pipe vise, they are unbreakable. These Vises are made entirely from wrought metal, tested in our Laboratories before use. Each Chain is hand made.

Nothing that engineering experience and technical skill can suggest to improve them is omitted in their manufacture. All are backed by our unconditional guarantee.

Three sizes for ⅛ to 8" pipe. Booklet on request.

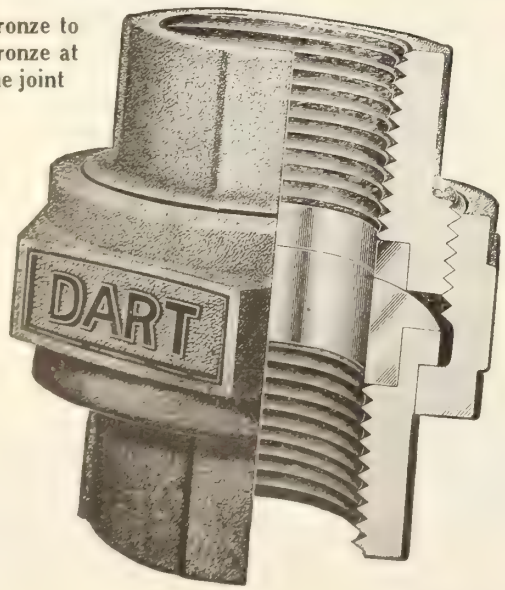
J. H. WILLIAMS & CO.
"The Drop Forging People"

78 So. Clinton St. Chicago, Ill.
78 Vulcan St. Buffalo, N.Y.
78 Richards St. Brooklyn, N.Y.

Western Canadian Agent: W. Bruce Campbell, 78 Confederation Life Bldg., Winnipeg

DART UNIONS

Bronze to Bronze at the joint



STAY TIGHT —*Permanently*

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Your Jobber Sells Them

Manufactured by Dart Union Co., Limited, Toronto, Ont.

MR. JOS. W. HAYS, *Author*

MR. JOSEPH HARRINGTON
Chicago
Formerly Advisory Engineer, National Fuel Administration for State of Illinois

MR. FRED R. LOW
New York City
Editor of Power

PROF. S. W. PARR
Urbana, Ill.
Department of Chemistry, University of Illinois

MR. ARTHUR L. RICE
Chicago
Editor, Power Plant Engineering

W. L. ABBOTT,
Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill.

MR. DAVID MOFFAT MYERS
New York City
Formerly Advisory Engineer, National Fuel Administration

These Men are America's Leading Combustion Experts

Every step of the training has their careful censorship, giving you the fruits of their broad and successful experience.

Hays School of Combustion
1108 State-Lake Bldg.
Chicago, Ill.

Better Jobs— Bigger Salaries

Let These Men Show You How to Get Them

Are you interested in sure and rapid advancement to a really worth while position in one of the best paying professions in the country today? If you are it will pay you well to read this announcement. It tells how you, with or without previous training, can prepare yourself in a short time for an attractive position that insures a lucrative salary and an assured future.

Remember—this profession is a new one—unlike all others, it is still uncrowded—and the demand for trained men far exceeds the supply. That's why your services will be in demand when you have acquired the necessary training. That's why you can count every effort a sure and wonderfully profitable investment.

Easy to Learn— No Experience Necessary

In most professions, to become proficient, long periods of intensive study, followed by years of hard training, are necessary. In this new profession—Combustion Engineering—the necessary training can be acquired in a few short months. Why? Because all the knowledge and experience—all the scientific research and experiments—all the labor and study of seven of America's leading Combustion Engineers have been condensed and classified to such a remarkable extent that what formerly required years of study can now be learned in a fraction of that time.

This training from the very first can be applied to the practical every-day problems of any power plant. At some point in the course you must spend some time in power-plant work if you have not already had the experience. That may prove to be your field or you may make it the stepping stone to an executive position. In either case your services will increase in demand and value as you progress in the training.

America's Leading Combustion Engineers Teach You

On this page are photographs of our educational staff. Probably you know some of these men personally. At least, all or most of them, are known to you by reputation.

Jos. W. Hays is the author. His reputation as a writer on Combustion Efficiency is world wide. In this course he has surpassed himself. Every lesson, every chapter, is written in such an interesting, comprehensive way, that the reading of the course is as pleasant as it is profitable.

Associated with Mr. Hays as reviewing and advisory editors are **I. E. Moultrop, W. L. Abbott, Jos. Harrington, Fred R. Low, David Moffat Myers, Prof. S. W. Parr and Arthur L. Rice.** These names alone are proof positive of the thoroughness and completeness of the course.

Especial attention has been given to make this course easily understood by everyone. It is stripped of all unnecessary technicalities and is written in a way that you can quickly grasp and understand. It is prepared especially for the man on the job—the busy man in office or boiler room who can commence putting his knowledge into practice the moment he starts the course.

Send for this FREE BOOK—TODAY

To enable you to get a better idea of just what this course is—just what it covers—why it is a guide to a better job and a bigger salary—why it enables *you* to cash in on the big salary awards that fall to the Combustion Expert—to make all these things clear to you, we have prepared the book "Opportunities for the Combustion Expert." Send for a copy of this book today. It's free.

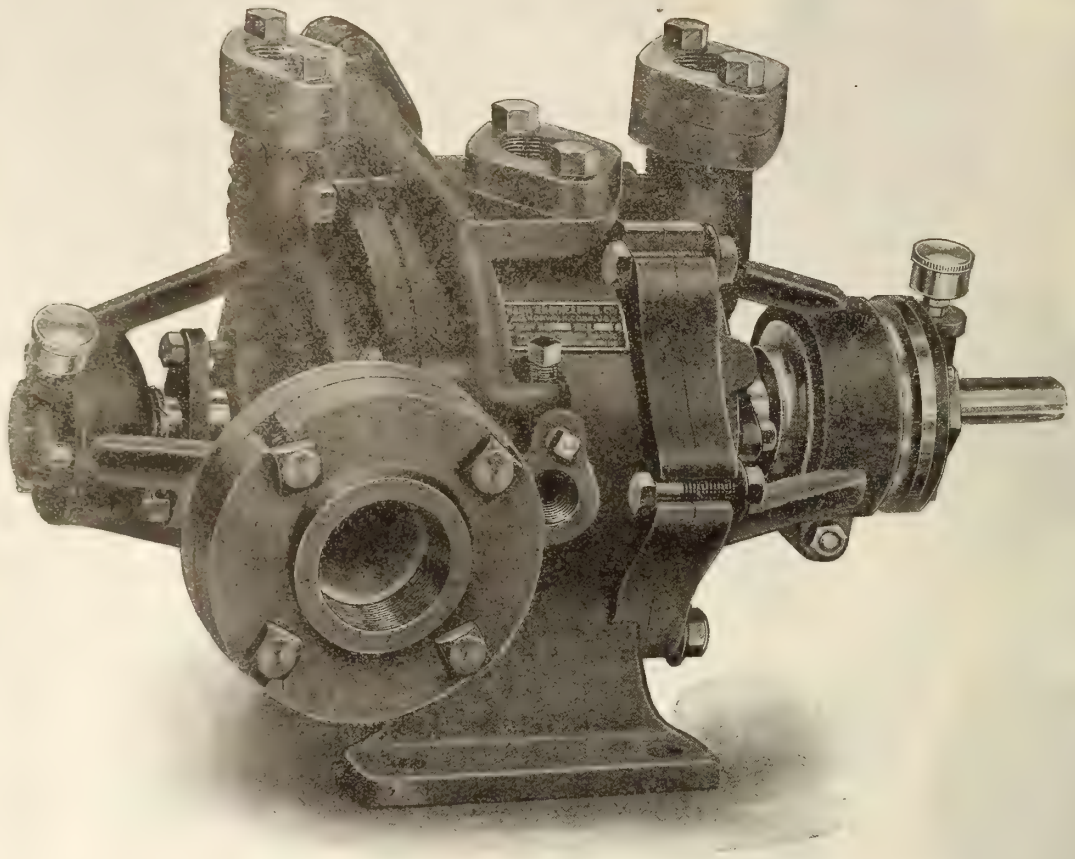
Mail the Coupon

Simply fill in the coupon and mail it to us. We'll send you a free copy of "Opportunities for the Combustion Expert" by return mail. Time is valuable. Get started today while the opportunities are greatest. Mail the coupon—Now.

HAYS SCHOOL OF COMBUSTION
109 North State St., Chicago

Without obligation, send me a free copy of "Opportunities for the Combustion Expert and details of the Hays Course.

Name.....
Street.....
City.....State.....
Firm.....
Position..... P.H. 5-20



JENNINGS TURBINE VACUUM AND LOW PRESSURE BOILER FEED PUMP

For return line heating systems, dryer exhaust systems in paper mills, or other vacuum work where large percentages of liquids have to be handled with gas the Jennings is without equal. Its distinct advance in principle and design over all other types is the result of many years experience in building turbine vacuum pumps.

The Jennings has two independent turbine units, an air pump and a water pump, combined in one casing, with the impeller of each mounted on the same shaft. The horsepower required to operate this pump is less than half that consumed by any other vacuum heating pump of the same capacity.

We would like to tell you more about the many distinct features of this pump. Write for full information.

THE ARTHUR S. LEITCH CO

1001-2 Kent Bldg., Toronto, Ont.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Power Plant of the St. Lawrence Sugar Refinery

A Brief Description of the Leading Features of This Montreal Plant, Where Tests on Oil and Coal Fuel Are Being Made

By J. H. RODGERS

THE abnormal large quantities of steam and water that are constantly required for the uninterrupted activities of a sugar refinery, necessitates the continued operation of the power equipment that supplies the many department with these essential elements. The St. Lawrence Sugar Refinery, when operating at capacity will use approximately 5,000,000 gallons of water every 24 hours, including that required for steaming purposes and the working of the sugar-making equipment. The demands upon the power end has been steadily increasing so that the present requirements of the plant approximates 5,000 horse-power.

The new boiler house is designed along the most modern lines, with the coal bunkers located directly above the front end of the boilers. In the new boiler house there are six 400 h.p. Babcock and Wilcox boilers arranged in two batteries of three boilers each. They are all fitted with the Murphy type of automatic furnace, and equipped with Green fuel economizers, one economizer being used for each battery.

In the fall of last year the company, after considerable study and investigation, decided to carry out an experiment in the use of fuel oil to determine its economic value in comparison to coal. In the new boiler house one of the batteries of three boilers was fitted with oil burning apparatus and each battery was made a distinct and separate operating unit, so that accurate records could be made as to the respective efficiencies. In the old boiler house, where four 375 h.p. and two 200 h.p. Babcock and Wilcox boilers are installed, the use of oil has also been adopted on the larger battery, but no attempt is made to carry out a competition test with the coal fired boilers, as the old boiler house is only equipped with the one economizer for the entire six boilers, and likewise the one set of recording instruments. The boilers in the old power house are equipped with the Jones Underfeed stokers and the time required for alterations to the grates and setting, for the use of oil, is much greater than for the Murphy type. In the latter it is possible to change over from oil to coal, or vice versa, in about 48 hours, while changes on the boilers fitted with the Jones stokers would require nearly a week. The feed pumps in the old boiler house are of the Garrison duplex type, outside packed and fitted with regulators. The new boiler house is equipped with Worthington centrifugal feed water pumps. All condensation from the entire plant is returned to the feed water tanks.

In the new boiler house a very close check is being kept on every detail of operation. Each battery is operated as a distinct unit and daily records are kept of the service obtained from each battery. Records are made of feed water temperature, outlet of each economizer, flue gas temperatures, all parts being equipped with thermometers. The boilers are fitted with Ellison draft gages, so that the furnace draft, draft in the combustion chamber over the fires, and the draft loss in the boilers, are indicated immediately to the man in charge, so that the actual furnace conditions are shown at all times, and any variation from ideal working conditions may be seen and corrected before serious loss is effected.

NEW BOILER HOUSE.

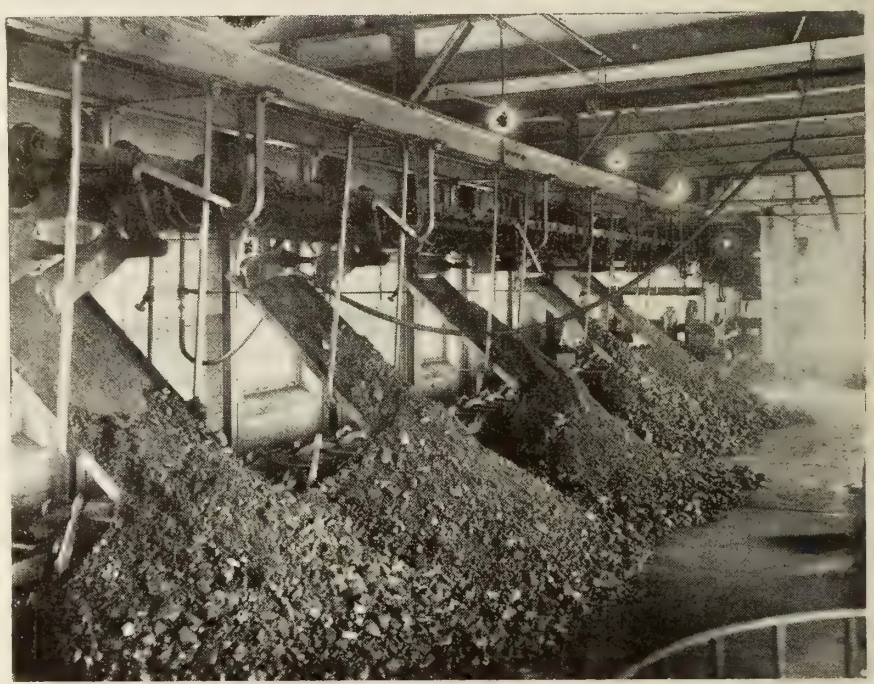
The coal used is American bituminous and, invariably, is shipped to the plant by rail and stored in piles, from where it is placed in carts and weighed on a Fairbanks scale, after which it is passed through a C. W. Hunt crusher and then elevated by means of a C. W. Hunt endless bucket conveyor to the top of the boiler house and dumped into the bunkers for supplying the old boiler house. A cross conveyor is used to deliver the coal to the new boiler house bunkers.

Owing to the heavy demands of the sugar refinery for large quantities of steam and water, it is imperative that no interference take place in the supply, and to insure constant service the system of water feed to the boilers has been installed on the interchangeable system, where front, back or cross connections, eliminate the possibility of temporary shut downs through the failure of some portion of the plant equipment.

For the oil service a 55,000 barrel steel storage tank has been erected some distance from the main building. This tank is provided with steam heating coils at the base and the oil is kept at approximately 60 degrees throughout the winter months. The condensation from this heating system does not return to the boilers, owing to the possible presence of oil in the water, and, therefore, is allowed to pass direct to the sewer.

Adjoining the large storage tank is the small pump house in which is installed a Connersville Lobe centrifugal pump, direct connected to a 7½ h.p. G. E. motor. This unit is located six feet below the base lever of the large storage tank, so that the oil flows to the pump house by gravity. From the pump house the oil is delivered through a 6 inch. pipe to the auxiliary tanks located in a small concrete building adjoining the new boiler house. The floor level of the auxiliary pump house is two feet above the bottom of the 8,000 gallon tanks, the ends of which extend into the pump house, with the greater portion outside the building but covered with three feet of earth. No woodwork, whatever, is used in this building and it is absolutely fireproof.

The conduit from the storage pump house to the auxiliary tanks is located 5½ feet below the ground surface, has a cross sectional area of 12 by 24 inches, and is made of wood, the total length being about 1,000 feet. Concrete manholes are provided every 200 feet. The 4 inch steam line is housed in this conduit and both it and the main delivery line for the oil are supported on rollers to take care of the expansion and the contraction. Heating of the oil storage can be done either with exhaust or live steam. The feed line is equipped with thermometers and safety valves.



COAL CARRIERS AND BUNKERS

Before passing into the three auxiliary tanks, each of which has a capacity of 8,000 gallons, the oil is metered by a Niagara meter. Each tank is fitted with indicators that show at a glance the height of the oil in the different tanks. Each tank is connected to a National Supply Co. rotary oil pump, direct connected to a 5 h.p. motor, one set delivering to the old boiler house, one to the new boiler house, and the other to the char kilns. As is the case in the feed water system, the oil piping layout is so arranged that the delivery is interchangeable, it being possible for any set to deliver oil to either of the other two departments.

Before the oil is delivered to the various burners it is passed through a National Supply Co. oil heater, which is steam heated on the contra-flow principle. From the main feed line the oil, at a temperature of 125 degrees Fah. goes to the burner where it is atomized by superheated steam.

For supplying light and power for the different departments and machines throughout the refinery, three large units are installed; one 600 h.p. Allis-Chalmers corliss engine direct connected to an Allis-Chalmers generator, one 400 h.p. Laurie corliss engine belt connected to two Allis-Chalmers generators; and one 100 h.p. Polson engine belt connected to an Allis-Chalmers generator. All engines are equipped with forced oil circulation.

PARTIAL VIEW OF ENGINE ROOM

Some Interesting Notes on Fuel Economy

The Following Article, Taken From a Report Made by C. E. Stroymeyer, is of Great Value to All Those Interested in Steam Plants

CERTAIN works, such as gas works, smelting works, forges, rolling mills, etc., consume far more fuel for heating purposes than for power. In these works much waste heat escapes up the chimneys of the heating furnaces, which might be saved by passing the waste gases through boilers. Very often this plan is carried out, but it is attended with inconveniences, even dangers, and each case must, therefore, be treated on its merits. Take, for instance, a heating furnace for armour plates. The value of a single plate may perhaps be equal to that of a boiler which might be installed over its furnace. The furnaceman has to watch the temperature and generally rivet his whole attention on the glowing armour plate. Suddenly the fireman tells him that the feed pumps will not work, so that the heating has to be interfered with and the plate perhaps spoilt. Then again the cranes and lifting arrangement around heating furnaces require much space, and it is not always an easy matter to find room for a boiler over or near a heating furnace. Another trouble is that such boilers, instead of being close together and under a central control and easily looked after, are scattered all over the works with isolated attendants, and, as is proved by the relatively frequent explosions of such boilers, they are not cared for as well as they ought to be.

Certain other works are practically pure power consumers; they use very little heat either for furnace work or for boiling and similar processes. These include engineering and hardware works, shipyards, sawmills and woodworking factories, rubber works, corn mills and seed crushers, water works, drainage works, collieries, power stations, electrolytic works and similar ones. Spinning mills, both for cotton and flax, also belong to this class, but they are often combined with weaving and other textile works, which use up the waste steam from the engines, and may form a single system as explained under the next class. It is obvious that if many of these works are grouped together in districts, as is for instance the case in the shipbuilding and certain engineering trades which have settled down on the Wear, Tyne, and Clyde, it may be advantageous to provide power from central stations if, as should be, it can there be produced economically.

In 1915 a brief report was prepared dealing with the coal consumptions of various types of steam engines under practical working conditions. It was then found that, on an average of about 30 cases, compound engines working at about 100 lbs. per square inch, consume about 2-7 lbs. of coal per i.h.p. net. Compound high-pressure engines consume about 1-85 lbs. of coal, and about 1-45 lbs. if superheated steam is used. The last-named consumption amounts to over 5½ tons per horse-power year continuous working, or 8,760 hours.

Most of the works dealt with were cotton spinning mills, which used up as much steam for heating and boiling purposes as would be produced by the burning of about 0-6 lbs of coal per i.h.p. per hour. This addition increased the above averages respectively to 3.3 lbs., 2-45 lbs., and 2-05 lbs. per i.h.p., except in a few cases where the totals were affected in a different way. In these latter works steam for heating, etc., is abstrated between the high and low-pressure systems of the engines. In the high-pressure system it has parted with the theoretical heat equivalent of the work done, and, as the drawn-off steam is required in the works for heating, this portion of the power has been produced at a minimum cost. Assume that a compound engine is developing 50 h.p. in the high-pressure cylinder, which is being supplied with 1,800 lbs. of steam per hour. Then assume that 400 lbs. of steam are withdrawn from the intermediate receiver. This leaves 1,400 lbs. for the low-pressure cylinder, which develops 30 h.p., making a total of 80 h.p. with a steam consumption of 1,800 lbs. This includes 400 lbs. of steam abstrated for heating purposes. A slightly smaller engine of exactly the same type would develop 80 h.p. with a steam consumption of 1,600 lbs. of steam, but the boiler would have to supply 400 additional pounds of steam for heating purposes, making a total of 2,000 lbs. as against 1,800 lbs.

Assuming that 1 lb. of coal evaporates 7½ lbs. of water, then in the above two cases we have in the first case a coal consumption of 3 lbs. of coal per i.h.p., including steam for heating purposes, and in the second case 2 2-3 lbs. for power, and 2-3 lbs. for heating, making a total of 3 1-3 lbs. or 11 per cent. more than in the first case.

The third class includes all those works in which more steam is used for heating and boiling purposes that can be supplied by the power-producing engines—and in many cases full advantage is taken of the fact that, when passing through an engine, steam only parts with the mechanical equivalent of heat for the power produced, as explained above, equal to say 2-5 lbs. of steam or 1-3 lb. of coal per i.h.p., and that all the exhaust steam can still be used for heating purposes. These works, therefore, obtain their power at the very cheapest possible rate, say 1¼ tons per horse-power-year continuous running, which under pre-war conditions of price is even cheaper than the often-quoted Scandinavian rates for electric power of 35s. per horse-power-year. Nevertheless it is these very economical works which have impressed some people as being extremely wasteful, and which have doubtless led to wild statements indulged in, even by a Cabinet Minister, about coal consumption being still as high as from 5 lbs. to 7 lbs. per i.h.p. Take the case of a dye works. It has two batteries of boilers, one high and one low pressure. Each printing machine is driven by its own little high-pressure engine; its own exhaust, supplemented sometimes by steam from low-pressure boilers, warms the drying cylinders. Doubtless each one of these engines consumes say 50 lbs. of steam per i.h.p., but it abstracts neither more nor less than 33,000 × 60 minutes, divided by 778 foot lbs. = 2,545 B.T.U., which are approximately equal to an evaporation of about 2½ lbs. of water and represented by the combustion in the boiler of 1-3 lb. of coal. The 50 lbs. of steam, less about 2-5 lbs. condensed in the engine, due to work done, pass into the back-pressure exhaust pipes, and are fully utilised for heating, boiling, and steaming purposes. The weight of fuel converted into power depends, not on the efficiency of the engine, but on that of the boiler. The weight of steam available for boiling purposes is practically a minimum if no condensation takes place in the engine, i.e., if the steam be superheated and the back pressure fairly high. Misled by the apparent wastefulness of using a number of small high-pressure steam engines throughout the works, occasional owners have been persuaded to replace them by electric motors. These changes have been absolute failures on a very large scale, tens of thousands of pounds having been spent with no other effect than that of increasing the coal bill enormously. The steam required for heating and boiling remained as high as ever, but the power instead of costing only 1-3 lb. of coal, as in the past, had now to be paid for by say 1-5 lbs. and even more.

A great saving of fuel could be effected if the above-mentioned well-established principle were to lead to the combination of works which require only power and such as use steam by heating. For instance, in the salt districts there used to be electrolytic works which used power, and close at hand were salt pans which required steam. The latter could have been worked free of cost with steam from the electrolytic works, or these could have had their power for ¼ lb. of coal per i.h.p., the salt pans paying for the steam used. This principle has to a certain extent been adopted at some power stations which sup-

plied exhaust steam to surrounding buildings for heating purposes. In the textile industries happy combinations of this sort are also not unknown; the spinning and weaving sheds which consume much power, supply steam to auxiliary sheds in which washing, printing, etc., is done, and where, consequently, all the exhaust steam is utilised.

The leading industries of this third class are bleaching, dyeing, calico-printing, weaving, most of the woollen industries, paper making, sugar refining, brewing, soap making, laundry work, and some chemical works.

In view of the increasing scarcity and dearness of coal, and the probability that some works may wish to reorganise their steam plant, it seems desirable to deal with steam and power utilisation in some detail, more particularly as manufacturers are likely to be confused in the near future by the central power stations which have been created by Act of Parliament, who will claim that their supply will prove to be a cheaper one than the production of power at the works. Their claim is based on the assertion that a central power station can use large power units and work more cheaply than the manufacturers who use small units. But this advantage, if it is a real one, must be very small, for it is claimed for moderate-sized dynamos that they work with an efficiency of 90 to 95 per cent., and therefore the possible gain by using very large ones can at best be only a small one. Another claim, which conflicts with the above is that central power stations can produce power with small units at the various collieries by using refuse coal for fuel. This is a doubtful claim, for it is based on the assumption that it will pay to mine the lowest and dirtiest layers of coal which are now, as a rule, left underground. Will it pay to bring it back to bank? If this dirty coal is to be mined and raised together with the good coal, it has to be picked which is an expensive operation; if it can be mined separately, perhaps by working two shifts at the good coal and one shift at the bad coal on the floor, the profit of the third shift would be a negative one. The labor would certainly be equally great, this impure coal being very hard, and its value could hardly exceed 30 per cent. of that on the good coal. Suppose the profit on the good coal to be 10 per cent. or the cost of getting it equal to 90 per cent. of its final value, then the cost of getting the dirty coal would be equally great, and as its value is, say, 30 per cent. of the good coal the loss would be 60 per cent., which is 200 per cent. on the value of the refuse.

Another claim advocated by central stations is that their load factor will be very small and with it their capital outlay. This comparison is valid only between central stations, but not between the works who would use their power. Those which run night and day have no peak load and are under even more favorable conditions than central power stations, who very naturally try to capture them so as to reduce their peak loads. Other works which run for, say, only eight hours a day have one unalterable peak load during these eight hurs, and their capital outlay on motors, etc., is proportioned to this peak load, which is 200 per cent. in excess of the average load. It does not affect their capital outlay whether the central station has or has not a heavy peak load, but it may affect the charge which the central station has to make for its supply.

All things being equal a factory ought certainly to be able to produce its power more cheaply than the price for which it could be supplied from outside, but there are, of course, cases where the absence of a good water supply, the saving of engine and boiler space, would make it profitable to obtain an outside supply.

In the following remarks it is proposed to deal only with power production at the individual works.

As far as can be ascertained electric losses are about equal to the belt and shaft losses in a well-planned factory, but unquestionably motors for driving are a great convenience, and the capital outlay involved in their adoption is very often justified, more particularly as their upkeep is small.

It is claimed for motors that they run at a very uniform speed, but this regularity depends entirely on the governing devices of the central engine, which in power stations are not always of the best. At any rate, as long as the central engine has a good governor it does not matter, as regards speed constancy, whether the power is transmitted electrically or by shafting. Irregularities no doubt occur if powerful machines are coupled to the ends of long driving shafts and are suddenly thrown in and out of work, but this is merely a bad arrangement and not an unavoidable evil. Even electric transmission would be similarly affected in a badly-designed factory.

A more important question, however, is that of steam economy, and whether reciprocating engines, turbines, or internal-combustion engines should be used; also whether it is better to use one large central engine or a number of small ones.

As regards internal combustion engines, it should be pointed out that theoretically, and to a certain extent practically, they are at present the most efficient power producers from fuel, and if it be intended to use up the waste heat from these engines there should be no insurmountable difficulty in passing their waste gases along pipes to those points where heat is required in the same way as steam is now carried through the work. It does not appear that this idea has been carried out, and it is certainly associated with the inconvenience that hot gases cannot be blown into water for boiling purposes, and, therefore, costly heating coils would have to be provided; but these hot waste gases might prove very efficient for drying purposes. They could be, and are, used for heating water in boilers and heaters.

As regards steam engines there can be little doubt that turbines will come largely into use, not only because their exhaust steam contains no grease, and can be used for almost any purpose without injuring the goods, but also because turbines are now so constructed that steam can be drawn from them at any convenient pressure and up to almost any amount.

Two extreme cases present themselves: Firstly, factories in which more steam is required for heating, etc., than can be passed through the engine; secondly, factories in which only a small portion of the steam passing through the engine is used for heating, etc.

It is already been explained that an engine whose waste steam is utilised is using only 2-5 lbs. of steam per horse-power hour, equivalent to one-third pound of coal. Such an engine is merely abstracting the power required on the spot, and passes on the surplus power or steam. It acts like a pulley belt on a main driving shaft of a factory. That shaft may be carrying a few hundred horse-power to the end of a large shed, and though this power passes through a number of pulleys, each one only abstracts the exact amount required locally. Therefore, as regards cost of power it does not matter whether a high back-pressure engine whose exhaust steam is used for heating is an efficient engine or not; it unalterably supplies power at a cost of, say, 2-5 lbs. of steam or one-third pound of coal.

In order to obviate the use of supplementary low-pressure mains, or where these are absent, the small engines which drive single machines which have to be heated by steam are made purposely inefficient, or rather they make themselves inefficient by a rise of the back pressure, so that consumptions of 80 lbs. or perhaps even 100 lbs. of steam per horse-power could be found in some works. Suppose now that a machine which is heated by the waste steam is improved so as to require less steam, then the inefficient engine will have to be replaced by a more efficient one, otherwise an enormous waste will result, due to blowing the exhaust steam into the air. As the steam demand is still further curtailed, the economy of the engine will have to be still further increased until a point is reached where the surplus steam must be dealt with efficiently by condensation.

This case is represented by cotton mills and similar works, and an occasional practice is to tap the engine for intermediate pressure steam. For convenience of studying the question we may imagine the driving shaft of such a factory to be coupled to two engines, the one of the most economic design, with superheaters and surface condensers, and the other one so designed that it exhausts into a low-pressure main. This one would be an inefficient engine for although it is converting only 2-5 lbs. of steam into power it is actually consuming anything up to 100 lbs. It will

however, be seen that the more efficient this wasteful engine can be made, the better.

Assume that the total power required is 800 i.h.p., and that the works also require 6,000 lbs. of steam per hour. Assume that the condensing engine, or the condensing part of the engine, consumes 15 lbs. per horse-power hour, and that the inefficient part consumes 62.5 lbs. per horse-power hour; then as the inefficient engine abstracts 2.5 lbs. for power, there remains 60 lbs. for heating per i.h.p., and therefore the inefficient engine must develop 100 h.p., while 700 h.p. are developed by the efficient engine. The steam consumption will be $700 \times 15 + 100 \times 62.5 = 16{,}750$ lbs. per hour. Subtracting the 4,000 lbs. for heating, the steam consumption is 13.44 lbs. per i.h.p. Assume now that the inefficient engine requires only 32.5 lbs. per horse-power hour, of which 2.5 are converted into power and 30 lbs. are passed away for heating purposes. Again, as 6,000 lbs. are required for this purpose, the inefficient engine must develop 200 h.p., leaving 600 h.p. to be developed by the efficient engine. The steam consumption will now be $600 \times 15 + 200 \times 32.5 = 15{,}500$ lbs. per hour. Subtracting the 6,000 lbs. for heating, the steam consumption is reduced to 11.87 lbs. per i.h.p.

Thus by drawing steam from the engine at a point down to which it has not been working economically—for instance, at a point where the pressure is still fairly high, a saving of 10 per cent. on the cost of power can be effected. If the steam is tapped at the lower pressure the saving would be .21 per cent.

Doubtless turbine designers could arrange matters, partly by increasing the boiler pressure and the superheat, so that the high-pressure part of the engine would work at a maximum efficiency, but in any case it will always be desirable to have the back pressure as low as possible, and that means that the distributing pipes of the exhaust should be of a reasonably large diameter.

Pipe System Lagging, &c.	A. Condensation per sq. ft.
Bare cast iron	1.169
Bare and 2" Kieselguhr	0.226
Bare and 2¾" Hairfelt	0.188
Bare and ¾" Cork	0.198

Pipe	B. Condensation per sq. ft.	Pipe	Ratio of A and B Pipes
132.0	0.937	145.0	1:1.10
25.5	0.166	25.7	1:1.01
21.02	0.125	19.4	1:.092
22.4	0.152	23.6	1:1.05

In the foregoing remarks it has been taken for granted that it will be found more advantageous, even in bleaching and dyeing works, to produce the power in a central engine and distribute it either electrically or by shifting, than to have small steam engines attached to the various machines and to utilize their exhaust steam locally.

One of the considerations which led to this view was that as it is practically impossible to arrange that the weight of the exhaust steam shall always be exactly what is required for heating, and because most of these machines have to be heated up before their own little engine turns them, it is necessary to provide a system of low-pressure mains, in addition to the high-pressure mains, and then of course the loss by radiation must be greater than it would be with only one system of pipes. The other consideration is that even if there were no low-pressure distributing pipes, no serious radiation losses would result if the small high-pressure pipes were replaced by large low-pressure ones. As equal weights of steam are required, the sectional areas of low-pressure pipes would have to be made larger than the high-pressure ones in the inverse ratio of the two pressures. The diameters would, therefore, be in the inverse ratio of the square roots of the pressures, and the radiation would be in the same proportion if the temperature were the same; but the high-pressure steam has a higher temperature than the low-pressure steam, and also a greater density, which should increase the rate of heat transmission in proportion to the increased density. Mr. A. Fischer's experiments on this subject indicate no such effect in one comparison, and only a slight one in three others, and taking the average of his four comparisons the conclusion to be drawn is that the radiation losses instead of increasing with decreasing pressures are sensibly the same for high- and low-pressure pipes, provided that their diameters are made to the inverse ratios of the square roots of the respective absolute pressures. As an example, take a pipe which has to deliver 6,000 lbs. of steam per hour at a velocity of 50 ft. per second. In case A let the absolute pressure be 152 lbs., the corresponding temperature being 360 degs. Fah. and the volume of 1 lb. 3.04 cub. ft. In case B, the absolute pressure is 76 lbs., the temperature 307 degs. Fah., and the volume of 1 lb. is 5.76 cub. ft. The respective diameters of pipes will be 4.32 in. and 5.94 in., and the surfaces of 100 ft. of these pipes would be respectively 113 sq. ft. and 155 sq. ft. The estimated condensations are contained in Table I.

The average ratio shows a slightly increased condensation of 2 per cent. for the low pressure (B) pipes. This is of no practical importance, and when rearranging a factory the relative merits as regards radiation of high and low pressure exhaust steam need not be gone into, provided the low-pressure pipes are made larger than the high-pressure ones as explained above. The choice of diameter depends on the loss by radiation and on the loss in the engine due to back pressure.

The West Penn Power Co. of Pittsburgh, Pa., have applied for charters for building power distribution lines throughout Clarion County. The old 33-cycle current will be replaced by standard 60 cycle. Many mines and industrial companies are expected to take advantage of the new service and electric current.

HANDLING ASHES FROM TWENTY-TWO BOILERS BY CENTRIFUGAL PUMPS*

By using water to wash away ashes from twenty-two 500-h. p. Babcock & Wilcocks boilers in the Lake Linden (Mich.) power plant of the Calumet & Hecla Mining Company only two eight-hour shifts of two men are required. In this system the ashes are dropped from ash hoppers into a 30 in. (75 cm.) semi-circular steel trough, supported on a metal framework as shown in the accompanying photograph. The ash hoppers are large enough to hold the ashes from two cleanings of the boiler under any conditions, and if the coal is of a fair quality, the hoppers will hold three cleanings of ashes. The pipe leading into the trough is an 8 in. (21 cm.) water main, and after the valve in this main has been opened the ashes are gradually dropped into the trough and washed away to centrally located pumps. The troughs are arranged in the shape of a letter H with boilers along each side and with the dumping place for the ashes in the center. The ashes are washed on to a grating from each side and dropped down into duplicate centrifugal pumps each of which is of sufficient capacity to handle the ashes. Any large pieces of clinker are broken up when they get on to the straining bars.

The storage capacity of the ash hoppers permits the use of only two shifts of ash handlers, each working eight hours. Two men work from 7 a. m. to 4 p. m., and two others work from 7 p. m. to 4 a. m., with one hour off each shift for meals. This leaves a three-hour stretch between each shift and two meal hours when there are no ash handlers on duty. In this way it requires only thirty-two man-hours to handle about 50 tons of ashes, which is at the rate of more than 1.5 tons of ashes per man-hour. This proved a very convenient and economical method of handling the ashes in the power house, but the principal gain over the old ash-car system is in the elimination of the cost and inconvenience of attempting to remove the ashes in cars.

The pumps each have a maximum capacity of 1,800 gal. per minute (110 l. per second) against a hydraulic head of 30 ft. (9 m.). Each pump is driven at 510 r.p.m. by the belt from a 50-hp., 440-volt., three-phase, 25-cycle, 750-r.p.m. squirrel-cage induction motor. The pump impellers were specially designed of hard cast iron to withstand the action of the ashes. It has been found that the impellers have to be renewed about every seventh week, and the cost of every such change is about $30. The pumps are so connected that they may be operated independently or together, as desired.

ARVID BAALACK,
Mechanical Engineer.
Calumet & Hecla Mining Co.,
Calumet, Mich.

*Electrical Review.

A Paper on Modern Boiler Practice

The Following Paper Read Before the Engineering Institute of Canada Gives a Very Complete Account of the Trend in Modern Boiler Design and the Economies Effected Thereby

By F. A. COMBE, A.M.E.I.C., Consulting Engineer

(Continued from last issue.)

Modern Boiler Design

In modern direct fired boiler design, the principle of higher gas velocities is also adopted where advantage can be gained, and the tendency is to reduce the heating surface, or increase the evaporative rate, of the boiler proper employing it primarily for steam raising, and adding additional independent surface for water heating, in order to get a more efficient total heat transfer by the increase in temperature difference for a portion of the total heating surface. This practically means combining a boiler and economizer in one unit proportioned to give the highest efficiency and resulting in less total heating surface and considerable saving in space and of many of the losses incident to the use of separate economizers.

A cross section of such a boiler is given in Fig. 5, a study of which will show that the maximum effect of direct radiation is obtained while the hot gases, entering the tube bank at the uptake end and passing at right angles across the staggered rows of tubes at high velocity through the long passages of the boilers and economizer fulfil conditions conducive to high efficiency.

In Figs. 6 and 7 are given two views of one of four boilers of this type recently installed at the Montreal Tramway Company's plant at Hochelaga, being the largest boilers in Canada. Each of these boilers contains 5,625 square feet heating surface in the boiler proper or steam raising section and 2,909 square feet economizer or water heating section, giving a total heating surface for the unit of 8,534. These boilers are capable of easily generating over 40,000 lbs. steam per hour at 200 lbs. per square inch steam pressure and 150 deg. F. superheat from a feed water temperature of 120 deg. F. It will be seen that the equivalent evaporative rate for the boiler proper is as high as 8.75 lbs. per square foot heating surface, or 5.75 lbs. for the whole unit, in spite of which, it is possible to reduce the temperature of the gases below what it would be with a standard boiler of 3.5 lbs. normal evaporative rate, that is to say, with considerably more heating surface. Each unit is steel cased, lined with special non-conducting material to minimize air leakage and radiation, and fitted with double chain grate stokers, having a total grate area of 224 square feet.

An interesting feature in connection with these units is the draft apparatus comprising a specially formed stack for each pair of boilers, having a constricted throat into which a high pressure air blast is delivered through a nozzle from a small fan; the action being that of an ejector, inducing a suction in the flue connections to the boilers.

A complete test of these boilers has not been made, but in a paper read before the British Institute of Civil Engineers about a year ago, details are given of a test made on a boiler of this type, approximately the same capacity, but containing 4,963 sq. ft. boiler heating surface and 4,086 sq. ft. economizer surface, in which a thermal efficiency of 88.33 per cent. for the unit was obtained, the exit gas temperature being 293 deg. F., and the evaporation per sq. ft. boiler heating surface 9.53; while another test made in 1916 at the Hague municipal plant with a slightly smaller unit gave an overall efficiency of 88.41 per cent. It is probably not possible to obtain such efficiencies with the coals usually obtainable here, but it indicates that a very high efficiency in steam generating equipment has been reached.

Boiler Efficiency

It is to be understood that in a boiler of the usual construction, where the temperature of the water in the boiler is practically at the temperature of the steam, it is obviously impossible to reduce the temperature of gases below that of saturated steam at the pressure carried, in fact, while it is possible to add heating surface to reduce the gas tem-

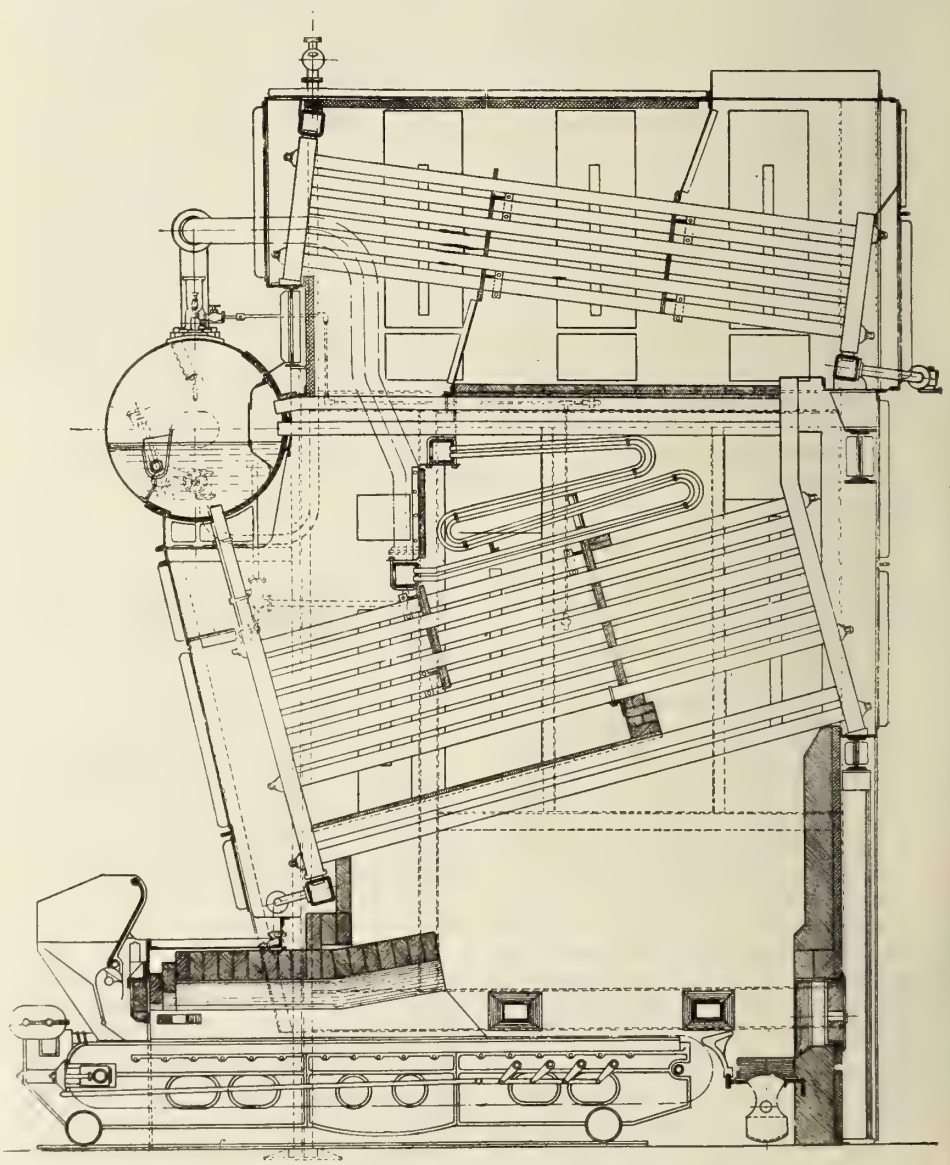


FIG. 5.

perature below 100 deg. above the steam, the very low transfer rate resulting from such a small temperature difference in the last passes of the boiler does not warrant the expense of the additional heating surface.

In a great number of published boiler tests the exit gas temperature is given as near the temperature of the steam, but such temperatures will usually be found to have been incorrectly measured, owing either to air leakage around the boiler damper or to radiation, as pointed out earlier in the paper. The saturated steam temperature referred to in this connection must not be confused with the superheated steam temperature leaving the boiler when a superheater is installed, as the exit gas temperature is often considerably below the superheated steam temperature, the superheater coils being placed in the high temperature gas zone.

For a proper consideration of the efficiency of a boiler, the steam pressure carried must be taken into account. It is not fair to compare the efficiency of a boiler operating at, say 100 lbs. pressure with a boiler operating at 200 lbs. pressure where the temperature of the boiler heating surfaces differs by 50 deg. and the necessarily increased flue gas temperature results in a greater heat loss with a coresponding reduction in the efficiency as usually measured. For this reason it has been proposed that the efficiency of a boiler be measured in terms of its "true" efficiency, or the ratio of the heat actually absorbed to the heat theoretically available for absorption, which latter value corresponds to a reduction of the temperature of the flue gas to the temperature of the steam. In the same way allowance is made in England and Europe for the burning of the hydrogen in the coal which leaves a boiler in the form of superheated steam, but which in a calorimetric analysis of the coal is condensed and its latent heat added in the heat value obtained. The revised heat value, corrected for the hydrogen content is termed the lower or nett calorific value of the fuel.

Stokers and Fuels

The greatest factor in the overall efficiency of a boiler unit lies, of course, in the combustion of fuel in the furnace. It is not within the scope of this paper to deal with the theory of combustion, and a great amount of literature has already been published on the subject, but one of the chief causes for inefficient combustion lies in the faulty design of the furnace and the lack of volume provided for the proper mixing and burning of the gases before striking the cool boiler heating surface. With hand firing under small boilers, the skill of the fireman in keeping an even, regular fire is also a big factor, but with larger boilers and automatic stokers a great deal of this work is taken care of, and, if operated intelligently, with the aid of recording instruments, a high degree of efficiency can be maintained.

The advantage of automatic stokers for plants of over 500 boiler horsepower has now become generally recognized and the only question for the engineer to decide is what stoker to instal. No type is suitable for all coals and conditions of service. Where boilers of a nominal evaporative rate of 3½ lbs. are to be forced to high capacities or where anthracite coal is to be burned, forced draft stokers will probably have to be used and in considering high overloads, allowance should be made for the extra upkeep cost generally entailed and the consequent need for reserve boilers.

Difficulties have frequently occurred through the installation of a chimney of insufficient height to freely take away the products of combustion from the furnace of a forced draft stoker when operating at a high rate, the assumption having been made that as there was an air pressure under the grate, very little chimney draft was necessary. The result has been that a pressure has built up in the furnace, causing excessive burning up of the brick walls by reason of the hot gases being forced into the cracks. A definite suction, say 1-10 inch of water, should always be maintained in a furnace of this type and as with boilers forced considerably above their rating the resistance through the boiler itself becomes considerable, it does not allow of much reduction in the height of chimney to be provided.

For steady running on continuous moderate loads, the natural draft stoker will probably give the best satisfaction; of this type the chain grate is the most common and probably the most logical way of burning high volatile coals, possessing the advantage of simplicity and ease of adjustment to suit the particular grade of coal and load conditions.

In view of the attention now being paid to the utilization of the Western Canadian lignites, it may be of interest to mention that a chain grate stoker was installed in 1913 in the University of Alberta, having a special setting of arches similar to that used in England and Europe and very excellent results have been obtained with the Edmonton lignites on this stoker, so much so, in fact, that several engineers in the Western cities have modified their standard stoker settings as far as possible to conform to it. A similarly set stoker has recently been installed at Moose Jaw, where the higher moisture Saskatchewan lignites will be burned, and from information received it promises to also prove satisfactory.

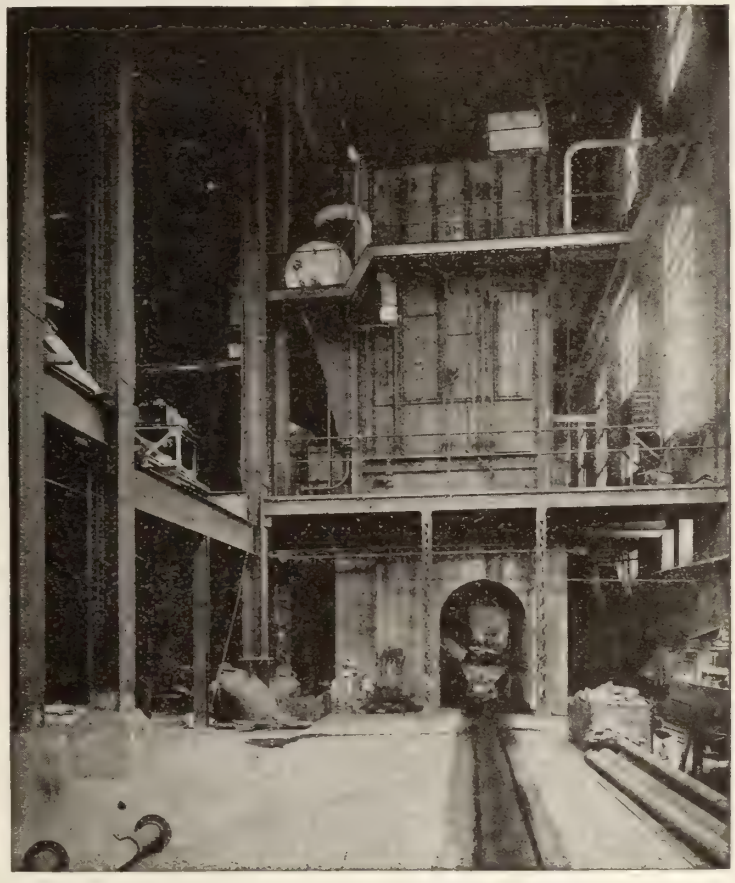


FIG. 6.

Fig. 8 shows the typical setting; the essential feature being the centre and back arch construction, which, by deflecting the gases and reflecting the radiated heat towards the front of the grate, drives off the moisture from the freshly fed coal. A front coking arch of the standard form is of no use for this class of fuel, as the excessive moisture prevents it getting hot and so hinders the ignition. This arrangement of arches is hardly suitable for burning higher grade bituminous coal, as the centre arch

would generally not stand up for long against the higher furnace temperatures, but it has been used extensively for low volatile or semi-anthracite coals, which cannot be burned satisfactorily with a natural draft chain grate stoker with the standard arch construction.

Oil and natural gas make excellent fuels in that high combustion efficiency and regulation can be easily attained with low operating cost and with increased cleanliness in the boiler room, but in Canada, oil is generally only economically available on the west coast, while natural gas is confined to but few localities, and the supply limited.

Powdered coal has been receiving considerable attention in recent years. At present the plant required for, and the cost of crushing, pulverizing and drying has generally limited its use to industrial plants where the fuel can be used in heating furnaces in addition to the boilers. For satisfactory operation, the coal must be pulverized to a degree equivalent to 95 per cent. through a 100 mesh sieve and should be dried to contain not more than 1 per cent. moisture.

A form of extension furnace is commonly used when fired under a boiler, the coal dust being fed through one or more nozzles into the furnace in a fine cloud. Air for combustion is partly carried in with the fuel and partly supplied through annular spaces around the nozzles, either under pressure or simply drawn in by suction. When properly regulated a high efficiency can be obtained and coal utilized which would be difficult to burn in the ordinary way, but care must be taken to avoid unconsumed coal being carried over into the boiler and also in handling the ash which settles in a molten slag condition to the bottom of the furnace, by reason of the high temperature attained, and which, if allowed to solidify, is very difficult to remove. As the finely powdered coal is in a highly combustible state, proper precautions must also be taken in the storing, distribution and firing to prevent explosions. Brickwork trouble from the high furnace temperature has been one of the difficulties to overcome with the burning of this fuel.

Blast furnace gas and by-product coke oven gas can be used to great advantage under boilers, a considerable advance having been made during the last few years in the efficiency obtained. This has chiefly been brought about through improvements in furnace design and types of burners, while the application of boilers of a similar design to those used for waste heat work now promises a still greater advance in this field.

Selection of Boilers

The best type of boiler to use in any plant must depend upon the conditions of service. For continuous steady loads such as in manufacturing plants where generally the boiler room does not receive special attention for operation, the standard boiler of 3½ lbs. evaporation per square foot heating surface will usually be found to be the best, with an installation of the regular separate cast iron economizer where conditions show that a saving will be made, and this is usually an easy matter to determine. An automatic stoker should also be chosen with a view to continuous steady service with the minimum cost for upkeep and repairs to stoker and furnace brickwork, and suitable for the particular class of coal which it is intended to burn.

In many manufacturing plants some kind of refuse can be utilized as fuel which usually requires a special form of furnace. Probably saw mills and pulp mills are the chief plants in this country where refuse is burned, being then in the form of hogged bark and edgings; and a straight extension furnace of the Dutch oven type is generally found to be the best, with a large surface of hot brickwork to drive off the moisture, when, as is usually the case, the wood is wet. Step grate furnaces are largely used in Europe. To obtain the best results, the areas and proportions of the furnace must be carefully designed; very often the chief consideration appears to be merely to get rid of the refuse without any effort to obtain the maximum efficiency, with the result that a considerable amount of coal is burned as an auxiliary which would not be necessary if the waste were properly utilized.

For large central stations and public service power plants, where floor space is of more value and load conditions special, the selection of boilers and stokers requires more study. In this service the load is usually very variable with short heavy peaks and a more elaborate layout and system of operation is justified. The general practice for these plants in the United States has been to get more and more out of the standard boilers of 10 sq. ft. per horsepower normal rating, in conjunction with regular economizers, by forcing them considerably during peaks. Particular attention is paid to good boiler and furnace design, and although the efficiency falls off at the high rates of driving, and the upkeep cost of brickwork and stoker is considerable, owing to the high furnace temperature, the practice has been considered warranted by the advantages gained. In these plants special precautions are taken to supply pure feed water, while expert attention is necessary for successful operation. In England and Europe the practice tends towards the use of boilers of the tvpe shown in Fig. 5.

The proper size of boilers to instal is, of course, governed by the size of the plant and the load conditions and no fixed rules can be laid down. In the United States there are some very large units, considerably larger than any installed in other countries, the Stirling boilers at the Detroit Edison Company's plant, shown in Fig. 2 having a normal rating of 2,365 boiler horsepower based on 10 square feet of heating surface per horsepower. In Canadian plants it will probably be a considerable time before units larger than 1,000 or 1,200 horsepower are warranted. There is a disadvantage in putting "too many eggs in one basket," as the failure of a tube or other cause of shut down means cutting off a big source of power and wasting a lot of coal, but in operation the efficiency is increased through a reduction of radiation and other losses over several smaller units.

Operation

There are comparatively few plants in Canada where a separate water purifying apparatus is installed; for small plants where moderate loads are carried on the boilers, some form of compound can be fed in with the feed water suitable for the nature of the water used, but as pointed out earlier, the boiler is not the proper place to treat the water and where the highest efficiency is desired or where boilers are to be run at high rates of evaporation, it is essential that the water be treated in a separate apparatus. In the most modern stations, the tendency seems to be towards the use of evaporators to purify the make-up feed water to ensure the absolute removal of all impurities, as in marine practice. It is not sufficient that heavy scale be prevented from actually adhering to the metal of the heating surface, as floating scale, which may temporarily lodge in one place, is apt to cause burning under high rates of evaporation. Oil is one of the most prolific causes for trouble in a boiler, the least sign of it often causing blisters on the boiler heating surface exposed to the furnace heat, even under moderate loads.

A trouble which may arise, unless proper precautions are taken, especially when using as feed water, the condensed steam from a surface condenser, is corrosion in the boiler and economizer from the air entrained in the water. The latest investigations indicate that it is the CO_2, and not the oxygen, present in the air which is the active agent in the corrosion and it is necessary that this be got rid of before feeding the water to the boilers, either by heating and the provision of efficient air escape pipes, or by chemical treatment with calcium hydrate (slaked lime). The use of air pumps which draw off the water and vapor together from surface condensers are particularly undesirable when the condensate is to be used for boiler feed as this water is strongly impregnated with air.

For efficiency and capacity it is also necessary that the outside of the tube heating surface be kept free from soot, and mechanical soot blowers are now being used to a great extent as an easy means of ensuring more regular and effective cleaning than is generally possible with the somewhat arduous task of hand cleaning with a steam lance.

While it is of first importance that good boilers and furnaces be installed, their value is to a great extent lost unless the boilers are kept clean and the plant efficiently run, and it is impossible to expect intelligent operation unless instruments and meters are provided as a guide for the operator. The old idea of

the fireman telling by a look at the furnace if coal was being completely burned is obsolete, and, after all, the furnace is only one factor of efficient operation, although the greatest. Some modern boiler rooms are now fitted with regular control boards and instruments by which losses can be immediately detected and located and there is no doubt that the cost of such indicators and the extra supervision entailed is saved many times over in the yearly fuel consumption. Coal scales and water meters are necessary for purposes of record and check on deliveries, yet they do not by themselves ensure efficiency in operation. If thermometers, draft gauges, flue-gas analysers, etc., are used intelligently as a guide for operation, the coal consumption will take care of itself; and with a proper log system, continuous records can be made over extended periods under actual operating conditions which are of real practical value and not subject to the often misleading conclusions resulting from short tests.

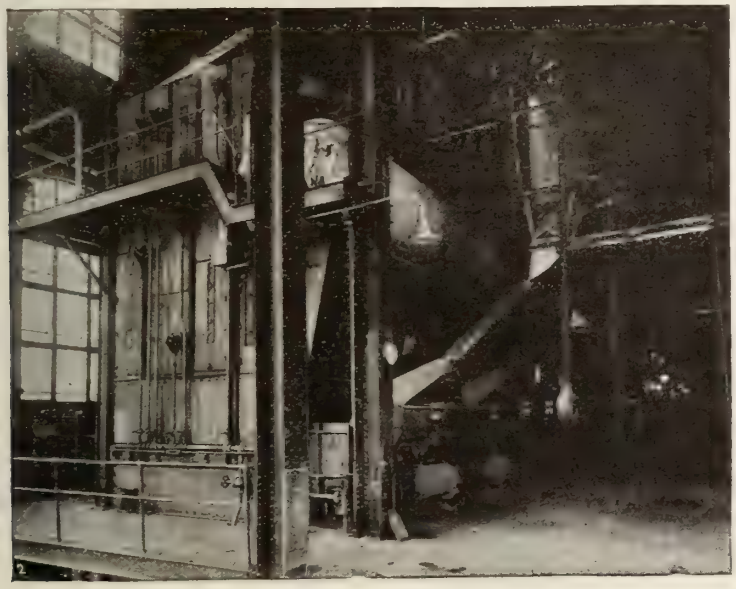


FIG. 7.

Probable Future Development

It does not seem likely that there will be any great departure in the near future from the present general design of boilers, but the probable adoption of steam at a higher pressure and temperature in turbines will lead to a certain modification with poossibly a more pronounced segregation of the evaporating and water heating surfaces. Several boilers of the type shown in Fig. 5 are already in service in England, and the United States, under a working steam pressure of 350 lbs. per square inch and a steam temperature of 700 to 750 deg. F., and others are under experimentation up to pressures of 500 and 600 lbs. These higher pressures, of course, prohibit the use of any flat stayed surfaces in boiler construction, and the very best material and workmanship must be employed; but from a constructional and operating point of view, higher pressures and temperatures will not be governed by boiler limitations.

With regard to methods of construction, welding of joints in drums does not at present seem likely to replace riveting, although it is receiving some attention and is used in conjunction with riveting on some marine boiler work.

During the last few years, several of the Canadian provinces have put into force very complete regulations to ensure safety in boiler construction and operation and an effort is being made for the adoption of a uniform code of laws for the whole Dominion. The advantage of this, in the protection it would afford to steam users, and the possibility of standardization for manufacturers would be very great; while if, in addition, a system of control, propaganda and educational work could be carried out by a fuel administration department, it would be of inestimable value to power plant operators and lead to conservation of our fuel resources which form a very large part in the cost of power production.

C. A. S. E. CONVENTION

Members of Exhibitors Association

Galt Foundry Co., Galt.
E. Leonard & Sons, London.
Equipment Specialties, Toronto.
Thompson-Gordon Co., Hamilton.
E. J. Philip & Son, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Empire Mfg. Co., London.
Allen General Supplies, Toronto.
The Canadian Manufacturer, Toronto.
C. B. Turner & Co., Toronto.
Chapman Double Ball Bearing Co., Toronto.
Boiler Repair & Grate Bar Co., Toronto.
Canadian Fairbanks-Morse Co., Toronto.
Canadian Allis-Chalmers, Ltd., Toronto.
H. Mueller Mfg. Co., Sarnia.
Boiler Inspection Dept. of Ontario.
Dart Union Co., Toronto.
Power House, Toronto.
Canadian Hauck Mfg. Co., Port Hope.
Garlock Packing Co., Hamilton.
Goldie & McCulloch Co., Galt.
Dunlop Tire & Rubber Co., Toronto.
France Packing Co., Tacony, Pa.
Darling Bros. Montreal.
Jenkins Bros., Montreal.
Geo. W. Cole, Ltd., Toronto.
C. A. Dunham Co., Toronto.
W. R. Sexton, Toronto.
Dearborn Chemical Co., Toronto.
Quaker City Rubber Co., Philadelphia.
Lunkenheimer Co., Cincinnati.
Power, New York.
V. D. Anderson Co., Cleveland.

Officers of Exhibitors Association

Honorary President—J. McCalley, 20 Riddell St., Woodstock.

President—James S. Mock, Montreal.

1st Vice-President—J. A. Fitzgerald, Montreal.

2nd Vice-President—Grant Cole, Toronto.

Secretary—Gordon Keith, 51 Wellington St. W., Toronto.

Assistant Secretary—Geo. W. Wilkinson, Philadelphia.

Treasurer—Lloyd M. Archibald, Toronto.

Exhibition Committee—A. Betton (chairman), Edward Hanson, Howard Fletcher.

Entertainment Committee—E. B. Curzon (Chairman), J. Thompson and Earl Gordon.

Reception Committee—W. R. Sexton (chairman), Harold Burbridge and W. W. Cockfield.

Next Exhibition will be held at Woodstock, June 22-24, 1920.

STEAM USED BY JETS

A recent article in "Engineering" gave some interesting results of investigations made into the amount of steam used by jets. The average figure is very much above what is usually estimated as the consumption of apparatus for increasing draught. The tests were made with nineteen varieties of boiler-firing apparatus in which steam jets are used, and the highest consumption noted was 21.4 per cent. of the steam produced. The lowest was 0.5 per cent., and the average 6.6 per cent. These figures should furnish some food for interesting thought.

Oil-Burning Furnaces is the title of a very interesting catalogue just received from the Gilbert & Barker Mfg. Co., of Springfield, Mass. There is an abundance of illustrations, showing clearly the details of the company's burners and furnace equipment, and there is some reading matter that sums up the value of this class of equipment in an especially clear and concise manner.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

THERE have been so many letters coming into this office with requests for instruction in the work for the graded certificate examination, that the need for a course has been strongly felt. In contemplating the work necessary, it has been realized that for some of those who want the more advanced grade, there will of necessity be a going over of old ground. However, the great majority of our correspondents wish to start from the beginning, and perhaps it will do no harm for some of the others to brush up their elementary knowledge.

The first thing taken up will be mathematics, and it will be assumed that every one can do the fundamental operations of addition, subtraction, multiplication and division. The course will, therefore, take up primarily vulgar fractions, go on to decimals, involution, evolution and the necessary mensuration which will be required. Having covered that groundwork, we will apply the knowledge gained to actual engineering problems, covering the boiler, steam engine, refrigerating and air compressor. The electric end will probably be dealt with separately and concurrently.

As this course is being undertaken for the benefit of our readers who will be candidates, it is hoped that if any points arise from time to time which are not perfectly clear, that they will not hesitate to write and ask for a fuller explanation. It is difficult sometimes to make a particular meaning clear to all, and the writer realizes this, having spent probably as much time as most in trying to see through an obscure point which was perfectly clear to others. On the other hand, there is nothing in the proposed examinations which should hold any terrors for the average man, and the bogey of formulae, and high technique, which is freely paraded, will be found to be a very harmless animal when approached boldly. Any man who has the initiative and confidence in himself to understand the handling of a power plant, has got the necessary intelligence to master the technical end of his work, if he applies himself to it. The obscure points will become clear, the seemingly hopeless will become simple, and the whole thing become of absorbing interest. The preliminary work is dry, we must admit. However, to be dry is the fashion now, and we will try and make it not too bad. Now that the preliminaries are over, let's go.

Vulgar Fractions

Vulgar fractions, or common fractions, are so called to distinguish them from the decimal fraction. The operations performed with them are those of addition, subtraction, multiplication and division, involution and evolution. A complete knowledge of the various steps required to perform these operations is absolutely necessary in the carrying out of calculations connected with the steam engine and boiler. While generally more complicated than the decimal, there are cases where their use is more convenient than the use of the decimal, owing to the ability to cancel, and thus simplify the work.

A fraction consists of two numbers, with a vinculum or dividing line between, the number on the top of the line, on the left hand side of the line if it is vertical, being known as the numerator, and the lower or right hand side number being called the denominator. The numerator expresses the quantity of parts, and the denominator the number of parts in a whole number. For instance, ½ or ½ expresses the fact that a whole number is divided into two parts and the fraction is one of the two parts. 13/64 similarly expresses that a number is divided into 64 parts, of which we are considering 13. The numerator subtracted from the denominator expresses the number of parts remaining, or in other words, the number that must be added to the numerator to make one unit. Thus 64 — 13 = 51 so that 13 + 51 = 64 and 64 1/64 parts makes one whole number. (An article by the writer which appeared in the December 20 issue of POWER HOUSE, entitled: "An Explanation of the Construction of Formulae," will be of use to the student at this stage.)

Fractions may be proper, improper, simple or compound. A fraction which is less than a whole number, such as ¾, ⅞, or 15-16 is a proper fraction. A fraction which is more than a whole number such as 16-15, 4-3, 3-2, etc., is an improper fraction.

A simple fraction is one that involves merely a numerator and denominator, such as we have seen, while a compound fraction includes several operations, such as:

$$\frac{\frac{3}{4}}{\frac{7}{8}} \quad \text{or} \quad \frac{\frac{1}{2}\left(\frac{7}{8}+\frac{1}{3}\right)}{\frac{3}{4}\left(\frac{9}{16}+\frac{7}{8}\right)} \div \frac{15}{16}$$

We will not consider these complications right away, but will explain the simpler operations first.

Supposing we wish to add together a number of fractions, say:

$$\frac{3}{4}+\frac{7}{8}+\frac{15}{16}+\frac{9}{32}$$

Before we can do so we must first find a common denominator. That is, we must find a way of expressing each fraction in the same terms, either 4ths, 8ths, 16ths, or 32nds, whichever is the most convenient. We proceed in this manner.

Take all the denominators thus:

4., 8., 16., 32

Divide the first one into each of the others:

$$4 \,|\, 8.\ 16.\ 32$$
$$2.\ 4.\ 8$$

Take the first figure of the quotient 2 and divide it into the remaining figures of the quotient:

$$4 \,|\, 8.\ 16.\ 32$$
$$2 \,|\, 4.\ 8$$
$$2\ \ 4$$

Repeat this operation with the remaining two figures:

$$4 \,|\, 8\ \ 16.\ 32$$
$$2 \,|\, 4.\ 8$$
$$2 \,|\, 4$$
$$2$$

Now multiply together all the divisors and the remaining quotient that is:

$$4 \times 2 \times 2 \times 2 = 32$$

and 32 is the new denominator. We now have to express each term in terms of the new denominator.

We have $\frac{3}{4} + \frac{7}{8} + \frac{15}{16} + \frac{9}{32}$. To get each term in terms of the new denominator we must divide each denominator into the new one, and multiply the numerator by the result. Take the first term. The denominator is 4. The new denominator is 32. 32 divided by 4 gives 8, and multiplying the numerator by 8 gives 24, which is the numerator of the first term with 32 as denominator. The

work is $\frac{32}{4} = 8, 8 \times 3 = 24$. The new fraction is $\frac{24}{32}$. The next term gives $\frac{32}{8} = 4$ and $4 \times 7 = 28$. $\frac{28}{32}$ and so on. The complete sum is $\frac{24}{32} + \frac{28}{32} + \frac{30}{32} + \frac{9}{32}$.

For convenience the sum is set down thus: $\frac{24 + 28 + 30 + 9}{32}$

Adding the numerators together gives 91 and placing this over the denominator gives the result of the sum as $\frac{91}{32}$ which is an improper fraction. To make this into a whole number and a fraction, divide 32 into 91: which is two and twenty-seven remaining, or $2\frac{27}{32}$.

This is a simple case and any one familiar with fractions would have found the new denominator, or to give it its proper name, the least common denominator, by inspection. The least common denominator is the least number which all the denominators can be divided into without a remainder. Let us take a mere difficult case add together: $\frac{3}{42}, \frac{8}{54}, \frac{9}{20}, \frac{3}{7}$

Take the denominators, and see if any of them will divide into any of the others: 42, 54, 20, 7. We see at once that 7 will divide into 42.

We see again will go into 54 and we get:

7 | 42. 54. 20
6. | 54. 20
9. 20

No further division is possible, so we have:

$$7 \times 6 \times 9 \times 20 = 7560$$

Now, instead of setting it down as above, we might do it a simpler way. Thus: 42, 54. 20, 7. We see 7 goes into 42. Cross out 42 and put the figure 6 underneath. 6 goes into 54. Cross out 54 and put 9 underneath. The result looks as follows: 6, 9, 20, 7

Multiply the figures remaining and get the new denominator 7560.

The new fraction will be

$$\frac{540 + 1120 + 3402 + 3240}{7560} = \frac{8482}{7560} = 1\frac{922}{7560}$$

It soon becomes easy to determine a denominator at almost the first glance if the fractions are ordinary ones as in our first instance. For instance, any fraction dealing with the ordinary divisions of an inch on a rule are always added mentally, even though some men will express a measurement as five-eighths, a sixteenth, and a thirty-second. $\frac{23}{32}$ instead of $\frac{23}{32}$.

Subtraction of fractions is performed in exactly the same way as addition as far as getting a common denominator is concerned. If we wish to subtract $\frac{3}{4}$ from $\frac{15}{16}$ we see at once that the L. C. D. (least common denominator) is 16 and the problem is $\frac{15-12}{16} = \frac{3}{16}$.

Suppose we have $\frac{13}{16} - \frac{3}{20}$. Sixteen will not go into 20 but perhaps there is some other number that will go into both 16 and 20; 2 will go into each, so will 4. Then we have $\frac{4 \mid 16 \quad 20}{4 \quad 5}$, and multiplying $4 \times 4 \times 5 = 80$ we get a new denominator. The problem becomes

$$\frac{13}{16} - \frac{3}{20} = \frac{65 - 12}{80} = \frac{53}{80}$$

In any case of addition or subtraction of fractions, if the various denominators will not divide into each other it is sometimes possible to find another number which will go into all of them, in which case the new number and the various quotients will be the new denominator. Take $\frac{7}{15}, \frac{8}{21}, \frac{9}{12}$, none of these will divide into each other, but each is divisible by 3, and we get

3 | 15, 21, 12
5, 7, 4

Then $3 \times 5 \times 7 \times 4 = 420$ which gives $\frac{196}{420} \quad \frac{160}{420} \quad \frac{315}{420}$

Take another case again more difficult at first glance. Find the L. C. D. of $\frac{7}{8}, \frac{9}{20}, \frac{18}{42}, \frac{16}{34}, \frac{8}{50}$. None of these will divide into each other. However, inspection shows us that 4 will divide into the first two terms. We proceed as follows:

Divide the first line by 4. The terms that cannot be divided are set down again in the second line. Looking at

4 | 8. 20. 42. 34. 50
5 | 2. 5. 42. 34. 50
2 | 2. 1. 42. 34. 10.
1. 1. 21. 34. 5.

the second line we see 5 will divide into 5 and 50, so we proceed, setting down again the terms not divisible by 5. We see 2 will divide into 2, 42 and 10, and we go ahead again, setting down terms that cannot be divided. We have left 21, 34, and 5. No single number will divide any two of these. We might divide 21 by 3, but it would make no difference as we would have still two terms left. We therefore proceed with the multiplication of the quotient and divisors, and get

$$4 \times 5 \times 2 \times 21 \times 34 \times 5 = 142800.$$

This is a big number, but nothing like as big as if we had not reduced it down by gradual cancellation. In that case we would have had $8 \times 20 \times 42 \times 4 \times 50 = 11.424,000$, which is much more unwieldy.

Now let us take a case where we have both addition and subtraction.

What is the sum of

$$\frac{7}{8} + \frac{9}{16} + \frac{3}{4} - \frac{1}{2} - \frac{3}{16} - \frac{1}{4}$$

The first step is to get the L. C. D. We see at once that it is 16. Then our sum becomes:

$$\frac{14 + 9 + 12 - 8 - 3 - 4}{16}$$

Now, in solving an expression like this we take all the terms with a plus sign and add them together, and all the terms with a minus sign, and add them together. Then the sum of the terms with minus signs is subtracted from the sum of the terms with plus signs. When a term has no sign before it the plus sign is always understood. We have then $14 - 9 - 12 = 35$, and $(-8) + (-3) + (-4) = -15$. Then our statement is

$$\frac{35 - 15}{16} = \frac{20}{16} = 1\frac{1}{4}$$

Let us take another case for example: What is the sum of

$$\frac{8}{12} - \frac{7}{8} + \frac{9}{32} - \frac{7}{42} - \frac{3}{4} - \frac{15}{16} - \frac{1}{64}$$

Our least common denominator will be

16 | 12. 8. 32. 42. 4. 16. 64.
4 | 12. 8. 2. 42. 4. 1. 4.
3 | 3. 2. 2. 42. 1. 1. 1.
2 | 1. 2. 2. 14. 1. 1. 1.
1. 1. 1. 7. 1. 1. 1.

L. C. D. $= 16 \times 4 \times 3 \times 2 \times 7 = 2{,}688$.
The sum will be:

$$\frac{1792-2527+756+448-2013-2520+42}{2688}$$

Add together

1792, 756, 448, 42 = 3038
2527, 2013, 2520 = 7060
3038—7060

We have therefore $\frac{3038-7060}{2688}$. The quantity after the minus sign is the greater so the answer will be a negative quantity.

We get $-7060+3038=4022$, and the result of the sum is

$$-\frac{4022}{2688}=-1\frac{1334}{2688}.$$

Cancellation

Before attempting any operation on fractional numbers, it is always best to reduce them to the lowest possible terms and thus simplify the work. Supposing you have a term like $\frac{28}{32}$. If the top and bottom terms, or the numerator and denominator can each be divided without remainder by the same number the resulting fraction will be exactly the same in quantity but much easier to handle. Looking at the fraction $\frac{28}{32}$ we see at once that both terms can be divided by four, which gives $\frac{7}{8}$ as the result, which is much easier to grasp than $\frac{28}{32}$. The same process can be applied to any fraction and the ease with which it can be done is a matter of practice. Suppose we have

$$\frac{39}{52}+\frac{45}{90}+\frac{16}{48}$$

Before finding the L. C. D. we see if the terms can be reduced. The first figure of the numerator of the first term is 3. Try if 3 will divide into top and bottom. It will go evenly into 39 but not into 52. It goes into 39 exactly 13 times, which shows that 13 will go into 39 three times. Will 13 go into 52? Trial shows it does exactly 4 times. Then divide 13 into numerator and denominator and we get instead of $\frac{39}{52}$ the simple fraction of $\frac{3}{4}$.

The next term can be seen at a glance; 45 will go into both numerator and denominator, and the fraction becomes $\frac{1}{2}$. The same with the third term; 16 goes into both and the fraction becomes $\frac{1}{3}$, and the whole sum becomes

$$\frac{3}{4}+\frac{1}{2}+\frac{1}{3}$$

the L. C. D. of which we can see is 12. There are several ways which make it easy to see if a fraction can be cancelled. If the last figure of either term is 5 or a multiple of 5, it can be cancelled by 5 or a multiple of 5. Thus $\frac{125}{325}$ can be divided by 5, giving $\frac{25}{65}$ which can be again divided by 5, giving $\frac{5}{13}$ which is the lowest term. Suppose the number is $\frac{84}{156}$. We can see at once that 12 will divide into both these terms, giving $\frac{7}{13}$. If the division cannot be seen at first, try a smaller number. Two goes into both terms, so try if 4 will go. It will go, giving $\frac{21}{39}$. We see at one that 3 will go into 21 and 39, giving the final result $\frac{7}{13}$. The simplest way is to divide by a small number first, and if it will go, try multiples of that number mentally till the highest one that will divide is reached.

Multiplication of Fractions

We can now proceed to consider the operation of multiplication, and we shall see as we proceed that the simplifying by cancellation can be well carried out in this work. Multiplication of fractions in no more difficult than multiplication of ordinary numbers. The operations are practically the same. We say twice times one are two, and in just the same way we can say twice times one half are two halves, or three times one third are three thirds. We might explain here that a whole number can be expressed as an improper fraction by making the whole number the numerator, and the denominator unity thus: $\frac{2}{1}=2$; $\frac{3}{1}=3$. In practice the denominator is usually understood, as it is of no effect. Let us illustrate what we have just said. In expressing three times $\frac{1}{3}$ are one, we would put the statement down as follows: $\frac{1}{3}\times\frac{3}{1}=\frac{3}{3}=1$. The method is to multiply all the numerators together, the product being the numerator of the fraction representing the solution. The denominators multiplied together form the denominator of the solution. Thus above we see the numerators multiplied together $1 \times 3 = 3$ and the denominators $3 \times 1 = 3$, which makes a fraction with an equal numerator and denominator or a whole number. Now, taking this same expression $\frac{1}{3}\times\frac{3}{1}$ we can simplify it by cancellation.

In multiplying fractions, any numerator can be divided into any demoninator, or any denominator into any numerator, to simplify the expression before the multiplication is performed. This point should be fully grasped as it makes all operations with fractions very simple.

Take our simple sum $\frac{1}{3}\times\frac{3}{1}$.

The denominator of the first term will divide equally into the numerator of the second term, which makes the whole expression become $\frac{1}{1}$. Now in practice we would not write it this way but in this form $\frac{1\times3}{3}$, the denominator 1 being understood. It does not affect the result in any way. We might also write it $\frac{1}{3}\times3$ which is the same thing. Any of the three expressions, $\frac{1}{3}\times\frac{3}{1}$, $\frac{1\times3}{3}$, or $\frac{1}{3}\times3$ mean the same thing exactly.

Now the above is a fraction multiplied by a whole number. Let us take a fraction multiplied by another fraction $\frac{1}{2} \times \frac{3}{4}$.

Proceed as before. Multiply the numerator $1 \times 3 = 3$. Multiply the denominators $2 \times 4 = 8$. The work would appear $\frac{1}{2} \times \frac{3}{4} = \frac{3}{8}$, or else, which is more convenient, make the line which divides numerator and denominator a continuous one, thus $\frac{1\times3}{2\times4}=\frac{3}{8}$.

Now let us take several fractions and multiply them together. Take anything we happen to think of, say

$$\frac{1}{2},\ \frac{3}{16},\ \frac{7}{8},\ \frac{14}{32},\ \frac{28}{20}$$

Put them down like this

$$\frac{1\times3\times7\times14\times28}{2\times16\times8\times32\times20}$$

Now see if any numerators or denominators will divide into each other, or if any number will divide both a numerator or denominator. None of the numerators will divide into a denominator, but one denominator will divide into a numerator, and it is possible to reduce some of the terms by division. To make is simple, let us put them down separately again.

$$\frac{1}{2}\times\frac{3}{16}\times\frac{7}{8}\times\frac{14}{32}\times\frac{28}{20}$$

(1) $\frac{1}{2}\times\frac{3}{16}\times\frac{7}{8}\times\frac{\overset{7}{14}}{\underset{16}{32}}\times\frac{\overset{7}{28}}{\underset{5}{20}} = \frac{1029}{20480}$

(2) $\frac{1}{2}\times\frac{3}{16}\times\frac{7}{8}\times\frac{14}{\underset{8}{32}}\times\frac{28}{20} = \frac{2058}{40960} = \frac{1029}{20480}$

(3) $\frac{1}{2}\times\frac{3}{16}\times\frac{7}{8}\times\frac{\overset{7}{14}}{32}\times\frac{28}{20} = \frac{1176}{81920} = \frac{1029}{20480}$

(4) $\frac{1}{2}\times\frac{3}{16}\times\frac{7}{8}\times\frac{\overset{7}{14}}{\underset{8}{32}}\times\frac{\overset{7}{28}}{20} = \frac{1029}{20480}$

Take each term separately. The first term cannot be reduced. neither can the second or third. The fourth and fifth we see at once can be. The fourth term can be divided by 2, and the fifth by 4, or we might divide the denominator of the fourth term and the numerator of the fifth term by 4. Always remember that if either a numerator or a denominator is reduced, a denominator or numerator to correspond with it must also be reduced. Dividing a numerator into a denominator, or vice versa, is always correct, providing the divisor is cancelled when the dividend is cancelled; but in reducing by outside divisors as we have just suggested, care must be taken to ensure that both a numerator and denominator are reduced at the same time. Let us illustrate this point.

First, cancelling the fourth term by 2 and the fifth by 4.

Second, cancelling the denominator of the fourth term and numerator of the fifth term by 4.

Third, by cross cancellation, and fourth cross cancellation, and cancelling one numerator and one denominator by 4.

The final result of the second sum is further cancelled by 2, and the third by 4.

Take a simpler case:

$$\frac{3}{4}\times\frac{8}{6}\times\frac{12}{9}\times\frac{\overset{2}{24}}{16}\times\frac{18}{24}$$

$$\frac{3}{4}\times\frac{\overset{4}{8}}{6}\times\frac{\overset{4}{12}}{9}\times\frac{\overset{2}{24}}{\underset{2}{16}}\times\frac{\overset{3}{18}}{\underset{2}{24}} = \frac{6}{4} = \frac{3}{2}$$

The second line shows how it would appear after cancelling.

There has not been a single multiplication operation in solving this problem. It has all been done by cancellation, and it is surprising how often this can be done in actual problems. It saves time, and also makes for accuracy. For instance, in a calculation frequently occurring in boiler work we get an expression of this kind, which can be reduced like this.

$$\frac{5\times5\times22\times2\times2\times16}{8\times8\times28\times1\times5\times5}$$

$$\frac{\overset{1}{\cancel{5}}\times\overset{1}{\cancel{5}}\times\overset{11}{\cancel{22}}\times\overset{1}{\cancel{2}}\times\overset{1}{\cancel{2}}\times\overset{2}{\cancel{16}}}{\underset{4}{\cancel{8}}\times\underset{1}{\cancel{8}}\times\underset{14}{\cancel{28}}\times1\times\underset{1}{\cancel{5}}\times\underset{1}{\cancel{5}}} = \frac{11}{14}$$

The rule to remember for multiplication of fractions is: First reduce all fractions to their lowest terms. Multiply all the numerators together for the new numerator, and all the denominators together for the new denominator.

Division of Fractions

The division of fractions is simply a repetition to a large extent of the multiplication of fractions. However, there are some points to observe that are different. If we wish to find out what number represents a fraction of a whole number, we multiply the number by the fraction. For instance, if we want to know the number representing ¾ of 2, we multiply $2 \times \frac{3}{4} = \frac{6}{4} = \frac{3}{2} = 1\frac{1}{2}$.

Now we really have divided into four parts and have then taken three of these. But suppose we wish to find out how many times ¾ is contained in 2.. We must divide ¾ into 2. To do this, we must first find how many quarters there are in 2 and divide that number by 3. Now we know that there are 4 quarters in 1, and in 2 there are $4 \times 2 = 8$. 8 divided by $3 = \frac{8}{3} = 2\frac{2}{3}$. Now, if we set this down in the ordinary way it would appear as $\frac{2 \times 4}{3}$, or $\frac{2}{1} \times \frac{4}{3}$. When we multiplied by $\frac{3}{4}$, our sum was $\frac{2}{1} \times \frac{3}{4}$. When we divide by $\frac{3}{4}$, the sum is $\frac{2}{1} \times \frac{4}{3}$.

Hence the rule for division of fractions: Invert the divisor and multiply.

Let us take an example: Divide $\frac{7}{8}$ by $\frac{15}{16}$. Invert the divisor and multiply, the statement becoming $\frac{7}{8} \times \frac{16}{15}$. Now 8 will cancel into 16 and the sum becomes $\frac{7 \times 2}{15} = \frac{14}{15}$. Similarly take $\frac{2}{3}$, divided by $\frac{12}{18}$. We get $\frac{2}{3} \times \frac{18}{12}$ which by cancelling becomes $\frac{6}{6} = 1$. Take:

$$\frac{14}{16}\times\frac{13}{12} \div \frac{7}{8}\times\frac{8}{10}$$

This is an example of a compound fraction, and means that the product of the first two terms should be divided by the product of the last two terms. It could also be stated thus:

$$\frac{\frac{14}{16}\times\frac{13}{12}}{\frac{7}{8}\times\frac{8}{10}}$$

or thus:

$$\frac{14}{16}\times\frac{13}{12} \Big/ \frac{7}{8}\times\frac{8}{10}$$

They would all mean the same thing. Let us take the first statement:

$$\frac{14}{16}\times\frac{13}{12} \div \frac{7}{8}\times\frac{8}{10}$$

This becomes $\frac{14}{16}\times\frac{13}{12}\times\frac{8}{7}\times\frac{10}{8}$, which by cancellation boils down to $\frac{13 \times 5}{6 \times 8} = \frac{65}{48}$.

In the second statement:

$$\frac{\frac{14}{16}\times\frac{13}{12}}{\frac{7}{8}\times\frac{8}{10}}$$

we can cancel out to begin with and our statement becomes:

$$\frac{\frac{13}{16 \times 6}}{\frac{1}{10}}$$

which is:

$$\frac{13 \times 10}{16 \times 6} = \frac{130}{96} = \frac{65}{48}$$

(Continued on page 239)

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

WHILE a knowledge of these things will not perhaps help an engineer in the operation of his plant yet they are of deep interest and help in the understanding of the more practical side of electrical science. This first article then will be devoted to a discussion of some of the simpler facts relating to this newer development in scientific knowledge and from this we can go on to the extremely practical power plant problems.

What is known as matter, iron, wood, any substance whatever, is supposed to be made up of an almost infinitely large number of small units called atoms. The theory which is called the atomic theory has been a development of the last century or so and in itself it explained a great number of facts about the world in which we live. There are supposed to be about 92 kinds of these atoms and from this small number all of the countless substances and materials existing are built up. Two tons of different kinds combine and produce a third substance differing from each. It is assumed that these atoms are very small and in fact their size has been estimated and even measured from certain experiments. It has been said that if a drop of water were enlarged to the size of the world each atom would be the size of a baseball.

In passing when two or more atoms hook up together the resulting unit is called a molecule and the molecule as a whole is what determines the properties of the particular substance.

For a long time it was held that atoms were indivisible, that is they were the smallest possible units into which matter could be divided. All this has been changed and this is where electricity enters into it and plays a most important part, for it is now held and is a generally accepted fact that the atom, and in consequence all matter is nothing more nor less than electricity.

That is rather an interesting statement for when it is examined closely the reader is forced to come to the conclusion that matter is not such a substantial thing after all. This is much more apparent when the theory is more closely examined in what follows.

Let us take the atom and look into its make up. Every atom is now supposed to consist of very small units of electricity of two kinds. Just as man and wife exist together and to outward appearances at least in harmony, so two kinds of electrical units or while not strictly correct we may say particles exist together in the atom and in their effects exactly balance each other. These two types are called positive and negative electrons, electrons being the name given to them to show that they are of an electrical nature.

It is further supposed that the positive unit is placed at the center of the atom and that the negative units are placed around it in space, in such a way that the force of repulsion and attraction between the negative and positive units exactly balance or nearly so.

Thus we can have four negative electrons placed at the corners of a cube with one positive nucleus in the center.

The properties of the elements, their comparative weight, their chemical activity, their electrical characteristics, in fact every property they possess is dependent upon the number of electrons in their atoms. Further the number of electrons is fixed for each element and when it loses one permanently it is no longer the same element but another one.

Thus radium by the loss of electrons is very gradually changing into something very much like lead and in doing so liberates anoher element, helium. The old idea of the fixed and unchanging nature of the elements is thus no longer true and it is supposed by some that they all are changing into others lighter than themselves.

It is now possible to predict how any given element will behave, solely from a knowledge of the numbers of electrons in its atom,—whether it will be a gas, liquid or solid at ordinary temperatures, whether it will conduct electricity or not, whether it will be active chemically or not and many other properties.

These little electrons are also called into play to explain the flow of electricity through wires for in them seems to be the explanation. It is thought that this flow is nothing but a flow of electrons from one atom to another or along the wire at a very high velocity. The theory also offers some possibilities in the explaining of magnetism.

It may be of interest to compare the size of the electron with that of the atom. If we took an atom and enlarged it until it had a diameter of one mile then the electrons in it would be about five feet in diameter while the nucleus would only be about the size of a pinhead. These things have all been calculated out with minute care and while some of them are open to modification yet in the main the theory is a harmonious, well knit structure capable of explaining nearly everything to which it is applicable.

Ever since some of the ancient philosophers first noticed that amber jet and other substances attracted bits of straw leaves and feathers, speculation has been rife as to the nature of what we now call electricity. It is only within the last few years owing to the advance in knowledge and the progress made in other branches of science that any real knowledge of electrical phenomena has been realized. And while the old saying that "we do not know just what electricity is," is as true to-day as ever scientists have a suspicion that they know a good deal about it and if they cannot explain electricity itself they can at least explain very nearly everything else in terms of electricity.

It is further possible to explain such widely differing things as chemical reactions, the action of radium and other similar elements, wireless telegraphy and even the constitution of matter itself in terms of one simple theory which covers pretty nearly the whole field of physics and chemistry.

It is seen from the above that matter is very much like a seive in structure and that it consists of scattered electrons and positive nuclei with spaces in between them comparable to the distance between the earth and the moon reduced to the same scale in between.

The ever curious human mind won't be satisfied in getting the thing down to this point and will ask next "What are the electrons or units of electricity made of?" This is where a good deal of discussion has arisen, and it is supposed by some that an all pervading fluid substance or medium exists to which the name of ether is given. In this and through it we receive light from the sun and wireless messages from Europe. It is also supposed to be at the root of the electron for the electron is supposed to be an ether strain. As a very crude analogy and on probably not at all in accordanace with facts one might suppose a bubble of compressed air to exist in the midst of a lump of jelly. It would exert a stress on the jelly and deform it. In the same way a strain is supposed to exist in the ether giving rise to an electron.

It is truly a most remarkable theory which will at once explain the constitution of matter, the nature of electricity and very nearly every physical and chemical phenomenon of which we are aware.

Some Fundamental Principles

While the nature of electricity and many of its relations to matter will always possess a fascination for the human mind, the engineer is more concerned with its practical applications and this series of studies will be confined almost solely to practical power plant problems. Before these are taken up it will be well

to dwell for awhile upon some of the elementary principles underlying the whole theory of power generation.

These principles apply equally well to the steam power plant and to every other prime mover or source of energy and once a clear conception of the differences existing between and the meanings of the terms work, energy and power are obtained, the initiation into electrical theory will come very easily.

Force

The idea of a force is familiar to all of us, a weight resting on a table exerts force upon it, we exert force upon whatever we are standing on, water in a dam exerts force upon it, compressed air in a tank exerts force upon the tank. In this country at any rate we usually speak of force as being measured in pounds,—that is a weight exerts a force of so many pounds upon the table upon the string or rope to which it may be attached.

This is all right so far as it goes but we can find another expression which conveys something further to our minds. If we have a weight of 100 lbs. supported by a rope or cable of 2 sq. inches area we can divide the figure denoting weight by that denoting area and call the result so many (50) pounds per sq. in. That is, an expression has been found which tells us the relation between the weight supported and the size of the supporting member. But we still have the idea of a simple force and it is quite in order to speak of the total force acting on a body or a portion of it expressed, say in pounds per sq. inch.

There is another unit which enters into many engineering calculation —length or distance and this can be combined with the idea of a force to obtain something totally different—work. If a weight of three pounds is lifted through a height of four feet, for example, what we call work has been done on the weight and it is possible to find an expression telling just how much work has been performed. Two things enter into this expression, the weight lifted and the distance through which it has been raised. So if the weight in pounds is multiplied by the height in feet a figure of $3 \times 4 = 12$, in this case, will be obtained and to it is given the name of foot-pounds.

Work always implies the idea of a force acting through a distance and in the English language the name given to it expresses this relation clearly—foot $\times$ pounds or foot-pounds. Occasionally the engineer runs across an expression for work given in foot-tons or in some similar fashion but this idea is clearly implied.

Occasionally the engineer or student runs across the word (Joule) in his reading. This is another name for work and is taken to mean 0.7373 ft. pounds. It is thus a name given to a certain definite number of foot-pounds and has a very simple relation to some of the electrical units denoting work. It will be taken up later on in this course of studies.

While weight can in general be considered as a force, all forces are not due to the weights of bodies or substances and are not measured in terms of the weights of the bodies acting.

For instance consider Fig. 1. A table supports a large block of iron substance and to this block a string is attached, leading both ways over pulleys to two scale pans, one on each side. It will be readily seen that the one scale-pan balances the other and the block has no tendency to move. If now a number of weights are placed in one of the scale pans until the block begins to move a certain force will be exerted on the block and its magnitude will be exactly given by the weights themselves and not by the weight of the block.

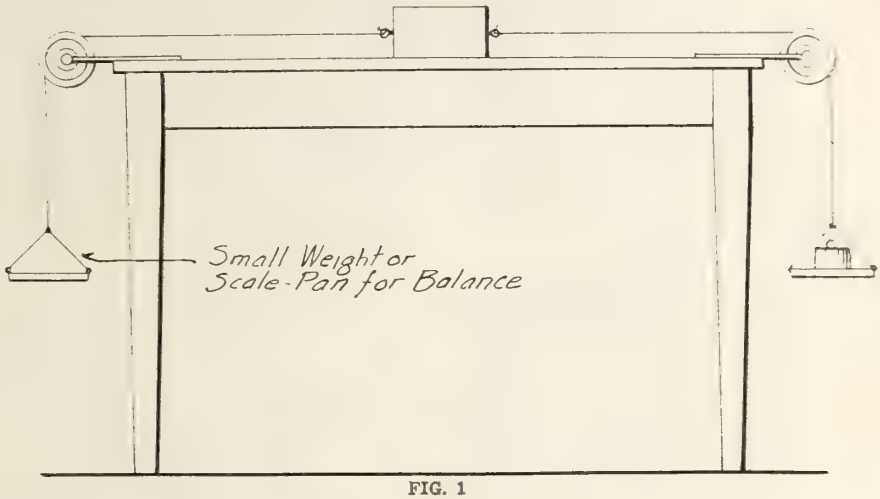


FIG. 1

If by this means, the block is moved say two feet by a weight of three pounds $2 \times 3 = 6$ foot pounds of work will have been done. The same amount of work will have been done by merely pushing the block along by hand or by pulling on the string.

Energy

Work and energy are very often confused even in the minds of those who by training ought to know better. Both are measured in foot-pounds and are mutually convertible.

If a man were to lift a weight of 10 lbs. from the floor to a table through a distance of three feet, he would be doing work to the extent of thirty foot-pounds. This work has disappeared and has appeared in the body in the form of increased energy. For the weight has been elevated in position and by this very fact it is capable of doing work in its turn. If it were pushed off the table and onto the floor it would in its turn do thirty foot-pounds of work on the floor, to its damage no doubt.

When the weight was at rest on the table it would be said to possess thirty foot-pounds of potential energy, that is energy which could be called forth at will. At the instant when it was pushed off the table it still possessed this amount of energy in the same manner but just before it reached the floor, while still again possessing as much energy as before, the form in which the energy existed had changed. At this instant its energy would be solely due to its motion and to this form of energy the name "Kinetic" is given, that is energy due to motion.

In falling the potential energy decreases and the kinetic inceases while at the instant of striking both vanish and are converted into work. The same reasoning can be gone through in respect to Fig. 1. Suppose the block on the table were at the left hand side of it and the right hand scale-pan were at the top. If a weight just sufficient to move the block were now placed in the scale pan it would fall pulling the block after it. When the block came to rest at the end of its travel the weight would be in its lowest position and all the work done at the expense of the energy of the weights would have been spent in the moving of the block. In this case the potential energy of the weights has been gradually used up in moving the system, in overcoming friction and the sum total of the energy has been similarly decreasing throughout the travel.

While energy thus may be expressed in terms of the force in general or by weight or mass, and by the distance through which the body falls or could fall, certain mechanisms do not permit of a ready calculation of this quantity in these terms directly. Such is the case of a flywheel or other rotating body which acts as a store of energy. In this case we have a body possessing weight and also possessing velocity. In this case it is possible to find out the energy possessed by the different portions of the wheel by multiplying their mass into the distance through which they would fall to arrive at the same velocity which possess by reason of their rotation. The sum of these quantities gives the energy possessed by the flywheel as a whole.

Portions of a flywheel remote from the axis possess more energy for the same weight than do portions nearer the axis since their velocity is greater.

Power

Power is often confused with work and with energy but it is open to simple

Chart of the Torsional Strength of Shafts

By the Use of the Accompanying Chart the Figuring of the Strength of Shafts is Made Comparatively Easy. Much Time Can be Saved Over the Laborious Use of Mathematics

By JOHN S. WATTS

THE accompanying chart will be found useful in determining the diameter of a shaft required to carry a given torque or torsional moment at any stress from 4,500 to 12,000 pounds per square inch.

To use the chart, simply follow along the horizontal line for the required torque and read off the diameter of the shaft on the diagonal line that intersects this horizontal line at the vertical line for the stress decided upon.

For example, the diameter of shaft required to carry a torsional moment of 120,000 inch pounds at a stress of 6,500 pounds per square inch, will be 4 9-16 in.

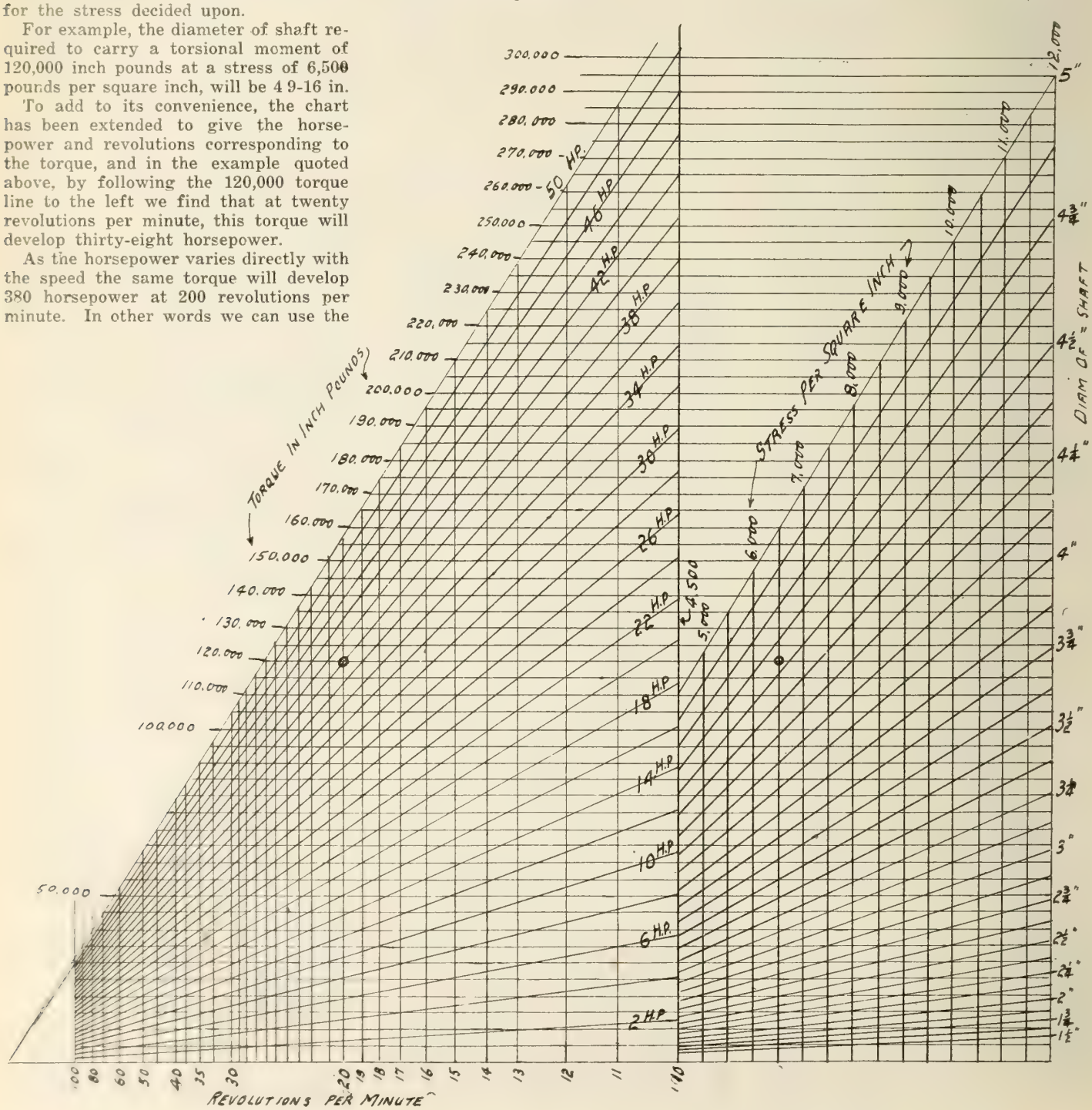
To add to its convenience, the chart has been extended to give the horsepower and revolutions corresponding to the torque, and in the example quoted above, by following the 120,000 torque line to the left we find that at twenty revolutions per minute, this torque will develop thirty-eight horsepower.

As the horsepower varies directly with the speed the same torque will develop 380 horsepower at 200 revolutions per minute. In other words we can use the chart for horsepowers and speeds above or below its range by simply dividing or multiplying the horsepower and the speed by ten, or any other convenient figure.

This enables us to use the chart to determine the size of shaft (up to 5 in. diameter) required to transmit any horsepower at any revolutions per minute, when the horsepower is given instead of the torque.

The chart will also be of material assistance in calculating geared or belt-drives, to transmit a given horsepower at a given speed as from the intersection of the horsepower and revolutions lines we read the corresponding torque, which, being divided by the radius in inches of the gear or pulley, will give us the load in pounds, to be transmitted by the teeth of the gear or by the belt.

It should be remembered that if the



gears or pulleys on the shaft are not close up to the bearings, a bending stress will be added to the torsional stress, and the shaft must be increased in diameter to take care of this additional stress.

The lowest stress, 4,500 pounds, should be used when the load is constantly reversing in direction and is suddenly applied.

A stress of 9,000 pounds may be used when the load is gradually applied, without shock and gradually reversed.

The maximum stress of 12,000 pounds is allowable only when the load is steady, does not reverse, and is applied gradually without shock.

A description of the method used in constructing this chart may be of interest and a help in making up other charts for solving similar problems.

First, we lay off the horizontal lines for the torques to a convenient scale, in this case 1 in. equals 40,000 inch pounds, and calculate the torsional strength of each diameter of shaft at the maximum stress, 12,000 pounds per square inch, by the formulae

$$T = \frac{\pi}{16} fd^3$$

and mark points on the torque scale to indicate each diameter at the points corresponding to the strength so calculated.

Now the maximum stress being 12,000 pounds per square inch, we measure along the base line, to the left, a distance equal to 12,000 to any scale, in our case we have chosen ⅜ in. = 1,000, and draw the diagonal lines for each diameter to this point.

Measuring back from this same point, distances equal to 4,500, 5,000, 5,500, etc., etc., and erecting vertical lines at each point, it is obvious that the height of each of these vertical lines to its intersection with any diameter diagonal line will be equal to the torsional strength of that diameter of shaft at that stress for which the vertical line is marked.

Now, coming to the triangle at the left, we calculate the torque which will be developed at ten revolutions per minute by fifty horsepower, by the following formulae:

Let T = torque in inch pounds.

$$\text{Then h.p.} = \frac{T \times \frac{2\pi}{12} \times \text{r.p.m.}}{33{,}000}$$

$$\therefore T = \frac{\text{h.p.} \times 33{,}000}{\frac{2\pi}{12} \times \text{r.p.m.}}$$

Marking this point on the torque scale on the central vertical line we have the point corresponding to 50 horsepower, and by dividing this height into twenty-five parts we get point for the torque corresponding to each increment of 2 horsepower up to 50 horsepower at ten revolutions per minute.

We now make the base line of the left-hand triangle ten inches long (to a scale of half size in the chart) because ten is the number of revolutions we assumed for the calculation of the horsepower on the central vertical line.

Now, as the torque is proportional to h.p.
the —, we scale back to the right from r.p.m.
the end of the base line, distances equal
to $\frac{10}{100}$, $\frac{10}{90}$, $\frac{10}{80}$, $\frac{10}{70}$, etc., the denominator
of these fractions being the revolutions per minute in each case, and raise vertical lines at each point so marked.

It can be seen that the height of any of these vertical lines to its intersection with any horsepower diagonal line will be proportional to the torque delivered by that horsepower at that number of revolutions.

THEORY AND PRACTICE OF ELECTRICITY

Continued from Page 237

explanation and should present little difficulty to anyone who cares to devote a little thought to it. We have seen that in the defining of work we had two quantities to consider force and distance. In considering power a third quantity, time, is introduced.

Thus it is conceivable that one man could lift a bucket of water from a well twice as fast as another, by virtue of his superior strength. In both cases the energy required and the work done are the same but the time varies. The first man is twice as strong and has twice the power. The familiar term horse-power originally devised by James Watt to measure the power or strength of his engines includes all three things, force, distance and time in its composition. One horse-power means 33,000 ft-pounds of work done in one minute. To find the horse-power that any mechanism is capable of exerting it is only necessary to find the amount of work done in foot-pounds and divide it by the time in minutes and by 33,000.

Thus supposing the man at the well lifted 50 lbs. of water and bucket through a distance of 60 feet in 4 minutes. Then the number of foot-pounds of work done would be $50 \times 60 = 3{,}000$ and since this is done in 4 minutes the horse-power would be $3{,}000 \div 4 \div 33{,}000 = 1\text{-}44$ or 0.0227.

It will be well to summarize the definitions of these different units as follows:

Work—Force by distance.

Energy—Force by distance through which the body could fall or through which it would fall to achieve the same velocity it possesses.

Power—Time rate of doing work, i. e. force by distance divided by time.

COURSES OF INSTRUCTION

Continued from Page 235

The third statement:

$$\frac{14}{16} \times \frac{13}{12} \quad | \quad \frac{7}{8} \times \frac{8}{10}$$

becomes at first glance:

$$\frac{14}{16} \times \frac{13}{12} \times \frac{10}{7}$$

7 cancels into 14, leaving 2 which cancels into 12, leaving 6. 2 will go into 16 and 10, leaving 8 and 5. The final results is: $\frac{13 \times 5}{8 \times 6} = \frac{65}{48}$.

Before going into the study of complex fractions, we will go over in the next article the meaning and use of the various signs employed, and then take up some complicated examples of fractions.

To Take up Civil Engineering—Due to recent amalgamation placing them in a very favorable position for carrying out large contracts, Messrs. Armstrong Whitworth of Canada have decided to enter the public works contracting field. The new development will be under the control of Mr. Robert H. Mackenzie.

Big Power Contract Let—The Nova Scotia Power Commission at a recent meeting let the contracts for the St. Margarets' Bay Power Development. The contract for the four electric generators went to the General Electric Co., and will be built in their shops at Peterborough. The Pacific Coast Pipe Co. of Vancouver were awarded contracts for wood stave pipe 6 feet and 10 feet diameter. The general construction contract, including the building of power houses, dams and intakes, were awarded to D. G. Loomis & Sons, Montreal.

The American Waterworks Association will hold its 40th annual convention in Montreal from June 21 to 24, with headquarters at the Windsor Hotel, the Windsor Hall being reserved for an exhibition display, where many American and Canadian manufacturers of waterworks equipment will have exhibits. The meeting will bring many prominent hydraulic engineers from many points of Canada and the United States, and it is expected that about 1,000 delegates will be in attendance. Extensive plans are now in preparation for the professional meetings and entertaining features. H. G. Hunter, of Montreal, is the chairman of the entertainment committee

The Administrative Commission of Montreal are again proposing that the City Council accept their suggestion for the adoption of a by-law relative to the compulsory installation of dry sprinklers in the basement of all public and other large buildings. The first suggestion as originally drawn up included dwelling houses, but in the revised form this class of building has been exempted. The purpose is to provide more adequate facilities for fighting fires where the nature of the material would produce noxious gases and suffocating fumes: the proposed method enabling the firemen to connect the hose and drench the interior without danger to themselves.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone 8971 Rector. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, MAY 20, 1920 No. 10

PRINCIPAL CONTENTS

The Power Plant of the St. Lawrence Refinery	223
Some Interesting Notes on Fuel Economy	225
A Paper on Modern Boiler Practice	228
A Course of Instruction For Graded Certificate	232
The Theory and Practice of Electricity	236
Editorial	240
Our Question Box	242
Developments in New Equipment	243

Delayed Certificates

WE HAVE received letters from a number of subscribers, who complain that they have not yet received their certificates, and fear that they cannot retain their positions on this account.

POWER HOUSE took this matter up with a member of the Board of Examiners, who explained the matter very clearly. In almost every case where delay in issuing certificates has occurred, it has been through the failure of the applicant to properly fill up the form of application. The chief neglect seems to be in making the affidavit, and the Board wish to call this strongly to the attention of applicants. The particulars of service and experience must be sworn to in order to be of use.

As regards the holding of positions, any man holding a position before the passing of the act may continue to hold it, irrespective of grading. If he wishes to move to another plant to take charge, he must obtain a certificate of the necessary class to cover it.

While Power House is anxious to give all the help possible to our readers, we would remind them that on matters of delayed certificates, grading, etc., they will get much more satisfaction by applying direct to the Board, the members of which are anxious to administer the act in a fair and equitable manner, and to the best interests of the engineers themselves.

Technical and Practical

FOR some time back we have had an animated correspondence in our columns on the merits and demerits of the graded certificate act, with slight diversions into the realms of philosophy, literature, the use of slang and other interesting bypaths. The term that seems to occasion much argument is the one so freely and glibly used, "technical man."

Now, one cannot point out a certain man, and say simply that man is a technical man, and point out a second man, and say this man is not a technical man. The first man may possess more technical knowledge than the second, it is true, but a third man may easily possess technical knowledge greater than the first two combined. They are all technical men. Technical knowledge runs all the way down from the men in the highest rank such as were Faraday, Rankin, Joule, or in later days Kelvin, Edison, and their contemporaries, to the newest student of a correspondence or technical school. From the highest to the lowest, all possess some degree of technical knowledge, and it is the difference in degree that makes the value of the man, in either the commercial or scientific field. As soon as a green hand enters into the boiler room, and masters the uses and names of the various boiler mountings, he has acquired a certain amount of technical knowledge.

There are certain branches or stages of technical acquirements that can be attained only by those who have no other work in life but the pursuit of abstract problems. These men achieve results which are of benefit to the world in general. Placed in a commercial position they would most likely be dismissed as incompetents by an intensely practical management. Other men take the principles the investigators have discovered, and embody them in designs which are afterwards turned over to others to carry out. The machine is built, the idea has materialized, but its success in the last analysis will often depend on the man who operates it. His success will depend on how far he can go in understanding the idea of the man who first visualized the principle. That is he must have some knowledge of a technical nature, as well as being able to perform the task of starting and stopping.

There is nothing beyond the reach of any stationary engineer in acquiring a technical knowledge that will be of great value to him in his daily work. There are many men who wilt mentally when confronted with the necessity of acquiring technical knowledge. A grasp of the ordinary rules of arithmetic, a little application to study, and in a very short time the man who has always looked upon himself as being only a practical man, finds he has achieved a measure of technical knowledge.

It is engineers themselves who should spread this knowledge. Organisations like the C. A. S. E. have it in their power to do an enormous amount of educational work, a power that we fear is not used as it should be in every case.

We cannot all be Kelvins and Edisons, but we can all possess the requisite amount of knowledge to make us experts in the line of work we are engaged in, whatever it may be.

Steam for Power and Heating

IN THIS issue there appears an article by Mr. C. E. Stroymeyer, on the economy of engines used for power, the exhaust from which is used for heating. This should be carefully read by steam plant owners and engineers in Canada, where the heating proposition is such a big feature of plant operation. Mr. Stroymeyers name in the engineering world is of such standing that any statement he makes can be looked upon as authoritative, and the reader can be assured that there is no ulterior motive behind it.

Although writing of conditions in Great Britain, his

remarks apply equally to Canada. In large factories in this country, there is a heating load for purely room warming purposes which lasts over at least six months. This is entirely apart from heating used in process work, such as drying kilns, cleaning tanks, japanning ovens, glue heaters, and dozens of other processes where heat is required. This heat is necessary no matter how the power is secured, and if both power and heat can be secured from the one installation, there is a corresponding reduction of capital cost. When it is a question of buying power in the summer months, and using engines in winter, it requires very clear proof indeed to show that any saving can be made in view of the capital lying idle.

The point lies chiefly in the fact of whether the boilers are efficient or not. If the loss between the heat units contained in the coal and those transmitted to the water in the boiler is a minimum, then in the average factory it will be a very difficult job for the salesman of the central station to show where he can effect an economy. If the boiler efficiency is as low as it unfortunately is in many Canadian plants, the engineer is supplying the central station with an argument ready made.

During the war, when the Government were bestirring themselves somewhat over the question of saving coal, some electric power companies saw an opportunity to get into steam plants where their best efforts had hitherto been unsuccessful. We know of one case where after many prolonged interviews, and comparisons of figures, the factory management made the power company a proposition. The power company were to make the change, install the synchronous machinery necessary to keep up the power factor, and the rotary converter, etc. If after one year they could show a saving in fuel sufficient to justify the outlay, the factory would pay for the equipment, and continue to buy power. If this saving could not be shown, the power company were to put things back as they found them, and be out the expense. This offer finished the negotiations.

There are many small industries where heating is a minor matter, and price of coal, labor, etc., preclude the use of a steam power plant. On the other hand, in cases where steam is used in large quantities for process work and heating purposes, the self contained steam plant is more economical and more reliable than any outside power. The wide awake engineer and factory manager will have his power plant costs always available, so that he can instantly compare them with any offer he may receive from a philanthropic central power plant salesman who wants to save him money.

Couldn't Earn $2.80 a Day

HOW things hop! Could you go out to-day and hire a moulder for $2.80 a day? You might not be able to hire one at any price, but certainly $2.80 would never get a hearing.

A moulder had answered an ad. of a firm in an Eastern Ontario town. He was making $2.50 a day, and was willing to leave for $2.80. He so informed the wise man from the East, and here is what he received in return.

The letter is dated June 3, 1909:—

Dear Sir,—

Your favor of the 1st to hand. The two places are already filled in my moulding shop for which I was advertising.

The applications which I have received are rather amusing. Moulders now-a-days do not know what to ask in wages. I do not believe it is possible for you to earn $2.80 a day. If any one could I would pay it, but I know that no moulder under me has ever done that yet. Nor come near it. Our moulders have steady work, every day the year round.

The sequel to the whole thing is that only a few weeks ago the same shop was advertising for moulders again, the wording this time reading "Highest Wages Paid."

Chance For the Skilled Man

ACCORDING to officials whose business it is to keep in touch with the situation, the fuel situation in Ontario, as far as power is concerned, is decidedly bad now.

Every ton of coal should be made to do, as near as possible, the duty of a ton. Steam plants, even at their best, are some distance removed from 100 per cent. efficiency.

The shortage of coal—and it is not apt to be remedied very soon—calls for the elimination of the tinker and the guesser in every department of the business that is touched by the production or transmission of power.

Industry calls for men who know—know how to get the best results from the fuel used—how to get results in transmission—how to eliminate as much friction as possible.

Increasing costs call for the same thing.

There's a great chance now for the man who wants to take himself by his own shoe-strings and pull himself out of the rut.

He may have to burn the midnight oil to do it—or he may have to burn the midnight oil if he doesn't, trying to figure out how to make ends meet.

Industry has not become simply a case of automatic production. You may get this idea at times.

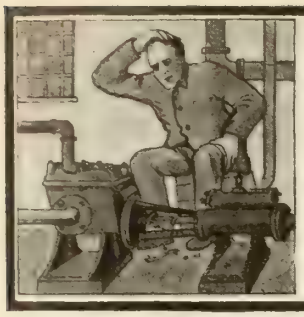
The man who is going to succeed is not the man who contents himself with looking after the machine.

The man who succeeds is the one who is keeping a few paces ahead of the machine.

The night classes, the technical papers and books are still the real stepping stones to men who want to get into that desirable class that are called in after the average man has failed to give results.

WELL, WHAT DO YOU WANT?
PAY WINDOW
PROFESSOR
I'D LIKE TO TRADE A TEN THOUSAND DOLLAR EDUCATION FOR A COUPLE OF DOUGHNUTS AND A CUP OF COFFEE.
FIGHTERS SHARE

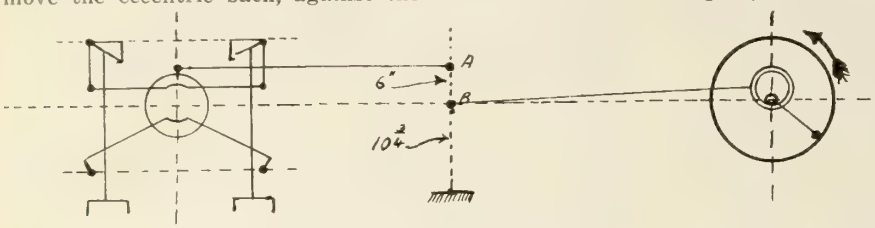
The public payroll!
Darling in New York "Tribune."



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question: The Corliss engine, outlined in accompanying diagram, is set to cut off at 1-5 stroke, and does not develop enough power. Can I make cut-off later? What effect will it have on the valve gear to move the eccentric back, against the



direction in which engine is running? By increasing the distance between A and B, to increase the travel of the wrist plate, would it make cut-off later and increase the power of the engine? Please explain action in all the valves.

Answer: The cut-off point in a Corliss valve is governed entirely by the knock off cam, which is actuated by the reach-rod from the governor. Lengthening or shortening this rod will move the cam on the bracket so as to release the hook either sooner or later. The limiting point of cut-off in an engine with this kind of gear is half stroke, but cut-off can be arranged at any position up to this limiting point. In the accompanying sketch it can be plainly seen that if the rod is lengthened, the knock-off lever which carries the knock-off cam, will be moved away from the latch hook which makes it have so much further to travel before releasing the hook, thus making cut-off later. Shortening will have the opposite effect.

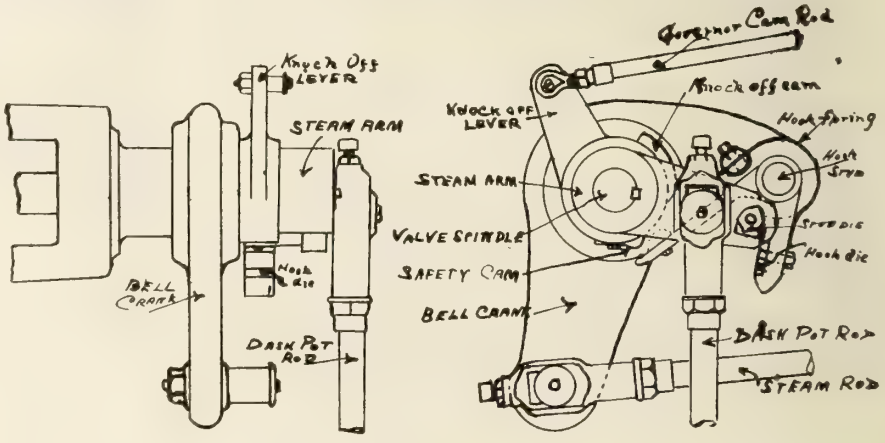
The effect of moving the eccentric, either by advancing or retarding it, will first affect the wrist plate movement. That is the part that is directly driven by the eccentric. Imagine the eccentric to have just 90 degrees advance, and the piston at the end of its stroke inwards. Then the centre line of the wrist plate would be vertical. Now if the eccentric is turned on the shaft, the effect will be to move the wrist plate off the vertical, either to the lead end or crank end of the cylinder. Now what will be the effect on the valves. Supposing that when the eccentric was at 90 degrees, and the wrist plate central, that the steam valves on the lead end was just on the point of hooking up. That is, whichever direction the crank moved, steam would be admitted as soon as the stroke commenced. Now the eccentric is moved ahead, the wrist plate will be moved ahead, and providing nothing else has been altered, the steam valve will be opened a small amount. Now the exhaust valve on the head end will, of course, be in the closed position, and the effect of this valve of moving the eccentric ahead will be to bring the edge of the valve closer to the part, which would make the valve open to exhaust earlier, and close earlier. So we see the general effect of moving the eccentric ahead will be to make the steam valve open earlier, and the exhaust valve open earlier and close earlier. The point of cut-off will be affected by moving the eccentric. If there were no governor knock-off cam, the cuh-off would be affected the same as all the other events, that is, it would be early.

Bringing the eccentric back will affect every event but cut-off, in the opposite direction, that is, it will make every event later. Taking our head end again with eccentric at 90 degrees and steam valve just on the point of picking up. Moving the eccentric back will move the bell crank lever further away from the die, so that it will have to travel further before picking up the valve, that is admission would be later. Cut-off, of course, would be late too if not made by the governor. The exhaust valve will have been moved so as to take the edge further from the port, making release later, and compression later. Generally speaking, advancing or retarding the eccentric of a Corliss engine has the same effect as it would in a slide valve engine, except in regard to cut-off. With the Corliss you have the added advantage of making independent adjustments of each valve after making the general adjustment.

Now our correspondent asks the effect of increasing the travel of the wrist plate.

Let us take again the eccentric with 90 degrees angle of advance, and crank at the inner centre. The steam valve is just about to open for admission. It will continue opening till released by the governor cam rod at the determined position of the stroke, and the remainder of the forward stroke of the wrist plate is lost motion as far as that valve is concerned. No matter how far the travel of the wrist plate is made, the period of admission is governed by the governor. The only point that might be gained is a slightly greater port opening due to the extra distance travelled while admission is taking place, and the one effect this would have would be to keep the admission line on the indicator card a little straighter, the gain of power being very very slight.

The effect on the exhaust valves of increasing the travel would be the same. The valve would travel a correspondingly greater distance in the same length of time as before. It might be necessary to alter the width of the bars, but generally there would be no gain. The engine is designed to perform the steam distribution with a certain length of valve travel, and giving it more will have but little effect unless carried to the extremes. Of course the point would have to be watched of the effect of the reach rods and hinge pins. You might cause the rod and lever to come in a straight line at some portion of the stroke, which would end in disaster.



Progress in New Equipment

THE MONO CO_2 RECORDER

Technical publications have printed hundreds of articles on combustion in which it has been repeatedly stated that an analysis of CO_2 alone is insufficient because the correct percentage of CO_2 varies with the kind of fuel used, the method of firing, the method of admitting air, etc. Thus in one installation 13 per cent. of CO_2 is the maximum that should be allowed. In another installation, 15 per cent. might be the maximum. In another 8 per cent.

The best way to be sure about it is to simultaneously keep tab on CO. It is highly important that no CO be present.

The Mono Corporation of America, 48 Coal & Iron Exchange, Buffalo, N. Y., now announces a recorder that enables the fireman to constantly see that no CO is present and that CO_2 is always maintained at a maximum.

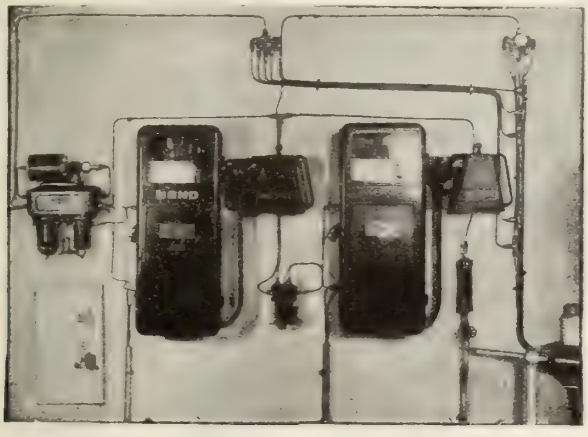


FIG. 1.

Bonus systems that have been based upon percentages of CO_2 have failed because the boiler room force soon learns how to so manipulate the dampers that a high CO_2 reading is obtained. Yet combustion is incomplete and the object of the bonus system is defeated.

Now that both CO_2 and CO can be recorded, the boiler room force finds it impossible to show an extremely high CO_2 without showing some CO. The fuel must be so burned that the percentage of CO_2 is as high as possible and at the same time there must be no CO. By so doing most economical combustion is effected.

The manufacturers of the Mono instrument have devised a premium system which they will be glad to explain to anyone interested. This system involves the use of a Mono rule which is laid over the chart. A record is kept on a sheet provided for the purpose and at the end of the month, the figures are added, the average determined, and the bonus is paid.

Fig. 1 shows the Mono Monoxide Recorder which will record both CO_2 and CO on one chart. The device shown at the left is called the "Monoxide Auxiliary Type K" or it is called the "Monoxide Supplement." It is this supplement which, coupled with the standard Mono CO_2 recorder, permits the recording of CO.

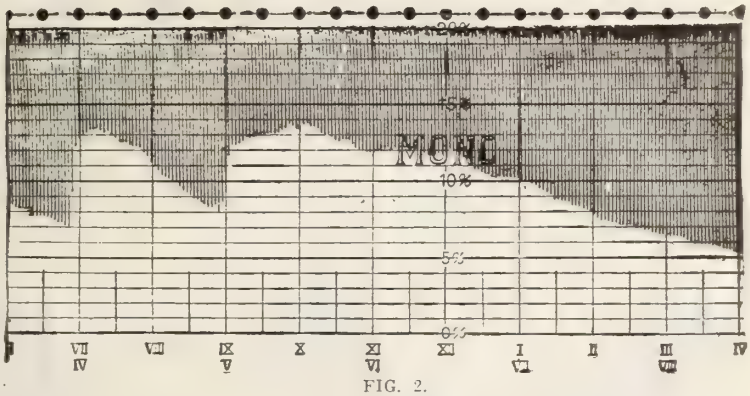


FIG. 2.

Fig. 2 shows a Mono CO_2 chart. Fig. 3 shows a Mono CO chart. When taken simultaneously, these charts of course give an absolutely accurate account of furnace conditions.

This same apparatus (without supplement) will record SO_2, hence it is a valuable instrument for use in pulp and paper mills.

The chemical field finds the apparatus valuable for the automatic analysis of nearly all gases: CO_2, CO, O_2, H_2SO_4, CH_4, N_2, etc.

The gas field finds the Mono instrument especially adapted to gas works for the determination of hydrogen, for carburetted water gas, and for carbon monoxide.

In fact, wherever gas is used to a great extent and where it is important that the gas be continuously, automatically, and accurately analysed, this instrument can be made to do the work.

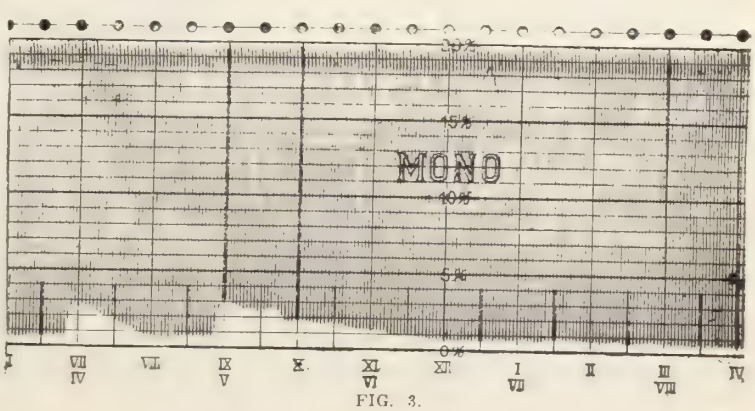


FIG. 3.

ROBERTS UNIT JACKS

The Roberts Mfg. Co., New Haven, Conn., handle a line of unit jacks and bolt couplers which should interest the mechanic in general. These jacks can be set to any height instantly by means of separate and interchangeable units. One merely builds up the proper number of units required and adjusts their rack jack. Lock joints connect each unit and are locked in place by means of a simple turn.

A surface gauge connection is also made, which can be clearly seen in the illustrations.

Readers can no doubt obtain all necessary details from a study of the various illustrations and will readily understand the advantages of such a system, especially for machine set-up work. All these jacks are made of first quality malleable iron, and will stand the strain placed on them in supporting work. These shop aids, as we might term them, are ideal for use on planers, vertical millers, horiontal mills, radial drills, boring mills, slotters, shapers, or in fact any machine upon which work has to be strapped in place. The erecting department will also find them of splendid service.

FROM LEFT TO RIGHT WE HAVE A TOOL-SETTING STAND, A LEVELING JACK, AND A SURFACE GAUGE CONNECTION.

THIS ILLUSTRATES THE LOCK JOINT. A SINGLE TURN FIRMLY LOCKS THE UNITS.

SOME EXTENSION UNITS AND RACK JACK.

This concern will also turn out what is known as an instant bolt coupler. By referring to the illustration showing work jacketed up and clamped, one can see a coupling in actual use.

This attachment is claimed to save the time and cost of making special bolts for special jobs. With the aid of coupler any length of bolt can be had by coupling up bolts you already have. Better still use studs for greater economy, for each bolt retains its own nut. These couplers are also made of malleable iron, and are designed to withstand high strains.

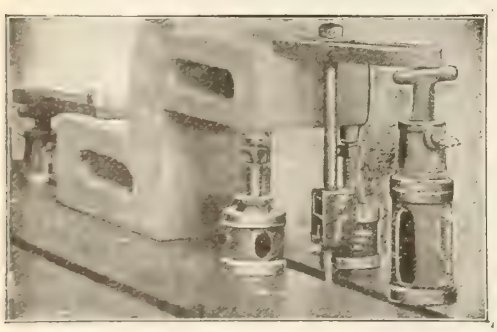


ILLUSTRATION SHOWING BOLT COUPLER AND JACKS IN USE.

HERE ARE THE UNITS. THEY CAN BE BUILT UP TO SUIT THE JOB.

The L'Air Liquide Society announce that their plant at London, Ont., is now in operation, and producing at full capacity. This is the seventh plant in Canada to be completed, and at present there are two others in course of erection, one of which will be in operation within a month of two. This news will, no doubt, be of interest to those requiring oxygen for use in their plants.

NEW PUBLICATION

Centrifugal pumps for sugar house service are described in Bulletin S, issued by the De Laval Steam Turbine Co., of Trenton, N. J. Centrifugal pumps are recommended for sugar house work because of their simplicity, reliability, high economy, wide range of capacity and small space requirements. There are no valves, and but two simple packings. The only parts subject to wear by rubbing are the bearings, the lubrication of which is automatic. Little attention is required, and inspection is easily made. De Laval Centrifugal pumps are characterized by horizontally split casings, by the fact that all parts are made to limit gages and are interchangeable, by comprehensive guarantees covering capacity, efficiency, and the relation between delivery and pressure, and by the fact that each pump is fully tested before leaving the shops. The present bulletin describes centrifugal pumps for handling raw juice, limed juice, soda, syrup, boiler feed water and injection water, and for maceration and hydraulic pressure service, etc. Motor and turbine-driven pumps, both single-stage and multi-stage, are illustrated and described.

The M. H. Detrick Company, of Chicago, Ill., has recently purchased the ash conveyor formerly manufactured by the Hagan Corporation, of Pittsburgh, Pa. The conveyor will be marketed hereafter under the name of the DETRICK-HAGAN CONVEYOR.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse	base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 50
Linseed oil, raw, single bbls.	2 90
Linseed oil, boiled, single bbls.	2 92
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Steam Trap SARCO Saves Money in Six Ways

Saves money because it saves steam. Being operated automatically by the expansion and contraction of a volatile liquid, the valve is closed **promptly** when the condensation has been discharged.

2. Saves money by keeping the line free from **all** condensate **all** the time. The Steam Trap Sarco drains condensate as soon as it forms.

3. Saves money by returning condensate to the hot well while **still hot**, instead of when cold from lying around, as in bucket traps. This **hot** water can, of course, be much more quickly and economically re-converted into steam.

4. Saves money because it requires no platform building, no supports, no pit-digging. Steam Trap Sarco is so small and compact that it can be installed at any point in the line, no matter how limited the space, and becomes practically an integral part of the line.

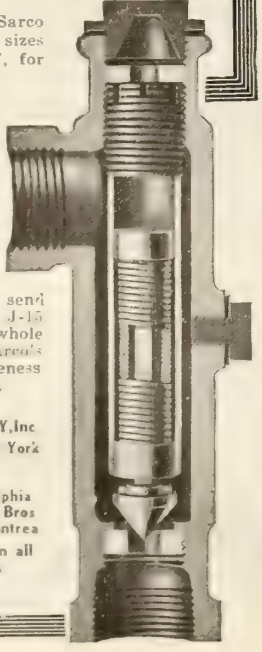
5. Saves money because it has no complicated parts to require adjustment, repair or replacement. It eliminates entirely all the levers, gauges, floats, stuffing boxes and other superfluous parts found in traps of the bucket or float type. It has, in fact, only one moving part.

6. Saves money right at the start, because it costs but **one-third** as much as float or bucket traps. Its compactness and simplicity of construction is the reason back of its lower cost.

Steam Trap Sarco is made in sizes from ¾" to 3", for any given pressure up to 200 lbs.

You can try it out for yourself **at our expense** by taking advantage of our 30 days' free trial offer.

At any rate, send for Booklet J-15 and get the whole story of Sarco's greater effectiveness and lower cost.



SARCO COMPANY, Inc
239 Broadway, New York

Buffalo Detroit
Chicago Philadelphia
Cleveland Peacock Bros
Montreal

Representatives in all principal cities

SUPERHEATED STEAM IN TURBINES

It is generally estimated that the gain in economy due to the use of superheated steam is about 1 per cent. for every 10 deg. of superheat. Thus, if steam having 150 deg. of superheat is employed, the resulting gain should be 15 per cent., irrespective of whether the steam is employed in a reciprocating engine or a turbine. There are certain disadvantages which follow the improper use of super-heated steam, the two most important of these being the effect of high temperature on the castings of the engine, causing distortion; and the difficulty of lubrication. In the turbine the effects of distortion may be particularly serious in view of the fine clearances which have to be adopted with certain types of turbine, and it may be stated that one of the reasons why the high-speed impulse type of turbine is adopted is because with this type, owing to the high velocity of the steam, the clearances can be made more generous in both the axial and the radial direction. It is, however, advantageous to keep that portion of the turbine which is exposed to the effects of highly superheated steam as small as possible, and for this reason in the first set of nozzles the fall of pressure is often about two-thirds of the total fall between boiler and condenser, so that on leaving these nozzles the temperature of the steam has fallen to such a degree that its effects are greatly reduced.—"Shipbuilding and Shipping Record."

ANNOUNCEMENT

Geo. W. Cole, Limited, condensation engineers, Toronto, announce the opening of a new office in Montreal. It will be under the management of Louis H. Bacque, and will be situated at 76 St. Gabriel Street, Montreal. They announce at the same time the appointment of Mr. George A. Young, 203 Scott Block, Winnipeg, Man., as their representative for the prairie provinces.

CATALOGUES

We have received two well illustrated booklets descriptive of the products of the American District Steam Company. They describe respectively the heating system installed by this company, and known as the "Adsco" System, and heating specialties used with it. The system is operated on the atmospheric plan, pressure of only a few ounces being used. The catalogue is very complete, and includes rules for computing radiation required for any given temperature. The specialties include reducing valves, damper regulators, diaphragms, safety valves, pipe fittings, and all the necessary apparatus for a complete installation.

The Geo. F. Foss Machinery and Supply Company, of Montreal, has just issued an elaborate and well-arranged catalogue, containing 1,300 pages, exclusive of index, the latter occupying about 50 pages. The book is profusely illustrated with cuts and diagrams. A prominent feature of this catalogue is the arrangement of the various lines and the systematic grouping of the different articles. The illustrations on a given page are designated by the same number, being distinguished from each other by the addition of different letters. A special index has been devised for locating all articles described and instantaneous reference is practically assured. A considerable section in the back of the book is devoted to useful and valuable information.

The Jeffrey Manufacturing Company, of Columbus, Ohio, have issued a bulletin which is numbered 141 and which features their single roll coal crusher. This booklet contains interesting information regarding sizes of coal for stoker users and shows illustrations and drawings of a number of typical installations of crushers with other apparatus.

Montreal Gives Contracts.—The Administrative Commission of Montreal has awarded contracts for electric pumps and apparatus, in connection with the waterworks, to the following firms: The Fraser Chalmers Co., one 30,000 gallon pump at a cost of $50,250, one similar pump to the E. Laurie & Co. at a cost of $45,200. The Canadian General Electric Co. have been awarded contracts for manufacture and installation of transformers, motors, etc., at a cost of $48,640.

The Mono Corporation of America, with Mr. F. D. Harger as general manager, announces its location at No. 48 Coal & Iron Exchange, Buffalo, N. Y., to manufacture and sell the various types of Mono apparatus for the automatic analysis of CO_2, CO, O_2, H_2, SO_2, N_2, C_1, etc.

This company will maintain a service and inspection department in connection with their laboratory and will arrange for regular inspection trips among their customers.

The Precision Instrument Company has recently moved their factory to Newark, N. J., where they are located at 21 Halsey Street.

American Manufacturer Wants Representation in Canada

Our proposition should interest an established machinery supply house now calling on steam power plants in Canada. For particulars, write Box 518, Power House.

(H) P.H.

FAIRBANKS-MORSE

A National Institution of Mechanical Service

IN Canada, as in every country in the world, there are names which, through years of service, have warranted national confidence and good-will. In the Canadian world of mechanical and engineering efficiency there is one name which enjoys the distinction of leadership. Its prestige carries through the entire coast-to-coast chain of sales offices and warehouses into every city, town, and hamlet.

Fairbanks-Morse products mark the farmer, the manufacturer, the artisan, and all users as careful and practical buyers of mechanical goods. The Fairbanks-Morse 100% quality seal is the buying guide for the consumer—the guarantee of satisfaction.

The Canadian Fairbanks-Morse general catalogue is a reference of what is standard in design and practice in mechanical goods. This book lists the largest variety of scales, valves, steam goods, oil engines, pumps, electrical machinery, machine tools, woodworking machinery, transmission appliances, railway contractor's and machine shop supplies ever published in Canada in one book. Your copy will be sent on request.

The Canadian Fairbanks-Morse Co., Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, St. Catharines, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Vancouver, Victoria. 1

Canada's Departmental House for Mechanical Goods

TRADE GOSSIP

The Locomotive Superheater Company, 30 Church Street, New York, have issued a new bulletin, T-5. This bulletin covers the advantages of superheated steam. The context presents the engineering reasons for these advantages from a new angle. The argument is clear and concise and should be of interest to all power plant owners and operators in every industry or power plant service.

No Strike in Galt.—An amicable settlement has been reached by the iron moulders and manufacturers of Galt, and all possibility of a strike has been removed. The moulders demanded a wage of 80 cents an hour and an eight hour day, but after two joint conferences an agreement was reached whereby the minimum wage will be 72 cents an hour, an increase of 7 cents, and the week's work 48 hours.

The Homestead Valve Mfg. Co., of Homestead, Pa., announces the removal of its New York office to No. 242 Lafayette St., New York City. The new office is on the third floor and is several times the size of its former location; the removal having been found necessary, due to the expansion of its New York business. The New York office is in charge of Mr. P. L. Rhodes, who has with him Mr. William Gormly, Mr. John Gormly, Mr. George Nagle, Mr. C. A. Tyler and Mr. W. B. Goering.

Orders for Steel.—Important developments are expected from a survey which is now being made of the iron ore area at Lock Lomond and at other parts of Cape Breton. The examination is being made by a geological expert in the employ of the Dominion Steel Corporation. The Armstrong Whitworth Company, one of the largest shipbuilding firms in Great Britain, has been endeavoring to place an order for 20,000 tons of ship plate with the Dominion Steel Corporation here. The Government of New South Wales has also been negotiating for 15,000 tons with the Dominion Government. A total of 19,000 additional tons have been sold to other Governments.

Northern Electric Changes.—M. K. Pike, general sales manager of the Northern Electric Company, is now on a business trip to the branch houses, and will be absent from the head office at Montreal for six weeks. A. Dwight Smith, former sales manager of the Montreal district of the Northern Electric Company, has been transferred to the Montreal head office, and will have charge of train dispatching, fire alarm and marine supply sales. N. S. Richards, who, for the past three years, has been sales manager of the Calgary house, has been transferred to Montreal, and appointed sales manager of the Montreal district, effective June 1st.

Meet in Rochester.—Rochester, N. Y., has been selected by the general executive board of the International Association of Machinists as the convention city for the association this year. Toronto was longer under consideration as a convention centre, but apparently lost favor at the last moment. It will be recalled that the association endeavored to get certain grants, as well as facilities with which to make the convention an all-round success. The grant was not donated, although the facilities were offered. Rochester has apparently made the grant which Toronto refused to make. More than three thousand machinists will attend the convention, which is to be held next September, and it will last three weeks.

General Strike.—The Toronto "Globe" carries the following:—Executive officials of Local 152, International Union of Steam Operating Engineers, who met in the Labor Temple to discuss phases of the wage schedule which they expect to go into operation on June 1 in local plants, admitted that officials with the authority to call a general strike of the craft in Canada were now in Hamilton, where the local union is engaged in a fight with the Steel Company of Canada. They said that these officials had the power to call this general strike, which would paralyze industry in Canada, upon twenty-four hours' notice to all local unions. "There is a very serious unrest among members of the organization throughout the Province upon wages. We are the lowest paid of any skilled craft," said Business Agent Cummings, who stated that the international officers in Hamilton had not asked for an expression of opinion upon a sympathetic strike.

"SAFETY FIRST"

Bend the Spout
to suit position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL

Note the flexible spout. It enables you to oil all places — many places that previously could only be reached with force pump cans with specially bent spouts.

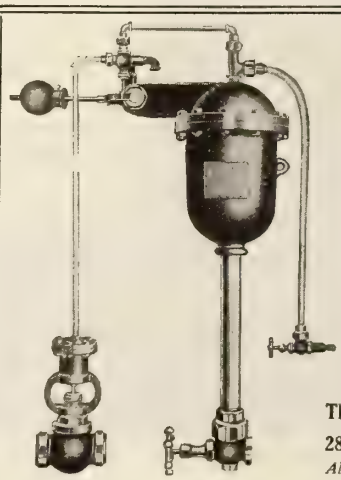
Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET, WEST - TORONTO, ONTARIO

CRANE MALLEABLE FITTINGS

CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.



ACT NOW!

You will be safe-guarded against boiler explosion due to low water, if you use VIGILANT REGULATORS. They cannot fail to operate and keep the water level where it will enable the boiler to produce the driest steam at the highest economy figures.

The slow uniform feeding of these regulators means fuel economy because the feed water is then heated uniformly to a higher degree.

Our instructive catalog will tell you more about the reason why the Vigilant will accomplish all that we claim for it, and more. Write.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor

D. K. McLaren Leather Belting

British Oak Tanned

Good Belting Cheapest in the End

The lowest priced belting is invariably the dearest. It does not give satisfactory service even when new—slips and is always thoroughly unreliable. A belt bought from the viewpoint of **service** is truly economical. The initial price may or may not be highest. **Learn what each is made of—and how.**

The Hide

The hides used in making D. K. McLaren's Leather Belting are cut from the backs of the choicest steers. The back is the strongest part and of even strength and elasticity through out.

The Tanning

The genuine British Oak Tanning Process gives McLaren's Belting that mighty toughness which makes them so lasting and reliable. No better method is known for treating leather for belts.

The Finished Belt

The use of McLaren's Belting reduces slipping to a minimum, thus saving considerable power. The lack of stretch reduces the amount of time, labor and attention required.
Let us send you a list of users. Then get their opinions.

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

HEAD OFFICE AND FACTORY:
351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

VANCOUVER, B.C.
334 Cordova St. West

TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 Germain St.

THE ANDERSON

Model "D" Steam Trap

Allows No Escape of Live Steam

The valve is always locked with at least three inches of water, making the escape of live steam impossible.

A strainer and sediment chamber prevent sediment or scale from getting into the valve.

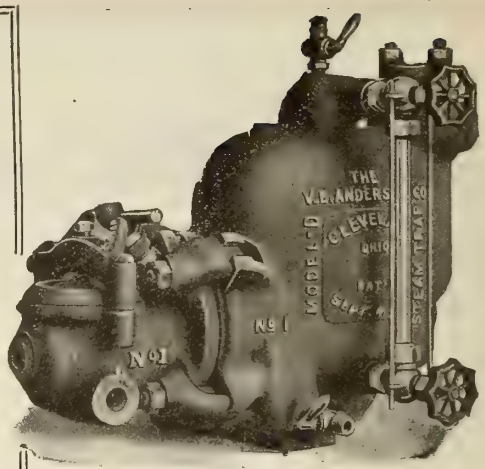
A glass water gauge, fitted to the valve, makes it possible to ascertain at a glance whether the trap is working properly.

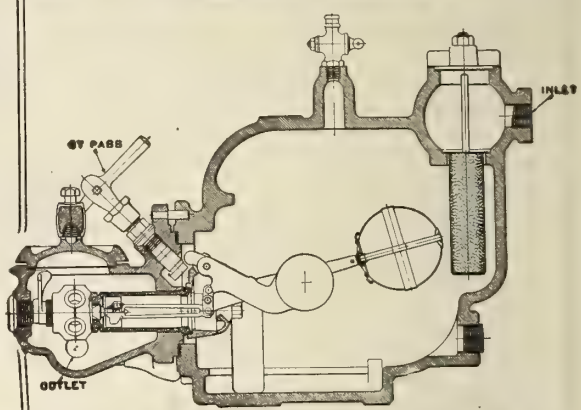
Both the valve and valve seat can be removed without breaking a steam joint or pipe connection.

The trap will lift water at any back pressure 5 pounds less than the pressure at the trap.

The Anderson Model "D" Steam Trap is accurate in every detail. Built of materials best suited for the purpose. Every part interchaneable.

Full particulars of these and other points will be forwarded immediately upon receipt of your request.





The V. D. Anderson & Company

1935 West 96th St., Cleveland, Ohio.

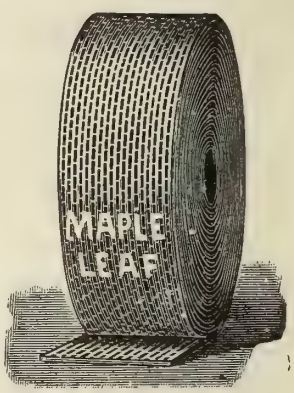
Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

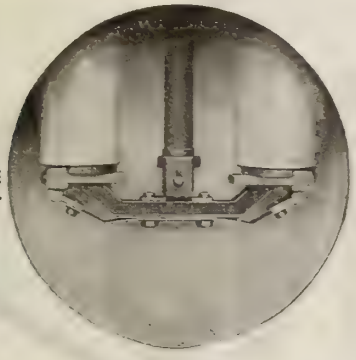
Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

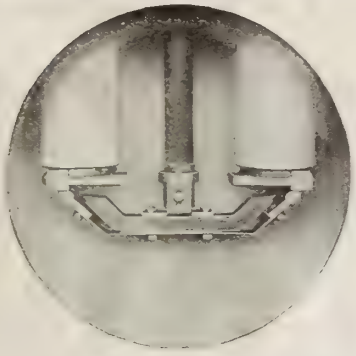
A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

FOUR CONDIT FACTS



1—Closed



2—Arcing Tips Protecting Brush

3—Open

Condit Oil Switch Construction

1. Note the perfect wiping contact of the Condit main laminated brush contacts, closed.

2. The circuit is broken by the auxiliary arcing tips. No arcing from main contacts.

3. Liberal Clearance when switch is fully opened.

4. Condit Type D-13 Oil Switch with individual Tank-per-Pole arrangement, providing high factor of safety.

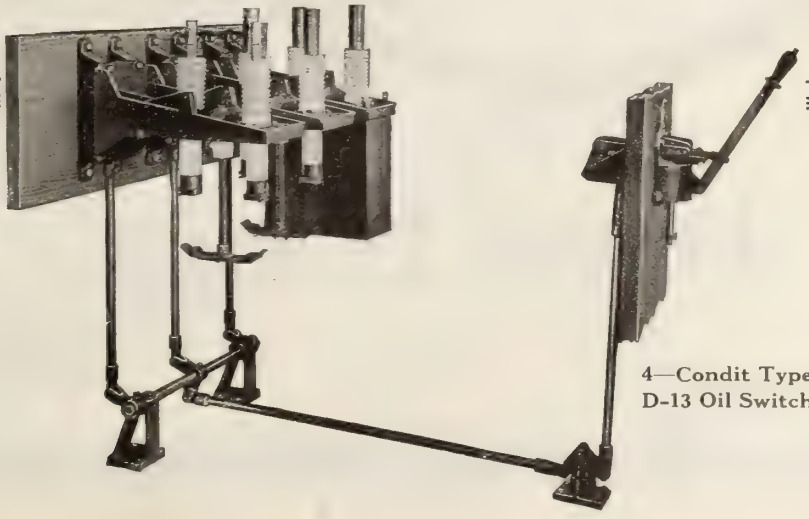
¶ Condit D-13 Oil Switch has a maximum capacity of

300 amperes at.....27,000 volts
500 amperes at.....25,000 volts
and
800 amperes at.....15,000 volts

Write our nearest Branch House for full information

Northern Electric Company
LIMITED

MONTREAL OTTAWA TORONTO LONDON WINNIPEG REGINA CALGARY
HALIFAX EDMONTON
QUEBEC VANCOUVER



4—Condit Type D-13 Oil Switch

TRADE
JENKINS
MARK

High Pressures Demand Exacting Service

The exacting service demanded of valves by high pressures cannot be met by merely additional all over weight.

Jenkins Extra Heavy Brass Globe Valves give exceptional satisfaction because of their extra weight of the **right** metal in the **right** places.

They hold absolutely steam, water, air and gas under high pressure for long periods without attention.

Every Jenkins Valve is made to withstand strains in excess of those which it will be called upon to endure in actual service. This is one reason why Jenkins valves are **dependable.**

The Jenkins line is so complete that—"There is a Jenkins Valve for every purpose."

Every genuine Jenkins Valve bears the diamond trade-mark—the sign of an iron-clad guarantee.

Catalog No. 8 upon request.

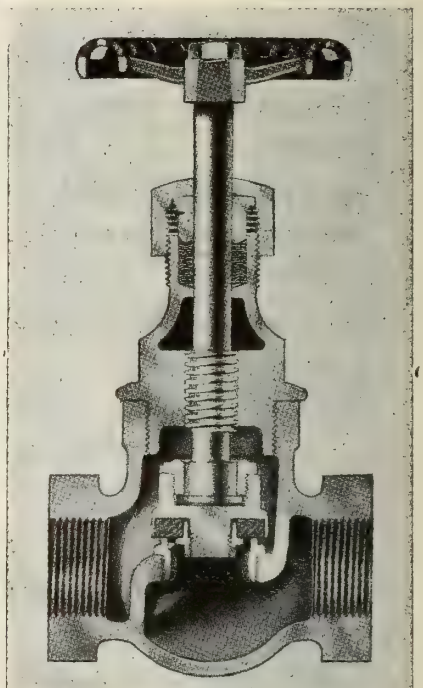


Fig. 128-S

Extra Heavy Brass Globe Valve

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works:
103 St. Remi Street
Montreal .Canada

Agencies in all the
Principal Countries
of the World

European Branch :
6 Great Queen St. Kingsway
London, W.C. 2, England

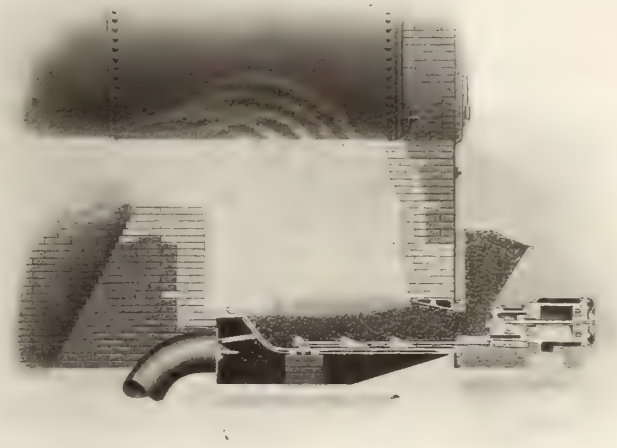
Jones Underfeed Stoker

Immediately Responds to Sudden Demands

Sudden demands for steam secure prompt action on the part of the stoker. The coal and fan automatically increase their speed the moment the steam pressure is reduced. Constant steam pressure is maintained even under fluctuating loads.

The Jones Underfeed Stoker eliminates smoke by stopping its formation, thus preserving the heating surfaces of the boiler free from soot.

Let us tell you the other remarkable advantages of the Jones Underfeed Stoker.



JONES UNDERFEED STOKER CO., LTD.
37-41 Britain St. Toronto, Ont.

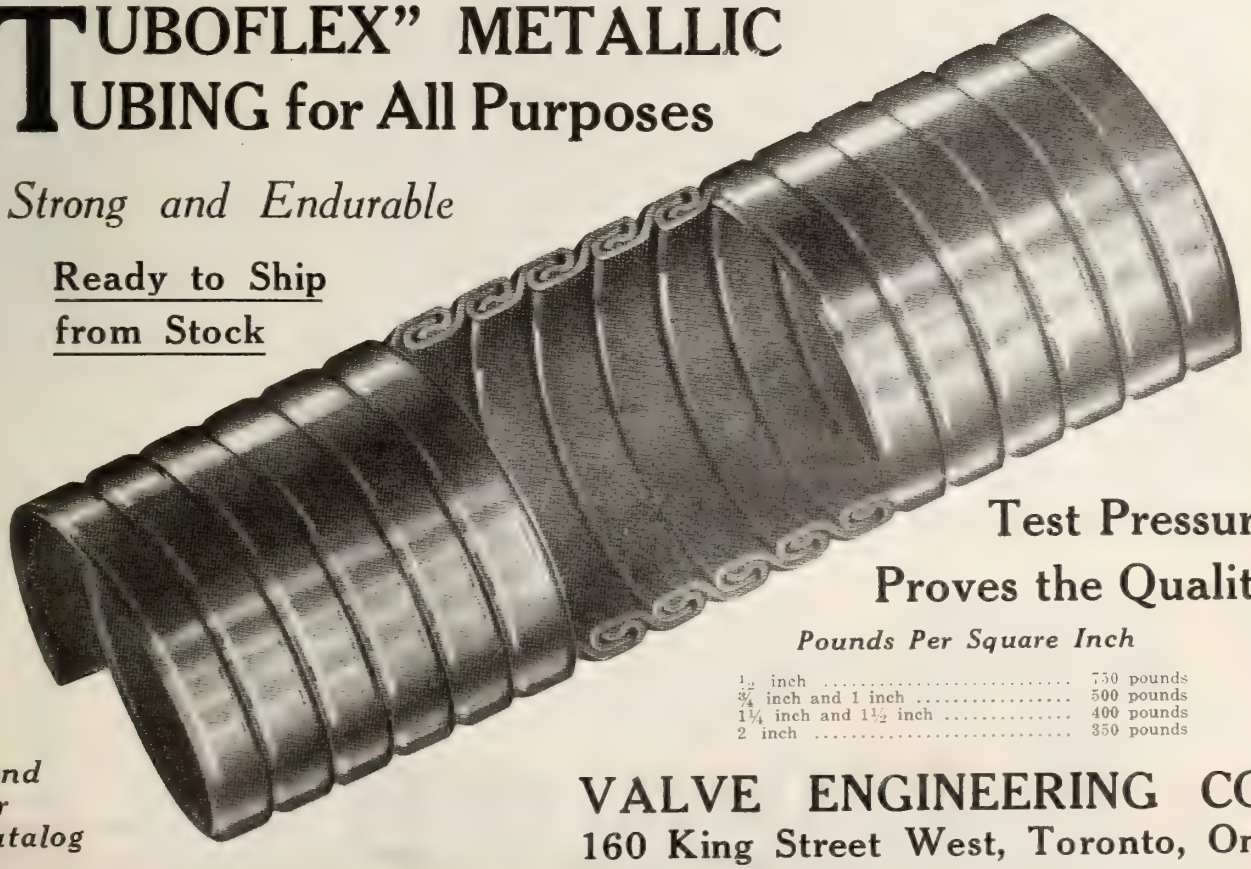
A Few Canadian Users

Dryden Pulp & Paper Co., Ltd., Dryden, Ont.; E. B. Eddy Company, Ltd., Hull, P.Q.; Canadian Packing Co, Toronto, Ont;; Halifax Electric Tramway Co, Ltd., Halifax, N.S.; Cornwall & York Cotton Mills Co., Ltd., St John, N.B.; Canadian Pacific Railway Company; Canadian Consolidated Rubber Company, Limited, Montreal; O'Keefe Brewery Company of Toronto, Toronto, Ont.; William Neilson Limited, Toronto.

"TUBOFLEX" METALLIC TUBING for All Purposes

Strong and Endurable

Ready to Ship from Stock



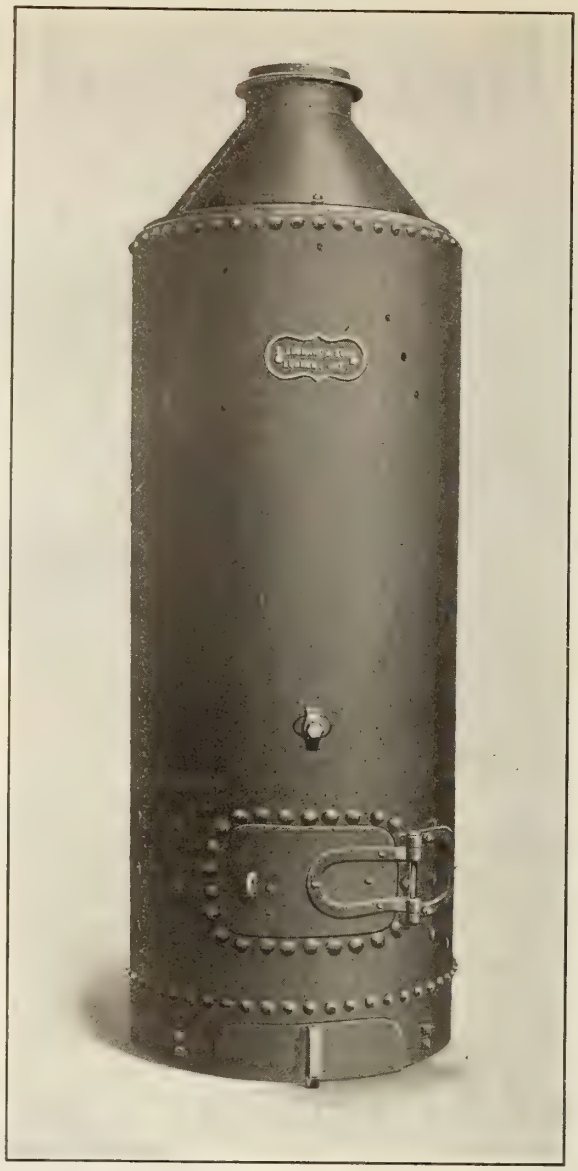
Test Pressure Proves the Quality

Pounds Per Square Inch

½ inch	750 pounds
¾ inch and 1 inch	500 pounds
1¼ inch and 1½ inch	400 pounds
2 inch	350 pounds

Send for Catalog

VALVE ENGINEERING CO.
160 King Street West, Toronto, Ont.



UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube
(Patented U.S. and Canada)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of All Types
Plate Work of Any Description
Grey Iron Castings

E. LEONARD & SONS, LIMITED

Head Office and Works: LONDON, Canada

Branches:

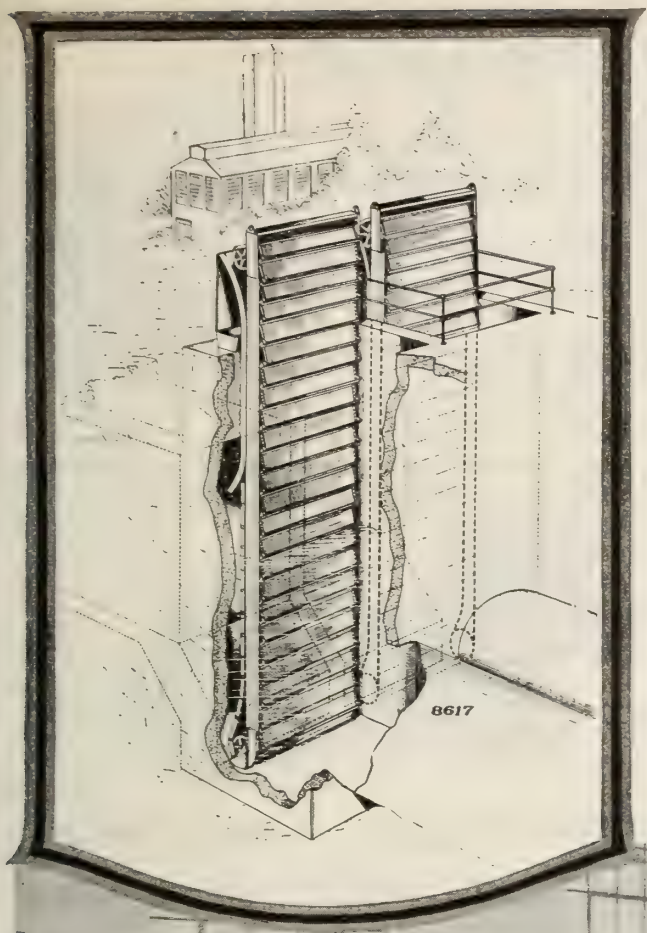
1790 St. James Street, Montreal, Que.
62 Water Street, St. John, N.B.

Agents:

E. J. Philips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning Street, Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave Street, St, John's, Nfld.

ESTABLISHED 1834

LEONARD



Get Clean Water for Your Condenser Intakes

by installing

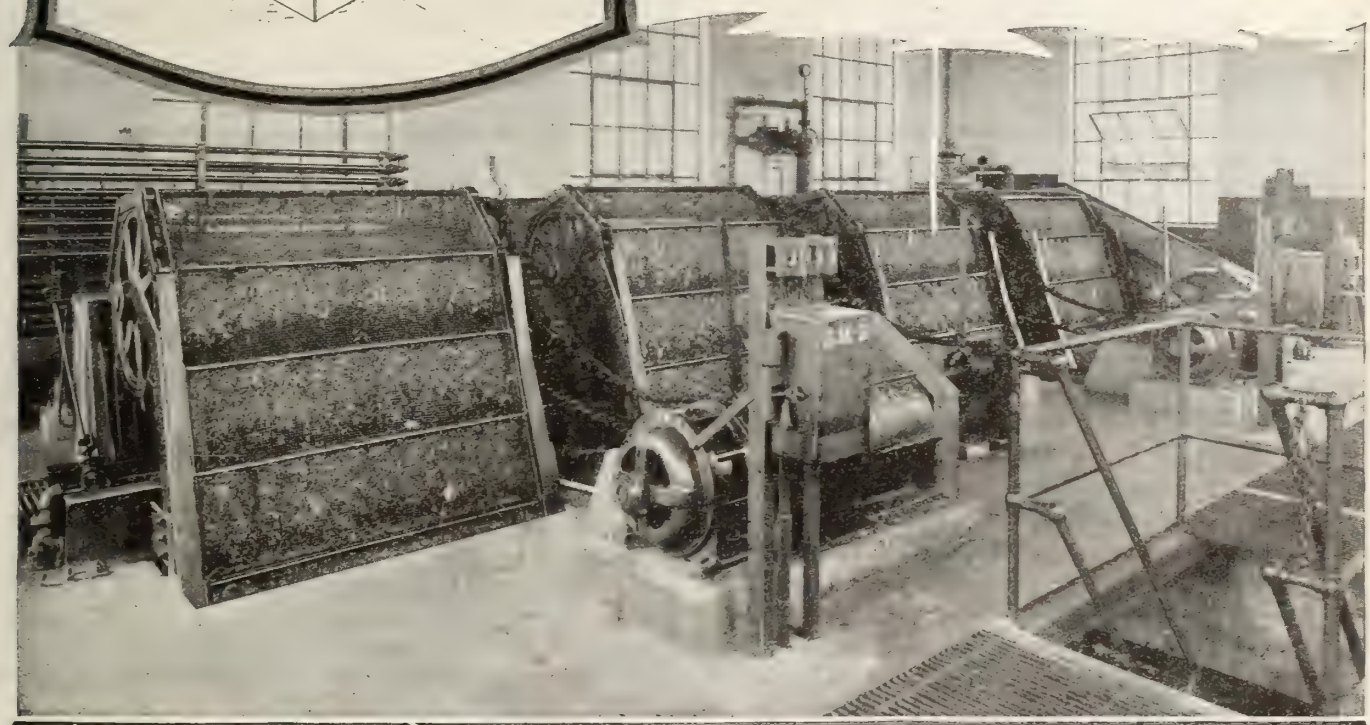
Link-Belt Water Screens

LINK-BELT Traveling Water Screens automatically remove the debris from the water and insure a steady supply of clean water to the condensers at all times. They are self-cleaning, require little attention and can easily be adapted to almost any intake system.

Let our experienced engineers investigate your system and make recommendations. Write for catalog.

CANADIAN LINK-BELT CO., LIMITED

WELLINGTON AND PETER STREETS
TORONTO



We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Portable Loaders
- ☐ Coal and Ashes Systems
- ☐ Coal Pockets

Write for Catalogs
Place X in Square

LINK-BELT
WATER INTAKE SCREENS

Showing ease with which Plibrico is laid in place.

PLIBRICO IS PLASTIC

and particularly adapted for Jointless, one-piece front-door arches, bridge walls, side walls, combustion chamber walls and baffles.

BETTER THAN FIRE BRICK

Can you see the advantage and economy?

Write for book on furnace building

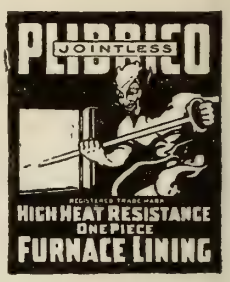
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U. S. Pat. Office.

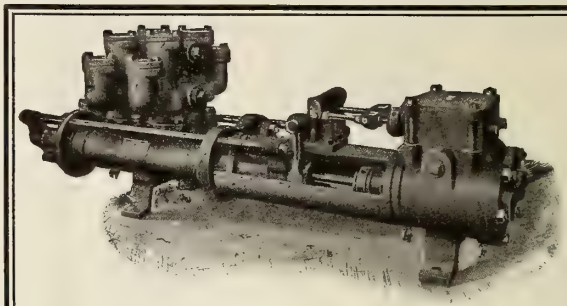
WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300



PUMPS

that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited

Hamilton, Canada

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

The J. C. Wilson Mfg., Co., Limited

BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.

172 JOHN ST
TORONTO

SCANDINAVIA BELTING

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

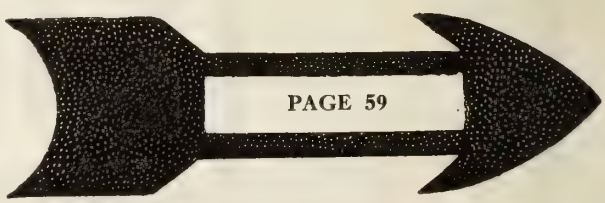
OTTAWA, CANADA

Special Castings ***Forgings***

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. ***Write for our latest catalogue.***

Patterns ***Machine Work***



THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co

27 COTE ST MONTREAL, QUE

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon .W. R. Rollo

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

Deputy Minister: W. A. Riddell, Ph.D.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

ECONOMIC Carling BLOWERS SUPERIOR

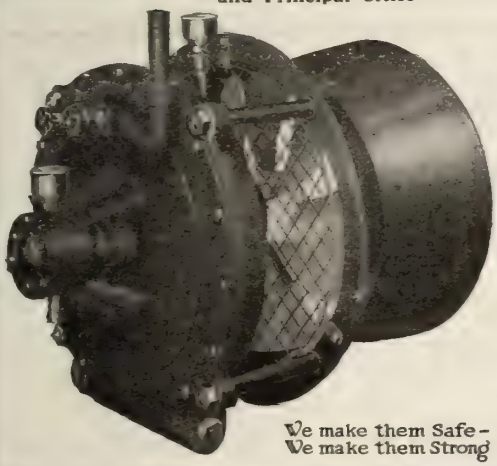
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

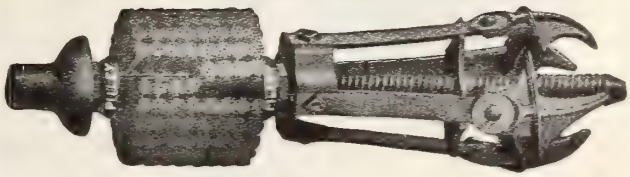
CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

The Simplest and Best Cleaner on the market is



PILLEY'S

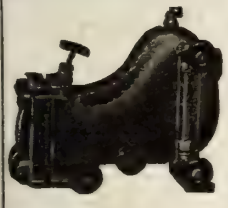
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal



McDANIEL IMPROVED **STEAM TRAP**

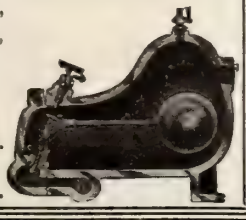
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

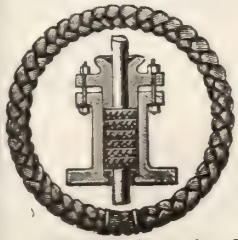
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

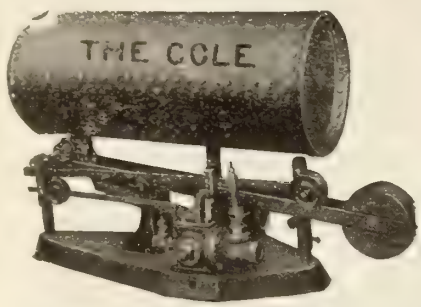
DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal

Two Established Facts

Man's capacity for good work is unlimited. Cultivate a sense of good and bad. It will help determine your capacity.

THE COLE Direct Return Boiler Feed Systems capacity for returning good, clean condensate back to the boiler is unlimited.



Remember this is a "Cole" year!

Boost for the "Cole" System of Steam Heating and Automatic Condensation Drainage.

Consult our Engineering Department on the probable fuel savings in your plant.

Geo. W. Cole, Limited

2002-4 Dundas St. West
TORONTO

Western Representative:
GEO. A. YOUNG
203 Scott Block - Winnipeg

Eastern Sales Office:
76 St. Gabriel Street
Montreal

Water Problems Solved

Our thoroughly capable organization will promptly and efficiently take care of your water problems—whether industrial, municipal or residential.

Prompt deliveries of the following lines:

Controllers for Temperature, Pressure or time.
Meters for Measuring Steam, Water, Air or Gas.
CO_2 Gas Analyzers—Hand Type.
Water Filters—Pressure and Gravity.
Thermometers for every use.
Gauges—Vacuum, Pressure and Compound.
Furnace Efficiency Indicators.
Hydrometers.
Steam Traps—Tank Type.
Separators—Steam or Oil.
Oil Filters.

Connelly Water Tube Boilers
Manufactured by E. Leonard & Sons, London, Ont.
Return Tubular Boilers
Steel Tanks Stack Plate Work

E. J. PHILIP & SONS

57 Queen St. West Toronto, Canada

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. **Glass Tubes and Rod**

S. & C. BISHOP & CO., St. Helens, Lancashire.

Canadian Letters Patent

The George T. Ladd Company, Pittsburgh, Pa., U.S.A., Owners of the Improvements in the Ladd Vertical Water Tube Boilers, covered by Letters Patent of the Dominion of Canada, Nos. 162,401 and 162,402 dated May 4, 1915, also Nos. 185,247 and 185,348 dated July 2, 1918, issued to Wm. H. Ritts and assigned to the George T. Ladd Company, have granted licenses to

The Goldie-McCulloch Company, Limited

GALT, ONTARIO

to manufacture and sell Vertical Water Tube Boilers, embodying the improvements claimed in said Letters Patent, and parties desiring to purchase this type of boiler can obtain them from this Company.

GEORGE T. LADD COMPANY

Farmers Bank Building
PITTSBURGH - - PENN, U.S.A.

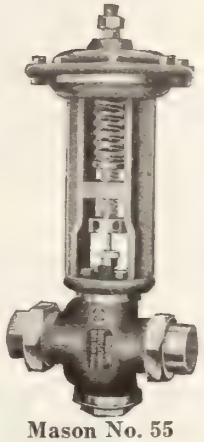
WHY "MASON"?

Mason Standard Bronze Reducing Valve

THE splendid reputation of the Mason Engineering Equipment is not the result of an accident, but the expected outcome of forty years of persistent effort backed by large capital and superior manufacturing facilities.

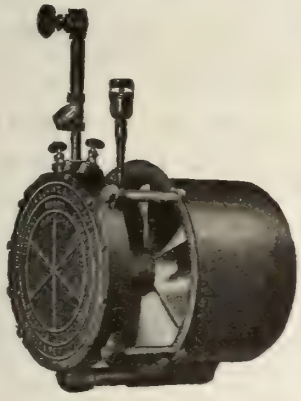
They hold the first place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend on these devices working in many critical locations and find them satisfactory. This is where Mason Service comes in. We have at your service a staff of engineers, specialists in the application of our devices. Their job is to see that you do not throw money away on unsatisfactory equipment, and to help you to choose equipment that will do the work required.

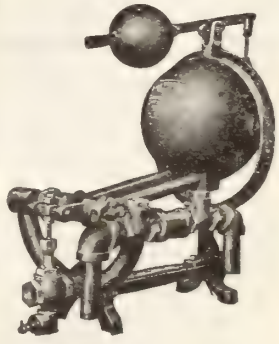


Mason No. 55 Pump Pressure Regulator

Coppus Turbine Driven Blower



New Bundy Return Steam Trap



We are very glad to hear from engineers who have a difficult problem in pressure regulation, engine or pump control, damper or blower regulation, or condensation drainage or returns. We have yet to hear of a problem, to which there is a possible solution, that we cannot solve.

THE MASON REGULATOR & ENGINEERING CO., LIMITED

MONTREAL
135-153 Dagenais St.

TORONTO
145 Wellington St. W.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Metlskin Mfg. Co., Rochester, N.Y.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betsoi Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd. Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd. T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk, Con.

HOMESTEAD
Quarter-Turn Valves

Homestead Valves will stay tight under any specified pressure up to 5000 lbs. Every valve unconditionally guaranteed. Try them on your lines—you take no risk.

Are Replacing Globes and Gates In Hundreds Of Plants

Here's Why

Only one quarter-turn is required to open a **Homestead** quarter-turn valve from absolute tightness **to a straight unobstructive flow,** while it takes anywhere from 6 to 10 turns of the wheel to open or close the ordinary globe or gate valve.

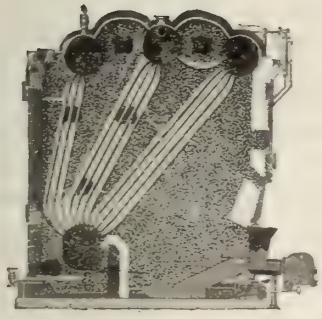
Homesteads are used for air, steam, water, oil or acids and will keep your pipe lines absolutely tight. **Order your requirements to-day.**

Catalog on Request

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

Starrett Hack Saw Chart

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS



Plastic Fire Brick in modern high stoker-fired furnace, including side and front walls, door arches, bridge wall and baffles.

Illustration shows Betson's Plastic Fire Brick Lining, including fire box, front wall of arch, furnace side walls, bridge wall, combustion chamber walls and rear arch.

Which Type of Boiler is Yours?

Regardless of type of Boiler or class of setting, when laid up of separate fire brick, furnace linings need frequent repair or replacement. This means overtime labor—perhaps a shutdown of the plant—at the best it is costly, annoying and repeated far too often.

BETSON'S
REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

is the ideal material for repairing and replacing furnace linings, and anyone can do the work.

Why not cut down this expense in your boiler room and increase the life of your boiler setting linings, baffles and arches, also reducing the infiltration of cold air?

Many keep a barrel or two of Betson's Plastic Fire Brick on hand at all times for emergency repairs.

Order to-day. Shipment will be made from our nearest branch or warehouse.

Write for pamphlet showing the way to use Betson's Plastic Fire Brick in your boiler room.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386—6, Rome, N.Y.

Canadian Distributor:
INTERNATIONAL CHEMICAL CO.
44-H LOMBARD STREET, TORONTO, ONT., CANADA

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

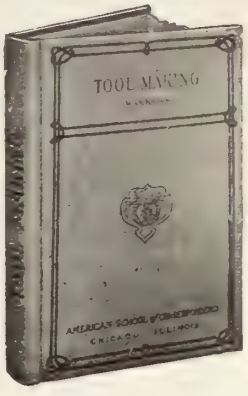
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

Clearance Sale of High Grade Technical Books



FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

Title of Book.	Name of Author.	Binding	Number of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	....
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	275	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Audels Answers on Practical Engineering	Harris & Associates	Cloth	254	Yes	.75
Gas and Oil Engines	L. E. Brookes	Cloth	192	Yes	.85
Ford Car	V. W. Page	Cloth	288	Yes	....
New Catcehism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Setting Valves of Canadian-made Engines	G. C. Keith	Paper	31	Yes	.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
How to Run Gasoline Engines	C. Von Culin	Paper	144	Yes	.50
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkin's Indicator	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Aids to Engineers Examinations	N. Hawkins	Cloth	222	No	1.50
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy of $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

153 UNIVERSITY AVENUE, TORONTO, ONT.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

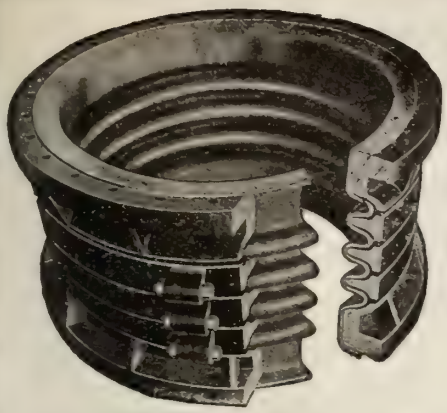
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



The Badger Self Equalizing

***Expansion Joint** will permanently prevent leakage, looseness and fractures, due to changes in temperature in steam, air, water and other pipe lines.*

Write for our new book today

E. B. BADGER & SONS CO.
81 PITTS STREET, BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes

There's a Tycos or Taylor
Temperature instrument for every purpose-

Taylor Instrument Companies
ROCHESTER, N.Y.
110-112 Church Street
Toronto, Canada

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman
(SOLE MAKER)
9, Westfield Road Birmingham Eng.

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester. N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Dunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd Sarnia.
Valve Engineering Company.

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

ROBB

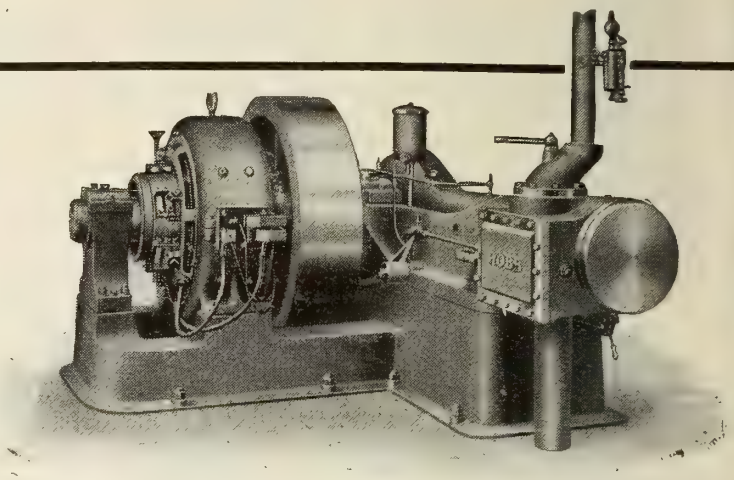
For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
Phone
Westmount 6800

Toronto Office:
20 Victoria
Street

INDEX TO ADVERTISERS

Anderson, The V. D. 44
All-Way Oiler Manufacturing Co. 42

Badger & Sons Co., E. B. 61
Betson Plastic Fire Brick Co. 57
Bishop & Co., S. & C. 52
Busch-Sulzer Bros.—Diesel Engine Wks 52

Canada Link Belt Co. 49
Can. Fairbanks-Morse Co. 41
Can. Farnsworth Co. ....Inside back cover
Can. Mead-Morrison Co. 8
Carling Turbine Blower Co. 51
Chaplin-Fulton Manufacturing Co. 42
Crane, Limited 42
Cole, Limited, Geo. W. 52
Coppus Eng. and Equipment Co. 7

Darling Bros. 50
Dart Union Company 12
Department of Labor 51
D'Este Company, Julian 9
Dominion Belting Company 44
Durabla Manufacturing Company 10

Electric Welding Company, The 50
Eng. and Mach. Works of Canada, Ltd. 2

Federal Engineering Company 50

Gilman, Frank 61
Goldie & McCulloch Co. 16
Gates, W. W. .....
Goodyear Tire and Rubber Co. 61
Gunns, Limited 42

Hans Renold of Can., Ltd., ...Front cover
Hays School of Combustion 13
Homestead Valve Manufacturing Co. .. 57
Hoyt Metal Company 2
Holden Co., Ltd., The ....Inside front cover

Imperial Oil Company 3

Jeffrey Manufacturing Co. 15
Jenkins Bros. 46
Jointless Fire Brick Co. 50
Jones Underfeed Stoker Co. 47

Ladd Co., The George T. 52
Laurie & Lamb 51
Leitch Co., The Arthur S. 14
Leonard & Sons, E. 48
Lunkenheimer Company 4
Lyman Tube and Supply Company 11

MacKinnon Steel Company 69
Manny Co., The E. S. 50
Mason Regulator and Engr. Co. 53
McAvity & Sons, Ltd., T. 4
McLaren, D. K. 43
Morrison Brass Manufacturing Co., Jas.
Outside back cover
Ministry of Munitions 55
McLaren, D. K. 67
Murphy Iron Works 9

Northern Electric Company 45

Page-Hersey Iron, Tube and Lead Co... 6
Penberthy Injector Co., Ltd. 5
Philip & Sons, E. J. 52
Pilley Packing and Flue Brush Mfg. Co. 51

Robb Engineering Works 64

Sanford-Riley Stoker Company 9
Sarco Company, Inc. 40
Scaife, Wm. B., & Sons Co. 64
Shell-Bar Boico Supply, Ltd. 63
Smart-Turner Mach. Co. 50
Starrett Co., L. S. 57
Steel Mill Packing Company 61
Sterling Engine Company 9

Technical Books 59
Tagliabue Company, C. J. 8
Taylor Instrument Company 61

Valve Engineering Co. 47
Victoria Foundry Company 50

Wall, J. W. 51
Watson & McDaniel Co. 51
Wilson Manufacturing Co., J. C. 50
Williams Co., J. H. 12
Worthington Pump and Mach. Corp. .. 12

York Manufacturing Company 10

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

Put a Farnsworth System to Work in Your Steam Plant

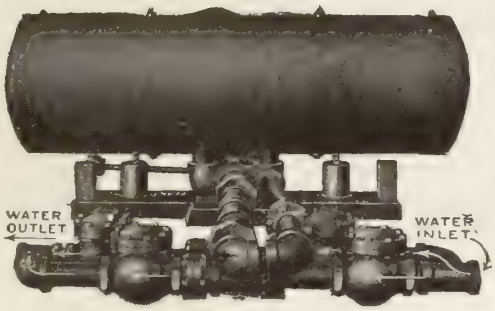
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no trunnions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE

Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

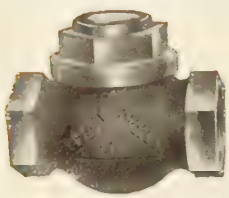
W. H. ROSE, Gen. Mgr.

BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

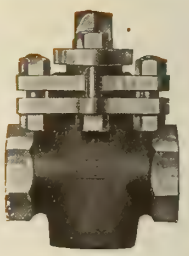
MORRISON

STEAM GOODS



J.M.T. Check Valve

UNVARYING IN QUALITY



Asbestos Packed Cock

The unvarying durability of Morrison Steam Specialties makes them safe and reliable. Before any article is allowed to leave the factory it is subjected to stress far in excess of that which it will be called upon to withstand in actual service.

The construction of the Morrison line represents the skill and knowledge obtained by over fifty years' varied experience.

Those familiar with Morrison products recommend them every time—they always make good. Approved by the Provincial Boiler Inspection Departments.

J.M.T. Reducing Valve

J.M.T. Globe Valve

Some of Our Lines

STOP VALVES,
CHECK VALVES,
GATE VALVES,
SAFETY VALVES,
RELIEF VALVES,
REDUCING VALVES,
STEAM TRAPS,

INJECTORS,
EJECTORS,
INSPIRATORS,
JET PUMPS,
STEAM GAUGES,
PIPE, TOOLS, ETC.,
VACUUM GAUGES,

AMMONIA GAUGES,
GAUGE BOARD OUTFITS,
LUBRICATORS,
PIPE FITTINGS,
STEAM WHISTLES,
ENGINE INDICATORS.

A full description of these and other Morrison lines, will be found in the Morrison catalogue. Write for a copy.

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

The James Morrison Brass Mfg. Co. LIMITED

93-97 ADELAIDE STREET WEST

Toronto, Ontario

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

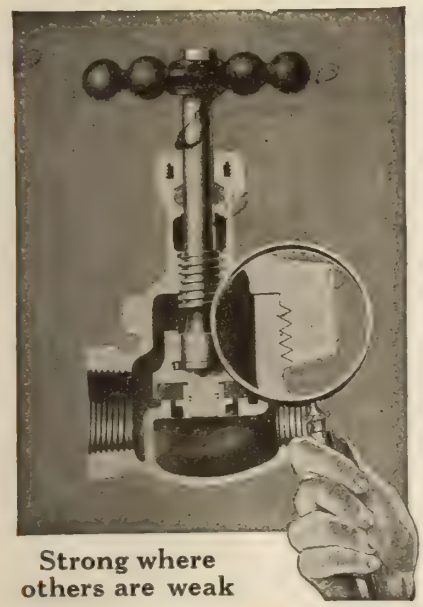
POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 11. Publication Office, Toronto—June 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year



Strong where others are weak

PENBERTHY LEADERSHIP

in the making of "All Quality" Brass Valves is not a matter of chance

It is because of our ability to give to the engineering public a better valve at no greater cost.

The outside bonnet construction is the first radical improvement made in valve design for many generations past and is found in all valves bearing our trade-mark.

All Penberthy Valves Are Government Approved

TRADE PENBERTHY MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY

Specified by the best Engineers

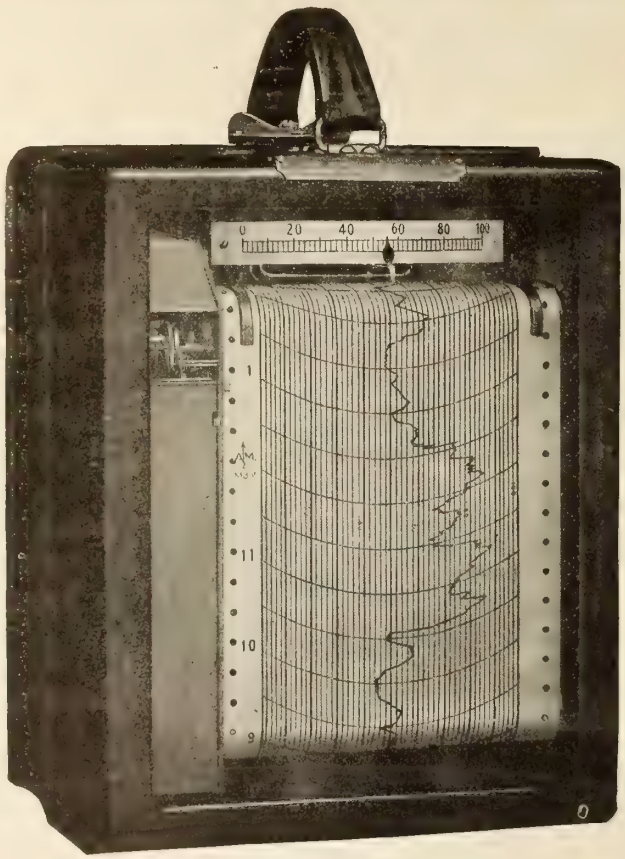
MANUFACTURED BY

PENBERTHY INJECTOR COMPANY, LIMITED - WINDSOR, ONT.

ESTERLINE

TRUE RECORDING INSTRUMENTS

Portable and Switchboard Types



Graphic Wattmeters **Graphic Voltmeters** **Graphic Power-Factor Meters**

¶ Ideal for generating stations, sub-stations, industrial and isolated plants where the value of a true load curve cannot be overestimated.

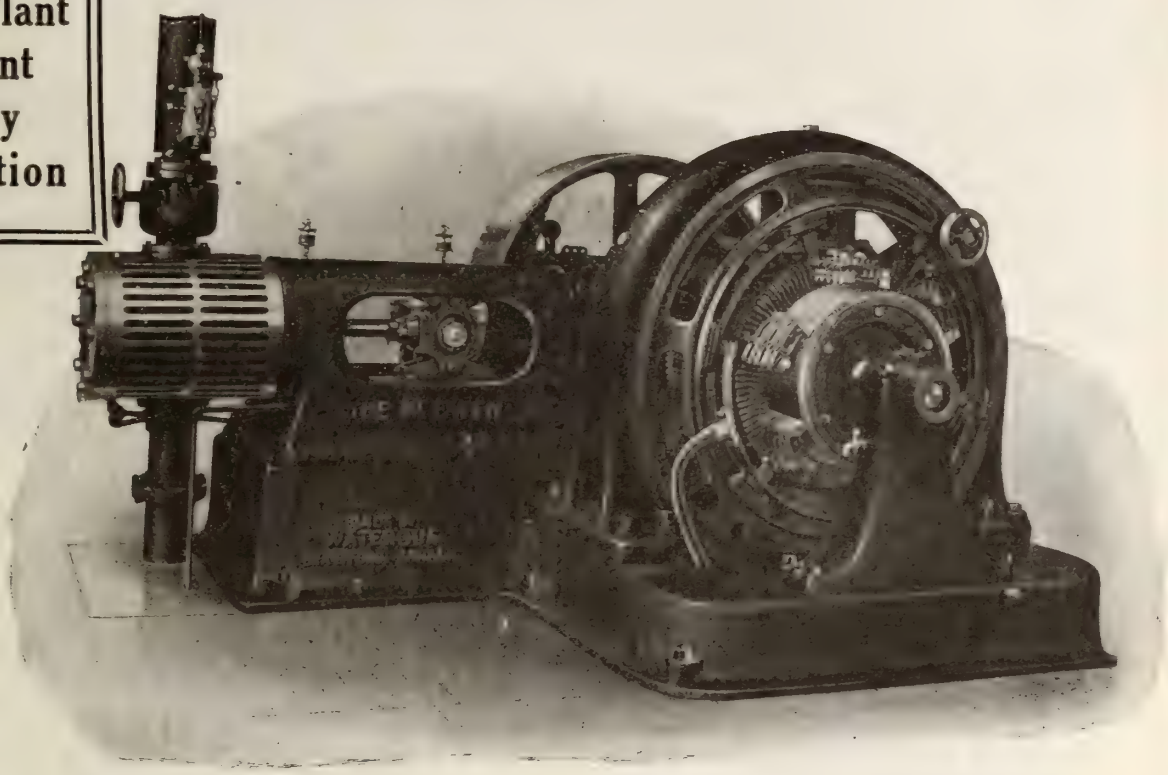
¶ The Illustration shows one of the Portable Graphic Meters, which is placed in an aluminum case with a glass face. The clock has an eight-day lever movement controlling the chart which is six inches in width and twenty-six feet long. A special inking device has been arranged for the marking of these charts. The holder will contain a supply for eight days and the ink is drawn through a tube to the pen by capillary action.

Write our nearest House for full information

Northern Electric Company
LIMITED

MONTREAL QUEBEC TORONTO WINNIPEG CALGARY VANCOUVER HALIFAX
OTTAWA HAMILTON LONDON WINDSOR REGINA EDMONTON

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

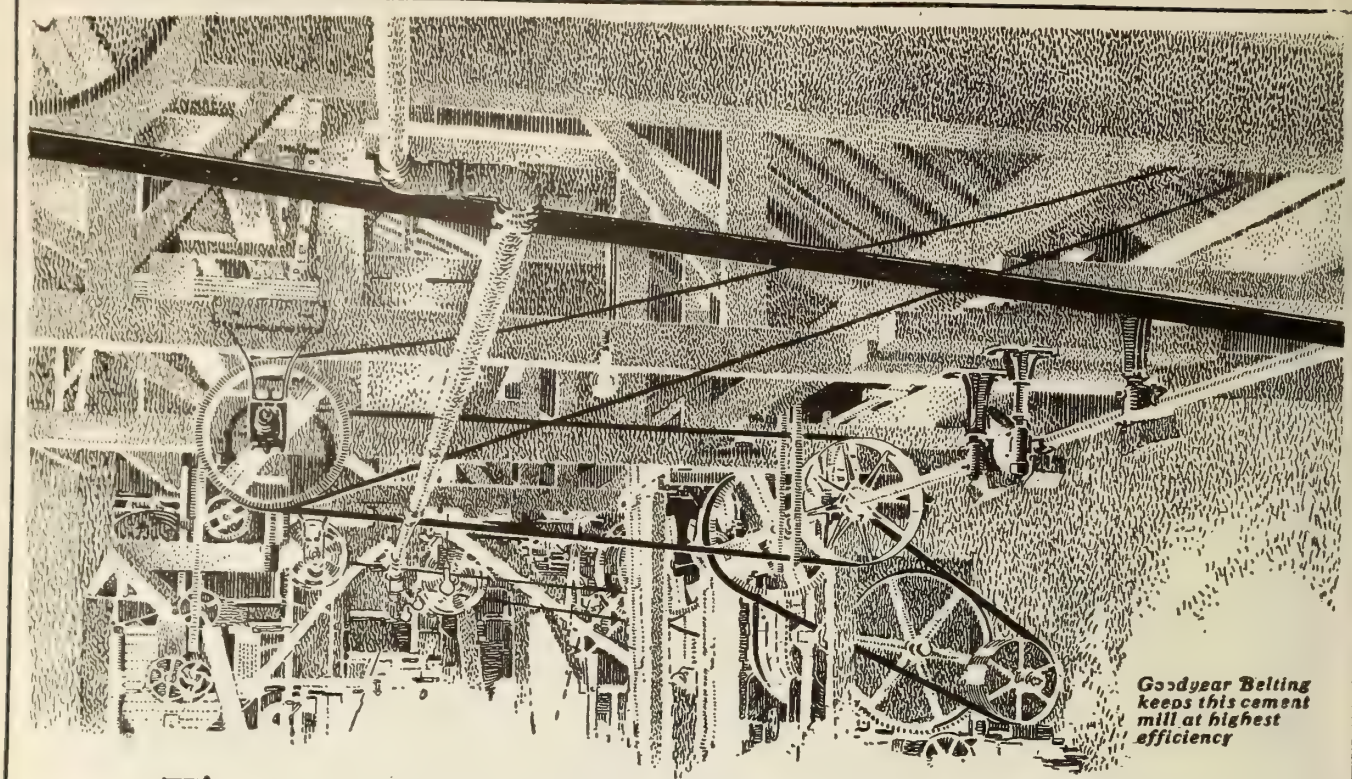
Your careful investigation of their actual service performance record in all parts of the country specially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

Waterous

BRANTFORD, ONTARIO, CANADA

POWER HOUSE, June 5, 1920, Vol. XIII., No. 11. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Goodyear Belting keeps this cement mill at highest efficiency

Troublesome Small Pulleys

Have you trouble getting belts flexible enough for small pulleys, yet strong enough to last?

Goodyear has produced Extra Power Belting—belting flexible enough that it need not be too tight! Gripping enough to prevent slipping at any speed!

For this is 5-point belting.

1. It is extremely strong, because of specially-designed, properly-woven fabric.

2. Yet it is very flexible, for it is not stitched, but is welded together with high-grade rubber, forced through and through the fabric and surrounding every thread. It hugs even small pulleys.

3. It has a friction surface which *grips*, dry or damp, and needs no dressing.

4. It has a seam *sealed* tight with high quality rubber.

5. The same rubber which gives Goodyear Extra Power its flexibility, prevents ply separation, even when the edge is worn or torn by shifters or accident.

The list of satisfied users of Goodyear Extra Power Belting on small pulleys is very great—too long to print here. But a few are:

O'Neil Morkin Machinery Co., Edmonton, Alta.
MacEachern Milling Co., Wetaskiwin, Alta.
Silver Standard Mining Co., Ltd., New Hazelton, B.C.
Hollinger Consolidated Gold Mining Co., Timmins, Ont.
Tilbury Flour Mills, Tilbury, Ont.
Chisholm Milling Co., Toronto, Ont.
Essex Canning Co., Essex, Ont.
Border Cities Tool Co., Windsor, Ont.
Brechin Roller Flour Mills, Brechin, Ont.
Nipissing Mining Co., Cobalt, Ont.
St. George Pulp & Paper Co., St. George, N.B.
Ungar's Laundry & Dye Works, St. John, N.B.
Ganong Bros., St. Stephen, N.B.
Robb Engineering Works, Amherst, N.S.
Ed. Sinclair Lumber Co., Newcastle, N.S.
O'Brien, Limited, Nelson.
Dominion Pulp Co., Chatham.
Richard's Mfg. Co., Campbellton.

Any one of these firms will be glad to tell you of their experience with Extra Power. Or a Goodyear Belting man will call without obligation to you. Phone, wire, or write the nearest branch.

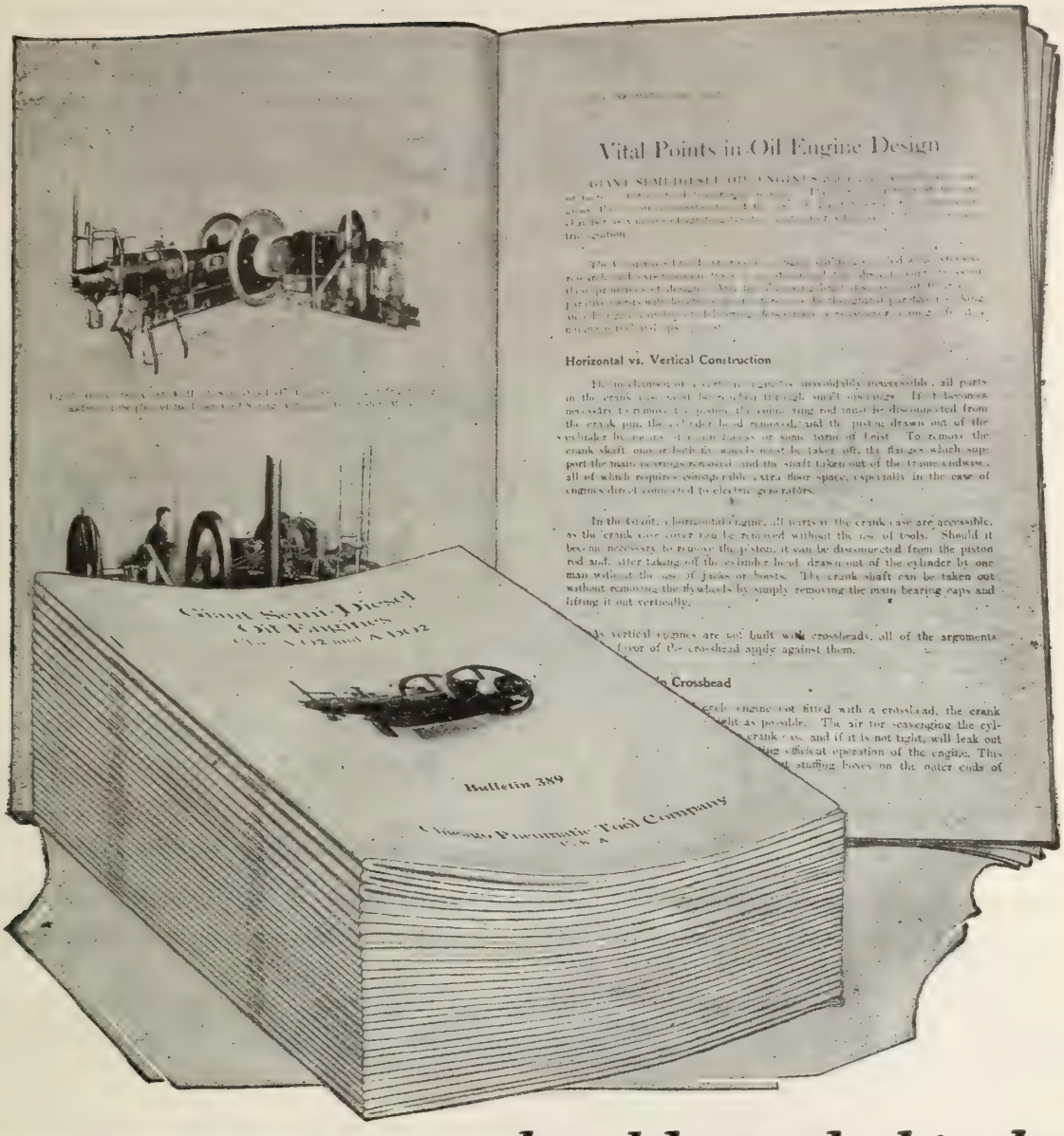
The Goodyear Tire & Rubber Co. of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in smaller cities.

GOODYEAR

MADE IN CANADA

EXTRA POWER BELT



Every power user should read this book

The low cost of fuel oil for power, **coupled with the time-proven dependability of the Giant Oil Engine is enabling power users everywhere to adopt oil as their standard fuel, and Giant Oil Engines their standard prime movers for operation on it. The book, "Giant Semi-Diesel Oil Engines" is an instructive publication from which every power user can glean many facts about oil engine design, construction and operation—facts that point the way to better, more economical power. Request your copy through the Company Branch nearest you.**

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN-38-H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CANADIAN CP PNEUMATIC

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

Binary alloys are classed as solid compounds, but in trinary and quaternary alloys only two of the elements are said to form a compound, as, for instance, in a tin-lead-antimony combination only the tin and antimony form the compound. Other characteristics in this connection will be discussed further on.

We give below the principal ingredients used in babbitt metals, and the approximate melting points, as we shall deal with these figures as we progress, viz.:

Tin, 446° Fahrenheit; Lead, 619° Fahrenheit; Antimony, 1166° Fahrenheit; Copper, 1992° Fahrenheit. It is axiomatic that good conditions will favor an inferior metal and adverse conditions militate against a good metal; hence it is not always possible to form an off-hand opinion as to the relative values of babbitts in actual service as careful comparative tests and records are generally necessary to reach a conclusion. In laboratory tests, however, comparative values can be determined quickly and acurately as maximum stresses can be applied and both water and oil lubrication used.

Genuine Babbitt was the first white metal alloy used for lining bearings and derived its name from isaac Babbitt, who first used it. He did not patent the mixture and was even uncertain as to its being the best, hence his patent merely covered the process of soldering alloy to the shell. However, his composition is about as good as can be made, and was used exclusively until lead base alloys appeared. Babbitt users naturally favored Genuine through force of habit and inherited custom and, therefore, when Magnolia was first introduced there was considerable opposition and mistrust regarding it.

(Continued next month)

For copy of complete article:

"New Truths and Old Fallacies"

Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:

Montreal: 225 St. Ambroise St.

10% Off Your Coal Bill!

Be Progressive—Use Nonpareil Shaking and Dumping Grates

Our guarantee will convince you. Nonpareil Shaking and Dumping Grates may be put under any kind of a boiler for a test period of thirty days. Should they fail to save 20% of fuel bills by giving better combustion, or prove unsatisfactory in any respect, they may be removed and shipped back to us—freight collect. **Write!**

So simple a girl can operate it with ease.

FIREBRICK WORK

There is one way to secure maximum satisfaction in your firebrick work. That is, Call in "Safety First" Sexton.

Sexton Boiler Settings are to be seen in some of the most important plants in Toronto. We shall be glad to give you their names and have you ask them what they think of "Safety First" Sexton's work.

Grate Bars and Repairs to Shaking Grates and Boilers of all sizes.

THE W. R. SEXTON BOILER SETTING COMPANY

127 D'Arcy St., TORONTO **Phone College 682**

To the man who doesn't care how it works, so long as it does the work

IF you are guided purely by precedent, when you select a steam trap, you will probably never know how good, how simple and how efficient a steam trap can be. Because there isn't a single thing about this 3-part Johns-Manville trap that in any way resembles the other kinds.

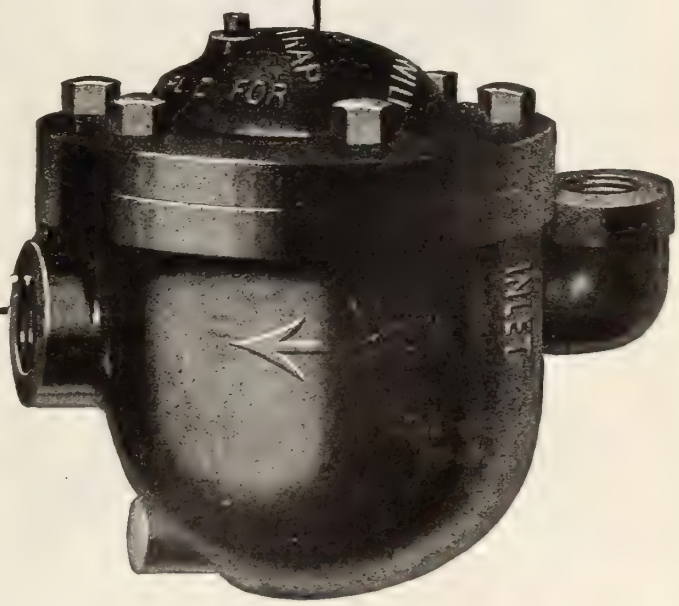
Four years ago the novelty of this trap appealed to everybody—now the efficiency of the trap itself has taken the place of its novelty features—because the trap brings results.

And now about results—The Johns-Manville Steam Trap discharges not only water of condensation, but air from any steam piping or apparatus, without the loss of steam. Size of pipe connections being equal, it has a greater capacity than any other trap of the same size that we have ever seen.

Year after year this trap has given and will give satisfaction to thousands of users to whom results are the only things that count.

Try out a Johns-Manville Steam Trap where you've been having trouble and watch it deliver the goods. Any of our branches will send the descriptive booklet and full information.

CANADIAN JOHNS-MANVILLE CO. LIMITED
Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa



COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS – MANVILLE

POWER PLANT MATERIALS

UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube (Patented)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

E. LEONARD & SONS, Ltd.
Head Office and Works:
LONDON, CANADA
Established 1834

LEONARD

Have Us Take Care of Your

Water Problems

Our organization is thoroughly equipped to give efficient service in solving your water problems—whether industrial, municipal or residential.

Prompt Deliveries Can Be Made in the Following Lines:

Controllers for Temperature Pressure or Time.
Meters for Measuring Steam, Water, Air or Gas.
CO 2 Gas Analysers—Hand type.
Water Filters — Pressure and Gravity.
Thermometers for every use.
Gauges —Vacuum, Pressure and Compound.
Furnace Efficiency Indicators.
Hydrometers.
Steam Traps—Tank Type
Separators — Steam or Oil.
Oil Filters.

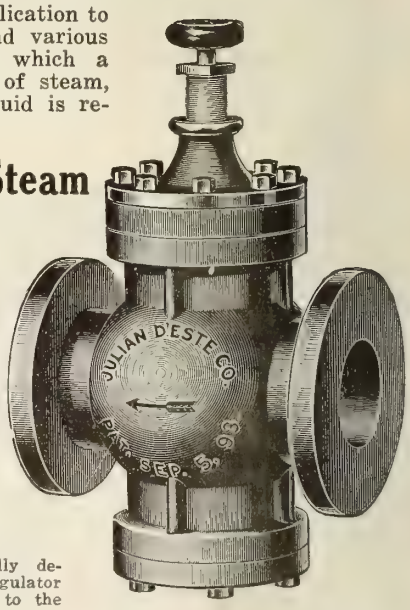
E. J. PHILIP & SONS

57 Queen St. W. Toronto

CURTIS Engineering Specialties

Universal City!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the



Improved Steam Pressure Regulator

has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

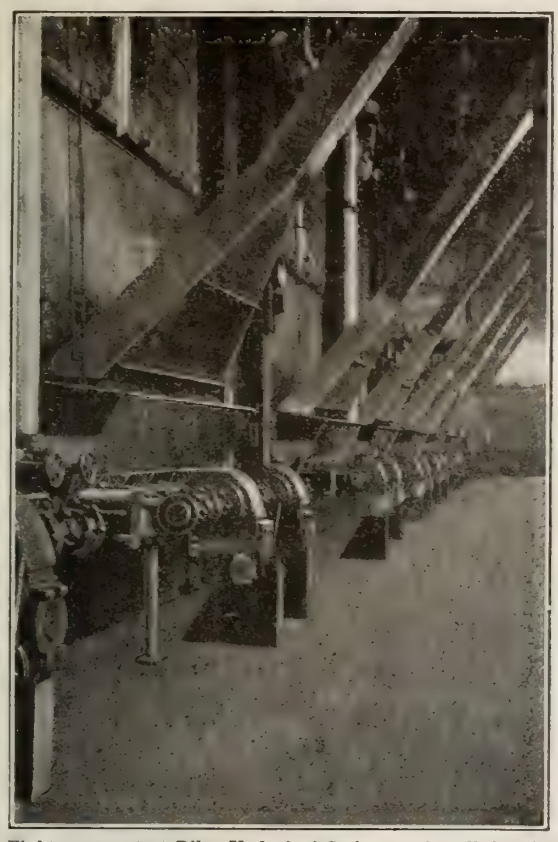
Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.



Eight seven-retort Riley Underfeed Stokers as installed under 600 horsepower B. & W. Boilers. Note the cleanliness of the boiler room and the absence of all operating mechanism underneath the stoker.

Riley Stokers Give

You Higher Efficiency and Lower Maintenance

The average efficiency the first year after installing Riley stokers at this industrial plant was 72%—the maintenance, $0.0035 per ton of coal fired.

RILEY UNDERFEED STOKERS

Such results have a meaning so significant that no engineer can safely disregard them.

The results are not unusual, but are typical of Riley Service. They are directly traceable to the three unique Riley features—*the moving grates—the continuous automatic ash discharge—the safety connecting rod.*

These valuable features are fully described in our catalogue HR-6.

For information on the Murphy Furnace for smaller boilers, see our advertisement in the last issue or send for catalog HM-6

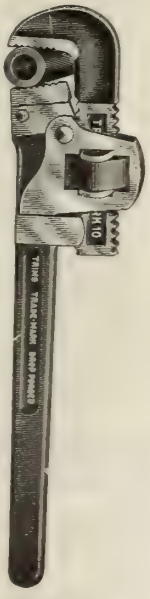
Sanford Riley Stoker Co.

Worcester, Mass.

British Licensees: Erith's Engineering Co., Ltd., London. French Licensees: Erith, Leroy & Cie., Paris, France.

TRIMO

THE WORD TRIMO



Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company

Roxbury (Boston,) Mass., U.S.A.

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office

Fireman's CO_2 Guide on Boiler Front

Continuous records (not intermittent)

No Chemical Solutions

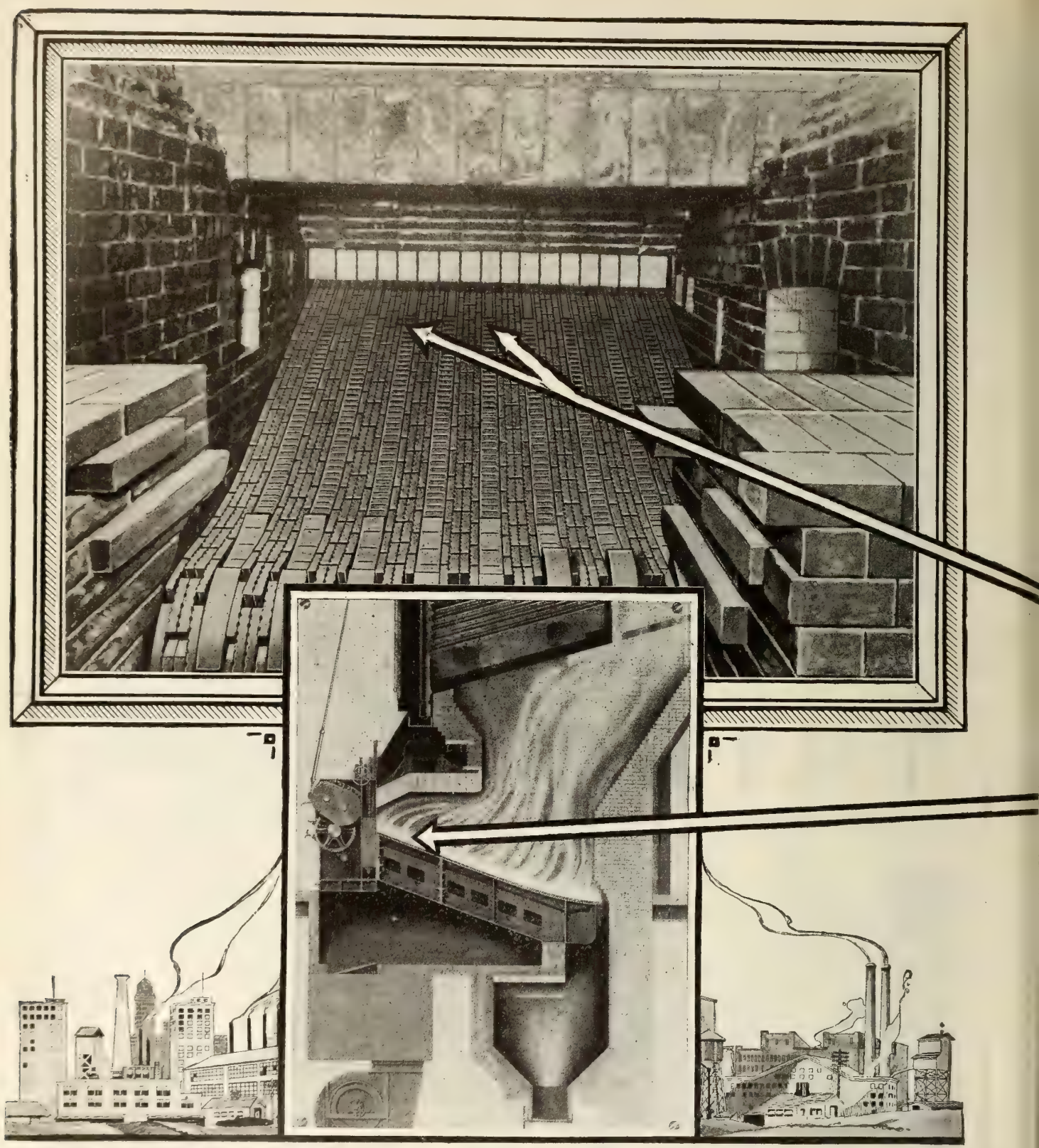
Send for Booklet

"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 EMPIRE BLDG., NEW YORK


LACLEDE
A BUSINESS INSTITUTION

THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

What Makes A Coal "Free Burning?"

Recent developments in stoker and furnace design have made it possible to produce a free burning fuel bed from low volatile coals by preventing the primary caking and ultimate coking of the coal. When freed of this caking tendency each individual particle of coal retains its identity during its journey through the furnace, thus causing the burning bed to appear soft, white and intensely luminous. Eastern bituminous fuels are in every respect as free burning as western coals when burned on the Stowe Stoker.

1. The air openings of these stationary tuyeres are designed to introduce large quantities of air through the fuel bed during the early stages of combustion.

2. The severe incline of the grate subjects the fuel bed more directly to the intense heat radiated forward by this scientifically correct furnace arrangement.

These two influences destroy the binding properties of that material in coal which forms the primary coke structure, and in addition volatilize the tarry oils before the final coking can take place.

We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices: CHICAGO, 1366 Peoples Gas Bldg.—PITTSBURGH, 901 Oliver Bldg.—NEW YORK, 504, Fifty E. 42nd St.

Agents:

PHILADELPHIA, PA.	KANSAS CITY, MO.	CHARLOTTE, N. C.	DENVER, COLO.
A. C. Warner Co.,	Thermal Efficiency Co.,	J. R. Purser,	Schwarz Eng. Co.,
Bulletin Bldg.	1210 Scarritt Bldg.	406 Com. Bank Bldg.	310 Mack Bldg.

WINNIPEG, CAN. Wm. A. Goold, 701 Merch. Bk. Bldg., MONTREAL, CAN. John C. Russell, 109 Place D'Youville

D130

CHRISTY

FOUNDED 1844 ST. LOUIS

LINDE

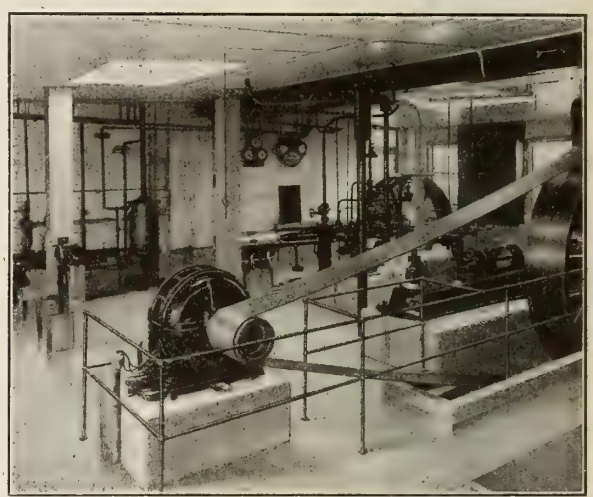
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

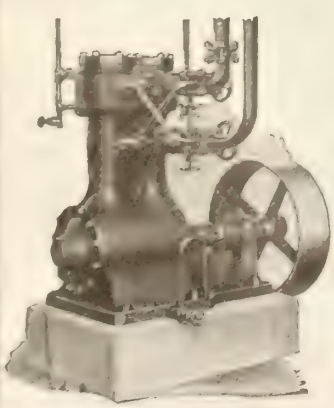


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

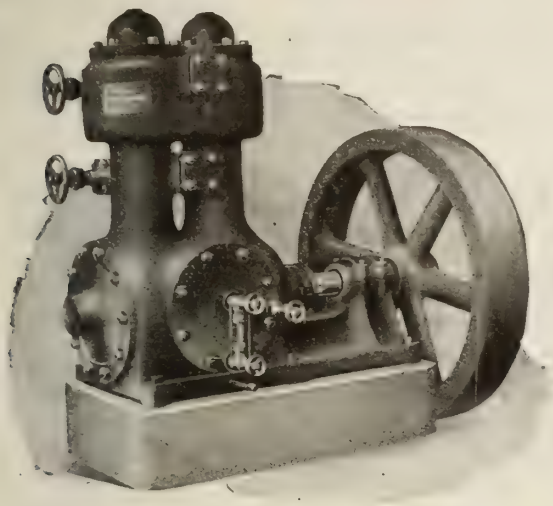
Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to **your** business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as **Standard throughout our plant**, as we find **them substantially made** and the **insulation perfect.** We also find the **Hardware stands up better than on any other door** we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are **equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.** We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"**The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market.**"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

An Investment—Not An Expense

TOO many users of refrigeration are apt to consider the insulation for cold pipes and tanks as an expense. And naturally the temptation is strong to cut first cost to the bone. Of course they are wrong, for good insulation—Nonpareil Cork Covering, for instance—is one of the most profitable investments they can make.

Under ordinary conditions Nonpareil Cork Covering saves 80% of the refrigeration that would be lost from bare, cold pipes and tanks. Generally speaking, that is enough to pay for its entire cost in the first twelve months. But it does not stop there. It is not an uncommon thing for Nonpareil Cork Covering to last ten years with ordinary care. In fact, it has records of twelve, fifteen and even twenty-two years of continuous service—paying a profitable return every year. The investment feature of Nonpareil Cork Covering appeals strongly to those who are using it. Doesn't it appeal to you?

The brine lines, ammonia lines, and brine coolers in the plant of the Sinclair Refining Company, Chicago, Ill., are insulated with Nonpareil Cork Covering.

If you are interested in a detailed description of the profit-paying possibilities of Nonpareil Cork Covering, you should have a copy of the 64-page illustrated book, "Nonpareil Cork Covering for Cold Pipes." Why not send for it to-day?

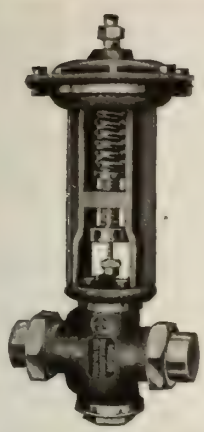
Armstrong Cork & Insulation Co.

504 McGILL BUILDING
MONTREAL, QUEBEC, CANADA.

Also manufacturers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High Pressure Covering for steam lines, feed water heaters, etc.; Nonpareil Insulating Brick for boiler settings; Nonpareil Cork Machinery Isolation for noisy machines; and Linotile for floors in offices, residences, etc.

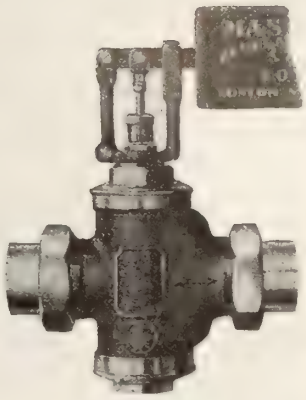
Nonpareil Cork Covering

For Cold Pipes and Tanks



Mason No. 55 Style
Pump Pressure
Regulator

SERVICE
RELIABILITY
POSITIVE ACTION
DEPENDABLE REGULATION



Mason Balanced Valve
Weight & Lever Type

THE TRADE MASON MARK

TRADE MASON MARK.

MASON

Mason Standard
Reducing Valve
Bronze Body

ON REGULATING APPLIANCES
MEANS
THE SAME AS THE
"STERLING" MARK ON SILVER

Mason Standard
Reducing Valve
Iron Body

THE MASON REGULATOR CO.,
BOSTON, MASS.

MADE IN CANADA BY
THE MASON REGULATOR & ENGINEERING
COMPANY LIMITED
MONTREAL & TORONTO

PUT YOUR OIL STORAGE PROBLEMS UP TO BOWSER ENGINEERS

ESTABLISHED 1885

Photographs of Oil Room Before and After Installing Bowser Equipment.

Photographs of Paint Room Before and After Installing Bowser Equipment.

Planning an Oil Storage System involves important details, easily overlooked by the inexperienced. Bowser service will suggest the proper system for your oils which when in operation, will bring almost unbelievable improvements in shop conditions, safety and saving.

The illustrations shown here give a fair example of what a Bowser Oil Storage and Distributing System does for the average business, large or small. There is some type of Bowser Storage Equipment suitable for your oil handling requirements.

Ask us to make a survey of your present needs. It will show you what you can expect a Bowser Oil Storage System to save you in floor space, oils, time, labor and money. This does not obligate you to buy Bowser equipment, and you will receive valuable information from such a survey.

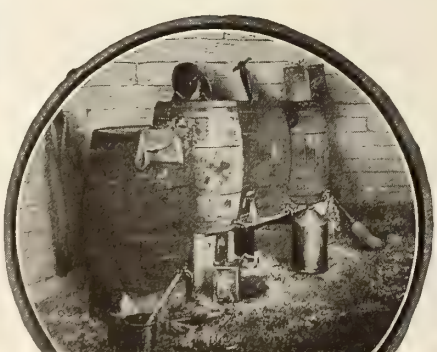
WRITE US AT ONCE.

S. F. BOWSER COMPANY, LIMITED

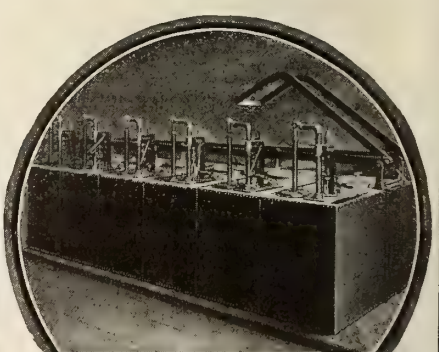
66-68 FRASER AVE., TORONTO, CANADA

LONDON
32 Victoria St. S. W. 1
HAVANA
Lonja del Comercio

PARIS
5 Rue Denis-Poissons
SYDNEY
6 Castlereagh St.



Wasteful and a Constant Fire Hazard



Bowser Equipment—Convenient, Clean, Saving, Safe.

REGISTERED
COPPUS
U.S.PAT.OFFICE

In the Confectionery Industry

Coppus in Confectionery Industry

Wherever candy is sold Huyler's trade mark means quality supreme. Wherever candy is made—there is an opportunity for COPPUS Turbo Blowers to save money in power plant operation.

These two 18" Blowers have been economizing time, fuel, and labor in the boiler room of the Huyler's Chocolate Company, 136 East 18th St., New York City, since July, 1917. They burn inexpensive fuel—keep up full steam pressure—and meet peak loads without extra exertion by the engineer, QUICKLY, EASILY CHEAPLY.

They can do this better than any other type of blower because of their

Standardized Construction
Rugged Reliability
Economy of Operation

What COPPUS Turbo Blowers are doing in other plants they can do in yours. If you will ask us we will be glad to send you complete information showing just how COPPUS Turbo Blowers can help you secure more power from your present equipment and greatly increase the efficiency of your power plant. Write for Blower Catalog

"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1011 Kent Building. Agents for Calgary:—W. J. Yec & Co., 413 McLean Block, Calgary, Alberta.

COPPUS TURBO BLOWER

REES RoTURBo

Single and Multi-Stage

Centrifugal Pumps

Self-Regulating

REES RoTURBo Pumps give high and permanent efficiency over a wide range of duties and being **self-regulating** insure the prime mover against overloading.

The low water velocity through all passages results in almost complete freedom from wear, even when pumping gritty water.

These valuable advantages are due to the REES RoTURBo Patent Pressure Chamber Impeller. It has other exceptional features worth knowing about—

Send for Complete Descriptive Catalog

The Goldie & McCulloch Co., Limited

Head Office and Works, GALT, Ontario, Canada

Toronto Office:
Suite 1101-2, Bank of Hamilton Bldg.

Quebec Agents:
Ross & Greig, 400 St. James St., Montreal, Que.

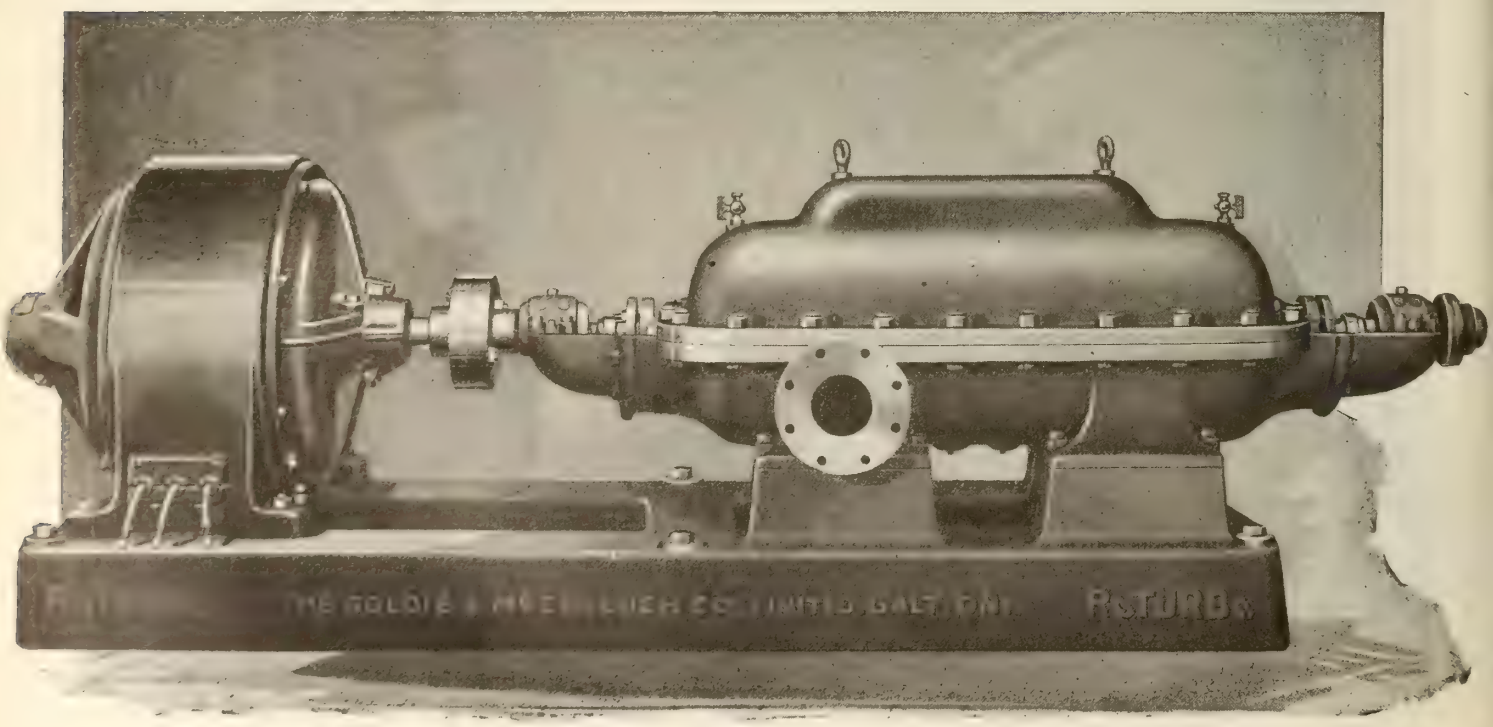
Western Branch:
248 McDermott Ave., Winnipeg, Man.

British Columbia Agents:
Robt. Hamilton & Co., Vancouver, B.C.

Dependable Power Plant Equipment

Made in Canada

We have the sole manufacturing rights in Canada for REES RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Jet Vacuum Pumps.



POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

The Hot Process Boiler Feed Water Softener

A Short Treatise on the Effect of Heat on Chemical Reactions, and an Account of Some Experiments Carried Out by the Harrison Safety Boiler Works

THE hot process softener in its present form is a recent development. By taking advantage of the fact that chemical reactions are more rapid and complete in hot water than in cold water, more efficient removal of scale and sludge-forming substances obtained. The apparatus performs the functions of the open feed-water heater usually found in steam boiler plants, in addition to those of a softener, and less space, lighter foundations, less housing, less piping and fewer fittings are required than for a cold process softener plus an independent heater. There are several reasons why scale-forming matter is more completely removed from hot water than from cold water.

Effect of Heat Upon Reactions. — Chemical reactions are enormousy accelerated by heat. This is a well-known and generally recognized fact, and was used in the household for ages before it assumed the dignity of a law of chemistry. Everyone knows that dishes and clothes are washed more rapidly and thoroughly in hot water than in cold water. Paper pulp is causticized in hot water, etc., etc. The exact law connecting temperature and rapidity of chemical reaction has never been determined accurately, some chemists stating that the speed of reaction doubles for each ten deg. C. added to the temperature, and others that chemical reactions are speeded up approximately as the twentieth power of the absolute temperature. These formulas are not in agreement, but everyone concedes that there is a tremendous increase in speed of reaction with rise in temperature.

Some years ago experiments were made in the chemical laboratory of the Harrison Safety Boiler Works to determine the effect of temperature upon the reactions which take place between softening reagents and scale-forming matter in boiler feed water. The results are shown graphically in Fig. 1.

It will be seen that the reduction in hardness, that is, in content of calcium and magnesium salts, is much greater at the end of ten minutes in water at 210 deg. F. than at the end of five hours in water at 50 deg. F., in fact twenty-four hours treatment in cold water does not bring the scale-forming matter down as much as does ten minutes' treatment in hot water. Subsequent heating to the boiling point of the sample, which has stood at 50 deg. F. for five hours reduces the magnesium hydrate to less than 1 grain per gallon, but the same result is obtained in hot water in 10 minutes. In performing these experiments, only sufficient softening chemical was added to combine with the scale-forming substance. In practice a slight excess is used, which reduces the hardness to lower figures.

The effects of heat can be verified in a rough way by performing the experiment shown in Figs. 2, and 4.

Place one pint of cold, untreated boiler feed water in each of two breakers, bring one of them up to the boiling point, but leave the other cold. Then add to each the amount of reagent theoretically required for transforming the scale-forming substances.

Stir thoroughly the contents of each beaker and note results. The reaction and sedimentation in the hot water will be much more prompt than in the cold water.

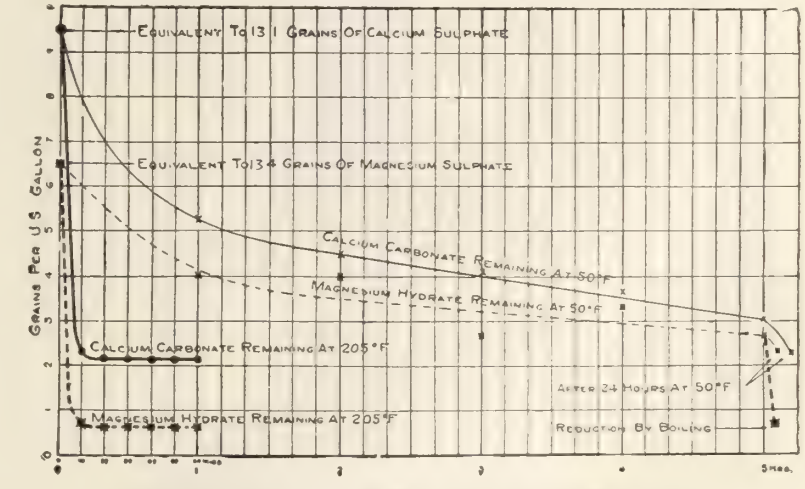
After precipitation has ceased in the cold water, decant the clear liquid and heat it to the boiling point. A marked after-precipitation will result, showing that the reaction in cold water was not complete. Do the same with the clear water from the hot water beaker. No after-precipitation will occur, so it is conclusively shown that the reaction is not only more rapid in the hot water, but is also more complete.

The substances resulting from the transformation of scale-forming matter are more nearly insoluble in alkaline hot water than in cold water, hence less are carried into the boilers in solution by water which has been softened hot.

Effect of Heat Upon Sedimentation.— The precipitates resulting from the transformation of scale-forming substances also settled more rapidly and completely from hot water than from cold water. Solid particles suspended in water settle to the bottom if their density is greater than that of the water or rise to the top if their density is less than that of the water. The force acting upon the particles is its weight less the weight of water displaced, and the force by which it is resisted depends upon the extent of its surface and the viscosity of the fluid in which the particle is suspended, multiplied by the velocity of fall. A maximum velocity is reached at which the retarding force is just equal to the accelerating force.

Viscosity is the resistance which a fluid offers to shearing. The co-efficient of viscosity may be defined as equal to the tangential force required to slide a unit surface at unit velocity at unit distance from another surface with the fluid between.

Obviously, a large particle will settle



SHOWING EFFECT OF TEMPERATURE ON PRECIPITATION.

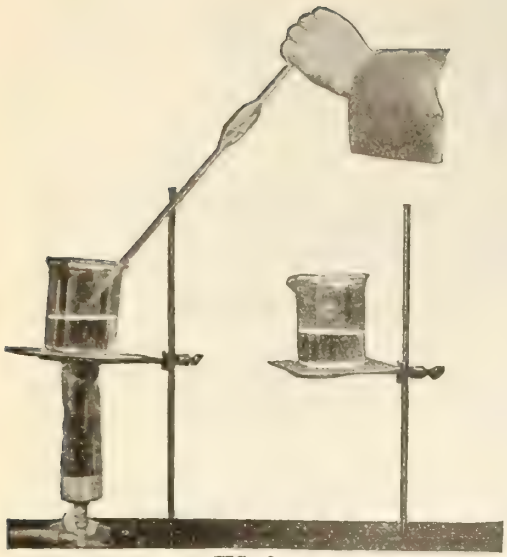


FIG. 2.

more rapidly than a small particle, because it contains a greater mass, and hence is acted upon by a greater force, in proportion to its surface. Considering a spherical particle, whose density is greater than that of water, the maximum velocity with which it falls is given by Stokes' formula:

$$V = \frac{2}{9}\,\frac{D-d}{N}\,gr^2,$$

in which V is the velocity, D the density of the particle, d the density of the water, g the acceleration of gravity, r the radius of the particle, and N the co-efficient of viscosity.

In a water softener the precipitated particles are of various sizes, and possibly of different densities, but any given particle will fall through the water at a rate depending upon the viscosity, and it is therefore of interest to note how the viscosity of water changes with temperature, as shown in the following table by Thorpe and Rodger:

Temperature Degrees F.	Coefficient of Viscosity
32	.01778
50	.01303
68	.01002
86	.00798
104	.00654
122	.00548
140	.00468
158	.00406
176	.00356
194	.00316
212	.00283

At the freezing point the viscosity of

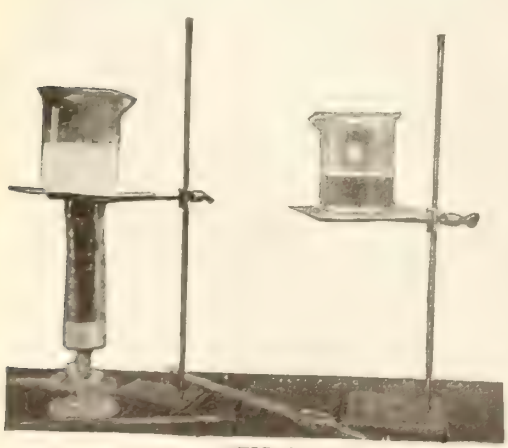


FIG. 3

water is over six times as great as at the boiling point, while as between water at 68 deg. F. and water at 212 deg. F., the increase in velocity of fall will be about four times.

Now, consider how this applies in a water softener. Suppose we have a large tank full of absolutely quiet water. A particle of any given size will descend four times as far as in an hour in hot water as it will in cold water.

Next, suppose we have a continuous softener in which the water is constantly flowing through the sedimentation tank. The rate of flow can be four times as great in a hot-process softener as in a cold process softener, without carrying particles of a given size to the pump supply pipe, or to put it in still another way, with a given rate of flow through the settling chamber much smaller particles can be separated out in the hot-process softener than in the cold-process softener. The further fact that the particles formed in a hot-process softener are larger than those formed in a cold-process softener renders the advantage of the hot process still greater, since the velocity of fall increases as the square of the radius of the particle.

It is therefore plain why the preliminary heating of the water, a feature which is peculiar to the hot-process softener, gives more complete chemical reactions and more thorough removal of the resulting precipitates.

The completeness with which scale-forming matter is removed from water treated in a hot-process softener may be shown by the following analyses of water before and after treatment in a commercial installation. In considering these results, it should be borne in mind that a grain is 2-7000 of a pound, or 1-58,415 of the weight of a gallon of water. The small amount of solida remaining in the treated water from a hot-process softener does not form scale in the boiler, but gathers as sludge, which is easily blown out.

	Before Softening	After Softening
Calcium sulphate	13.00	none
Calcium carbonate	12.30	.36
Magnesium carbonate	5.36	.94
Silica	.82	.35
Iron and aluminum oxides	trace	trace
Total increasing solids.	31.48	1.65
Organic and volatile	6.32	2.98
Sodium carbonate	...	4.80
Sodium sulphate	.64	12.60
Sodium chloride	2.28	1.92
Total non-incrusting solids	9.24	22.30
Free carbonic acid	2.45	

The chemical reagents must be fed to a softener accurately in proportion to the amount of water and to the impurities in the water, so that the treated water may not deposit scale on the one hand or contain an excess of unused reagents on the other. For proportioning the reagents to the raw water supply various mechanical arrangements have been devised.

In some softeners, the raw water flowing to the softener turns a water wheel or operates a tilting bucket, whcih, in turn, operates dippers by which the reagents are ladled out to be mixed with the raw water.

Such appliances, widely used with cold-process softeners, are usually located above the reaction chamber of the softener, involving the lifting or hoisting of the reagents 15 or 20 feet or more above the ground level.

In other softeners, a certain portion of the water, divided from the main supply by means of orifices or weirs, flows through chambers containing the reagents. In one such proportioner, the water in flowing through the reagent tank becomes saturated. This method is faulty, however, since solubility varies greatly with temperature.

In another form the water displaces the reagent from a tank, at the same time diluting that which remains in the tank. Elaborate means for adjusting the orifices progressively as the reagents become more and more dilute are therefore required.

None of these methods is well adapted for feeding chemicals to a hot-process softener, which should be designed for operation under a few pounds' back pressure, since it is necessary to carry a few pounds' back pressure upon the

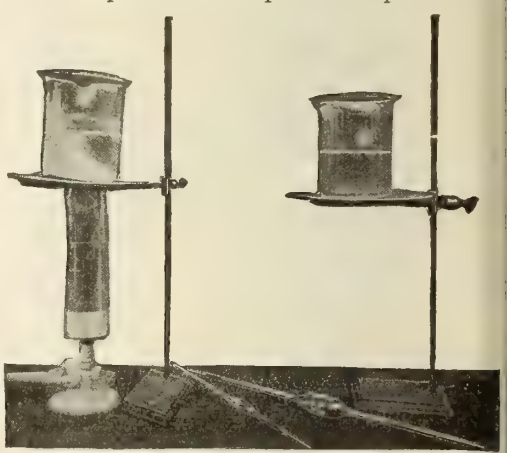


FIG. 4

exhaust steam, in order to insure a temperature of at least 205 deg. F. of the treated water at all times. With the methods just mentioned, it is necessary that the chemical feeding equipment be enclosed within the steam space, or else that the chemical and raw water, after being proportioned, be pumped into the softener against the back pressure. If the water wheel, or the tilting bucket, is enclosed so that the reagents can flow by gravity directly to the reaction chamber, steam finds its way into the chemical tank, where it condenses, diluting the reagents and rendering the feed inaccurate. The dividend flow method involves an additional pumping of both the raw water and the reagent, and is therefore complicated and expensive.

In still another arrangement the raw water is passed through a hydraulic motor, of the reciprocating or of the rotary form, which drives a small chemical pump. This method is defective because it is practically impossible to prevent slippage past the valves and pack-

ings of such motors and pumps, which renders the proportioning inaccurate.

The chemical proportioner used in the Sorge Cochrane hot-process softener to regulate the feed of chemicals in proportion to the flow of raw water is a true flow proportioner. The chemical to be fed to the softener is forced through an orifice by a pressure just equal to the differential pressure set up by the flow of the raw water through an orifice in the supply pipe.

To understand how the device works, refer to Fig. 5. Between two flanges in the pipe through which the raw water softener is placed a thin orifice disk.

From the two sides of the orifice, small pipes lead to the opposite ends of a cylinder containing a piston. The piston is thus acted upon by the differential pressure due to the flow of water through the orifice.

The vertical piston rod extends through water glands at each end of the cylinder. On the lower end of the rod is a valve disk, which closes over an opening, through which a fluid mixture of the reagents is constantly being forced by a centrifugal circulating pump. The weight of the piston, rod and valve disk is counterbalanced.

The differential pressure acting upon the piston pushes the disk down upon and tends to close the opening, while a pressure builds up underneath just sufficient to balance the differential pressure. The pressure of the chemical solution is therefore directly controlled by the differential pressure resulting from the flow of fater through the orifices in the raw water pipe. Through a simple pipe connection, this pressure acts directly at the chemical orifice, insuring an effective pressure on this orifice at all times equal to the differential pressure on the raw-water orifice. Most of the chemical solution supplied by the circulating pump flows out from under the disk and through a strainer, and hence back into the chemical solution tank. The proportioned chemical flows through the chemical orifice into a funnel, from which it is taken by a chemical feed pump, lifted to the softener and forced in against any back pressure that may exist in the latter. The back pressure in the softener thus does not affect the proportioning.

As the chemical, before escaping through the small orifice, is not in contact with air, no incrustation occurs therein, but to provide for dislodging any obstruction, a cleaning needle is so arranged that it can at any time be forced through the orifice by the pressure of the hand.

Besides being accurate, this arrangement has other advantages:

Only one chemical solution tank is required, which is at the ground level, where it can be charged without hoisting of chemicals or inspected without climbing a ladder.

The motor which drives the circulating pump also drives agitating paddles in the tank. Milk of lime can thus be kept in suspension and fed as well as purely fluid reagents. The large saturator tanks necessary where lime water is used are eliminated and the difficulty, due to the fact that lime water varies in strength according to temperature, is avoided.

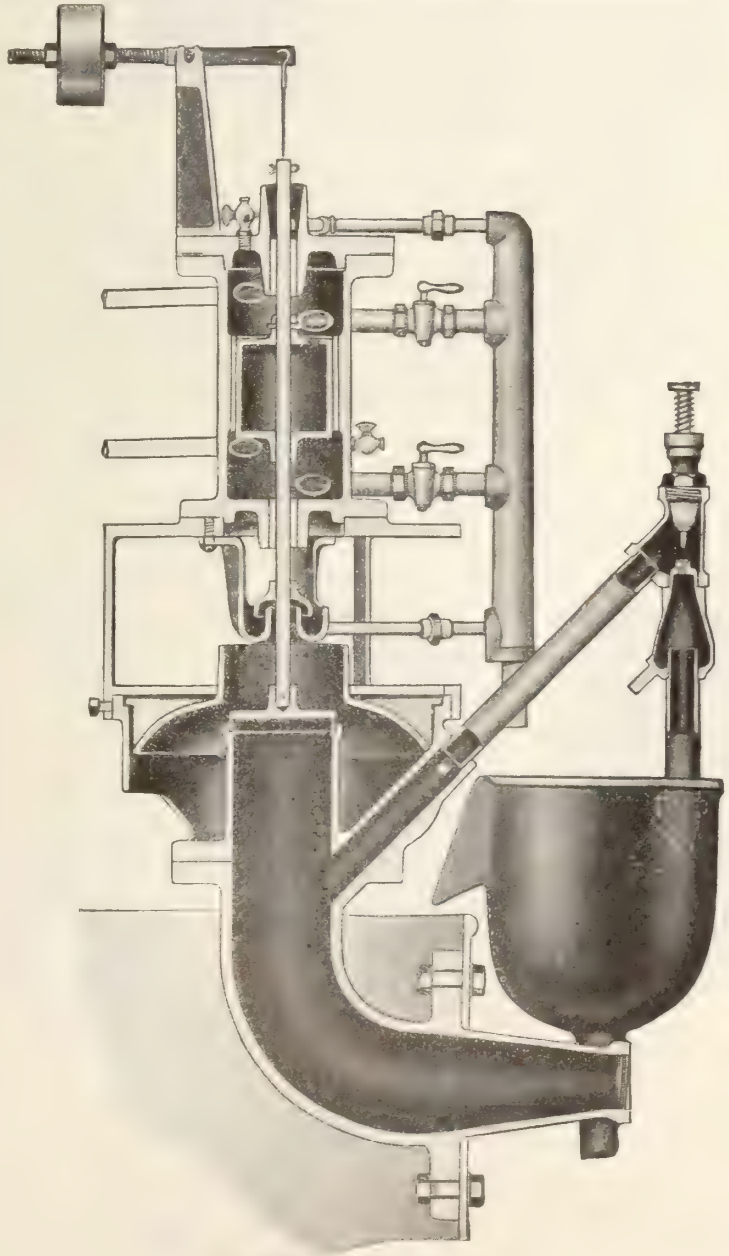
Solutions of caustic soda or sodium carbonate, lime water, milk of lime, or any mixture, are all handled equally well and fed accurately.

The accuracy with which the solution is fed is well within 2 per cent., which is closer than attendants will measure out chemicals into the chemical tank Representatives test results are shown in the following table:

Rate of Flow of Raw Water Gals. Per House	Rate of Flow of Chemical Gals. Per Hour	Chemical For Gallon of Water	Variation Per Cent.
1740	134.6	.0773	0.28
1590	122.2	.0769	0.22
1410	86.8	.0769	0.22
1160	86.6	.0769	0.71
710	54.6	.0769	0.22
411	31.8	.0773	0.28
290	22.4	.0775	0.52
164	14.3	.0771	0.03

The chemical treatment is controlled by drawing a sample of the treated water from time to time and titrating with standardized solutions, the whole operation requiring about ten minutes. By locating the titration readings thus obtained upon a chart for correct chemical treatment, the operator sees at a glance what change, if any, is required in the amounts of the chemicals.

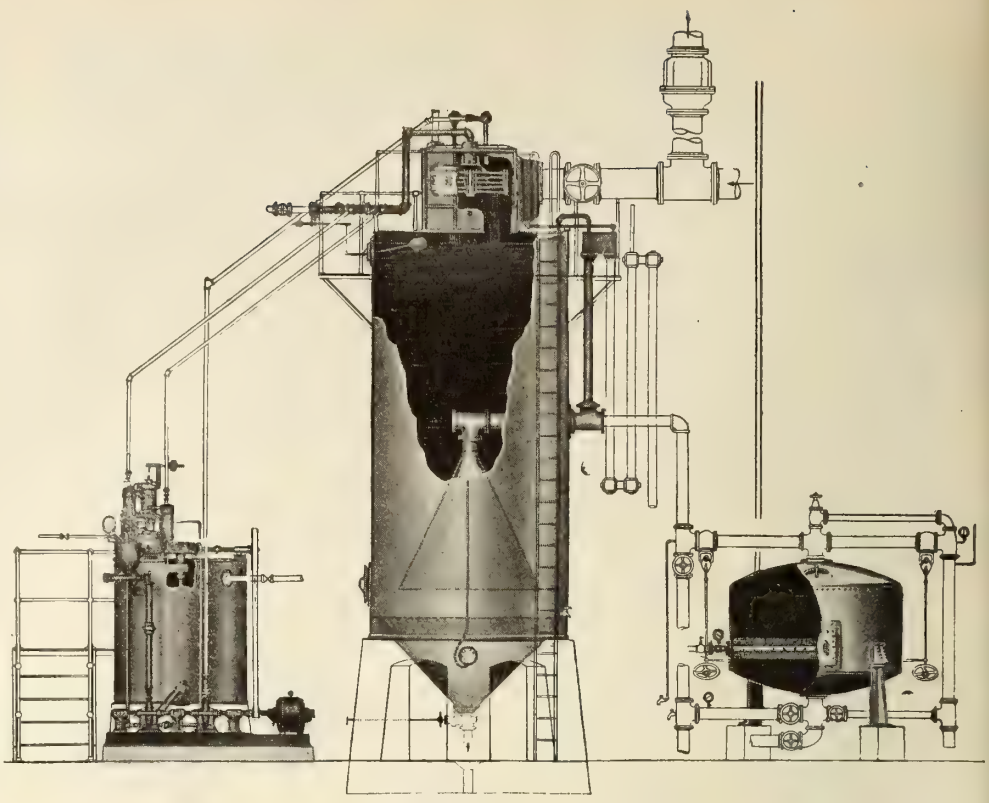
The Sorge-Cochrane hot process apparatus, as may be seen in Fig. 6, is simple and compact. The open heater, with an oil separator attached for purifying the exhaust steam used for heating the water, is mounted directly over the reaction and sedimentation chamber.



CHEMICAL PROPORTIONER.

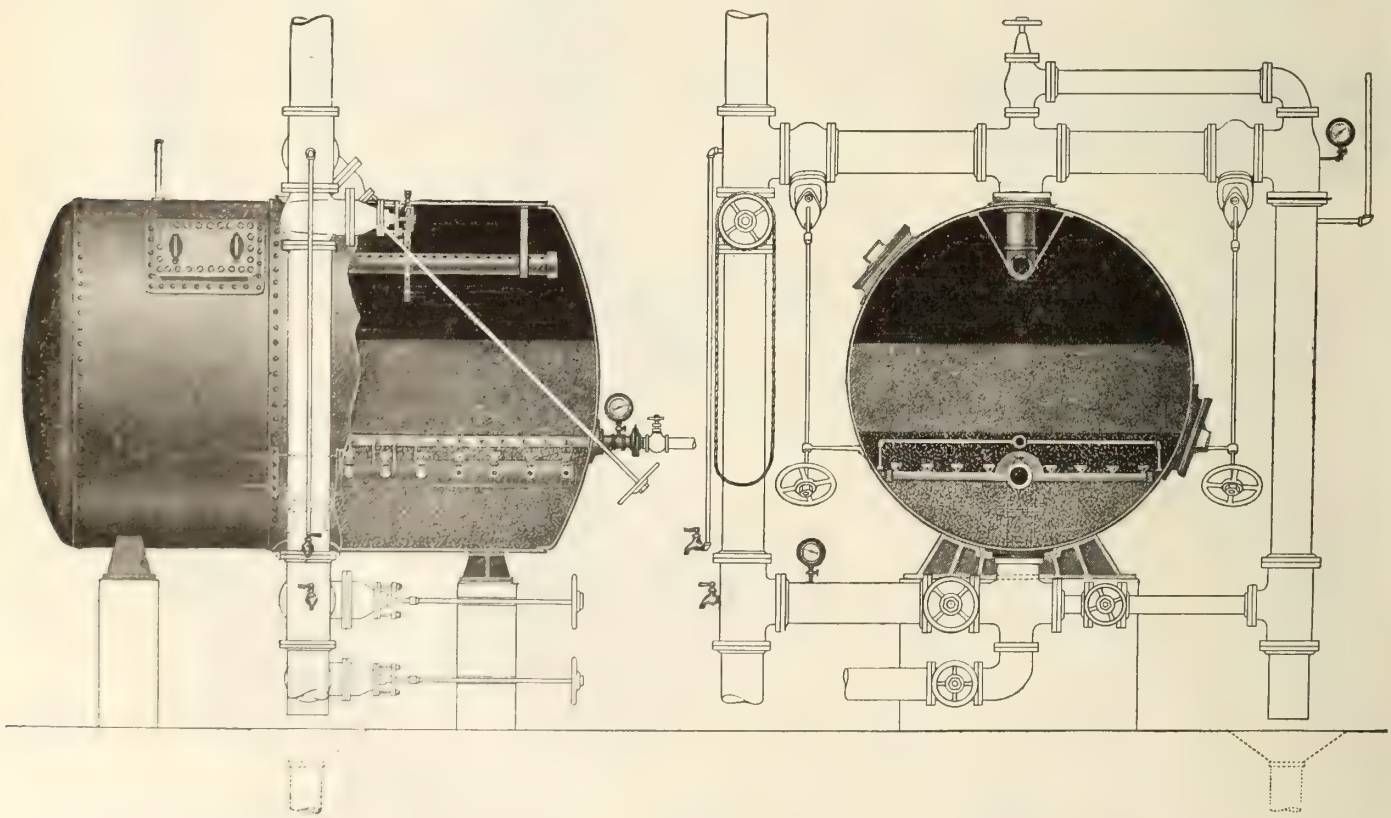
The water is heated to steam temperature by spraying it over trays, which also serves to release oxygen and other disolved gases. It is then mixed with the reagent and falls directly into the sedimentation tank. There is no constricted piping between heater and tank to become chocked with scale. In fact, the water does not pass through piping from the time when it is first heated until it has been through the sedimentation chamber, even the overflow receiving only settled water.

The precipitated matter deposits in the conical bottom of the sedimentation chamber, from which it can be quickly washed by the opening of a single valve. In order to eliminate convection currents the hot water and the softening reagents are delivered at the top, and travel slowly to the bottom, from which the clarified water is drawn off by an inverted funnel. The precipitates formed when the water is first mixed with the chemical fall through the water below, securing a screening effect and gathering together the smaller particles. All precipitates are carried to the conical bottom of the tank, from which they are readily blown out by opening a sludge valve at the lower end or apex of the cone.



HEATER ARRANGEMENT.

Filters.—The removal of scale-forming matter at high temperature by sedimentation is so effective that for many waters and plant conditions it is entirely practicable to dispense with filters. Many softeners are accordingly installed without filters and are successfully protecting the boilers from scale and corrosion, even though the softened water contains a slight amount of suspended matter. Other conditions demand the use of filters, for which a low-pressure sand filter is placed between the sedimentation tank and the boiler feed pumps or meter, the water flowing through the filter by gravity. These filters deliver a crystal-clear water, which contains no solids except those in solution, and no mud-forming properties except the amount which is below the exceedingly low limit of solubility of calcium and magnesium monocarbonates, silica, etc., at the boiling point. This water will leave no troublesome deposits in the feed lines, pumps or meters, and



FILTER TANKS.

is particularly suitable for boilers operated at high ratings.

The filter is essentially a bed of fine sand resting upon a bed of gravel. Embedded in the gravel layer are strainer heads or valves. The strainer valves are of a self-cleaning type, having a movable head or disk, which rests upon the stationary part of the valve in such a way as to leave small openings or ports around the edge. In back washing, the water is admitted through the strainers in a reverse direction and lifts the disks or heads, increasing the openings of the ports to double the normal size, with the result that any particles of sand or other substances which may have lodged in the port during the filtering operation are released and carried out by the wash water.

The strainers may be screwed into a collecting and wash water distributing manifold, as illustrated in Fig. 7, or into a diaphragm.

Embedded in the gravel layer is an air dstribution system consisting of a main pipe with laterals, the latter perforated on the underside to permit the escape of air throughout the gravel layer. The air is used for loosening up the filter bed preliminary to back washing, the proper rate of air admission being controlled by an orifice in the pipe connection.

The filter chamber is connected to the softener through valves at the top or inlet and to the boiler feed pump from the bottom or outlet chamber. There is also a valved by-pass from the softener directly to the boiler feed pump suction. The inlet and outlet of the filter are connected through hand-operated gate valves to a waste pipe, to which a relief valve at the inlet also discharges. Finally, there is a connection to the outlet opening from a water supply, for back washing. A pressure gauge is provided to show when the filter needs washing. Back washing is done at intervals, several times daily, the frequency depending upon the character of water. In some installations, more than one filter is installed, so that it is not necessary to feed unfiltered water to the boilers while washing.

SHEFFIELD WIRE ROPE

Sheffield is justly proud of its wire ropes, for it makes the steel as well as the ropes, and Sheffield steel being the best it naturally follows that Sheffield ropes are the best, whether for ships' rigging or for mining haulage purposes. Wire ropes were first made in Sheffield in 1860. First there was a considerable demand for these ropes from colliery companies, then from the big works in the district, and next from the shipping fraternity. Besides the local demand for colliery haulage ropes, for ropes for the heavy steel and engineering works, and for shipping, there was very soon a big trade in wire ropes for various foreign countries and the colonies, especially for the gold mines. But the biggest demand has been, of course, on shipping account. Both naval and mercantile ships very speedily became users of wire ropes, and Sheffield has done a big trade in this line for two generations. All classes of wire ropes are made in Sheffield. The original works have been greatly extended, and fresh works, established in 1887 and in 1910. These have, in turn, also been extended quite recently. More than 6,000 tons of wire ropes are now turned out annually. There are dozens of different qualities or classes and gauges. There are ropes for rigging, for lifting, for haulage, for aerial or overhead railways, flexible ropes for drums and pulleys, and ponderous ropes for mining equipment, each and every kind made from some special steel to suit the purpose. The wire these various ropes are made from is all of high strain quality—80 to 120 tons per square inch—and the greatest care is taken in the processes of manufacture to produce the necessary uniform hardness, toughness and flexibility, according to the work for which the ropes are designed.. To avoid brittleness and to withstand the abrasion on pulleys, for instance, special steel is produced, and both the wire and the ropes are put through special processes. Everything in this group of products, from ropes weighing many tons to the finest wire for pianos, is made in Sheffield, from Sheffield steels, and by workmen who are artists in their line. Only a few months ago Sheffield sent out a rope five miles long, and 21 tons in weight, whilst much longer, but not heavier, ropes have been made from time to time. At the present moment a machine is being completed in the city which will spin and carry ropes up to 30 tons in weight. Every imaginable requirement of the navy, the mercantile marine, and of mining is being anticipated by Sheffield wire rope makers. There are three big wire rope-making plants in the city. The Sheffield Wire Rope Company, Ltd., is established at Darnell, within the city boundary, and produces every kind of rope required for shipping, mining, crane and engineering purposes. Messrs. John Shaw, Ltd., of the Yorkshire Wire Rope Works, Sheffield, supply the same classes, and besides having a big British shipping connection they make a special point of colonial requirements, and have branches in Melbourne, Adelaide, Perth, Kalgoorlie, Auckland, Johannesburg, and Bulawayo Messrs. Wm. Cooke & Co., Ltd., of the Tinsley Wire Rope Works, Sheffield, particularly specialize in the heavy varieties of rope, and do a big and growing trade in shipping, trawling, engineering and mining ropes.—"Syren and Shipping."

In a recently issued Bulletin of the United States Geological Survey some information was given on the subject deep wells and shafts. This Bulletin, according to the South African Mining and Engineering Journal, is incorrect in regard to the depth of shafts. It says that the deepest mine in the world is shaft No. 3 of the Tamarack Mine in Houghton County, Michigan, which has reached a depth of 5200 ft. The Bulletin, it is presumed, refers to metalliferous mines only. If this be so, then the deepest mine in the world is the Turf shaft of the Village Deep, Limited. The vertical portion of this shaft intersects the reef at 4300 ft. and on the continuation of the blanket beds the incline has been sunk an additional 3000 ft. The vertical depth from the surface to bottom of the incline is now 5861 ft., so that the Village Deep Turf shaft is more than 600 ft. deeper than the No. 3 of the Tamarack Mine. The Turf shaft is now, in fact, down to sea level.

Particulars were recently given in the Bulletin of the Federation of British Industries of Finland's potential water power resources. Out of a total estimated water power of 3,000,000 horsepower at average water level it is considered that about 1,050,000 horse-power could be of direct use for industry. Of this only 150,000 horse-power is at present utilised, thus leaving considerable possibilities of development. Of the 79 waterfalls in Finland with potential capacities of horse-powers from 5000 to 300,000, 42 range from 5000 to 20,000 horse-power, 25 from 20,000 to 50,000 horse-power, 6 from 50,000 to 100,000 horse-power, and 6 from 100,000 horse-power to 300,000 horse-power.

Experience has shown that wire ropes of compound construction, subjected to corroding influences, are likely to deceive engineers as to the strength remaining in them, says a circular issued to managers of mines on the Rand, South Africa. Where reduction of diameter or circumference of the rope has taken place, not accounted for by the evidence of wear, the part of the rope under examination should first be fully loaded and then relieved of the load. Any noticeable difference in circumference in these circumstances and slackeneing of the outside wires when the load is off will indicate that internal corrosion has taken place. The extent of corrosion inside the strand can only be estimated by the slackness of the outside wires. The corrosion between the strands can be further examined by untwisting the rope or displaying the strands sufficiently with a marlin spike.

A new form of black japan, in which a non-combustible solvent is employed, has recently been brought out in America. The material, is, in fact, an emulsion of the asphalt oil base with water. It is stated that this japan has no tendency to settle out, even after months of storage, and that, owing to its being suspended in water, losses by evaporation are practically negligible. The japan is applied to small articles by placing them, charged positively, in a negatively charged iron tank of japan. An even, smooth coating of japan is deposited on the articles, and since the japan is deposited free from solvent, there is no resultant drip when the lot is conveyed to the baking ovens. In the case of large articles the metal is pre-heated before dipping.

A Description of the Busch Sulzer Diesel Engine

At a Time When the Internal Combustion is Assuming Such an Important Position in the Engineering World, This Article Describing the Principle and Operation of a Well-Known Type Should be of Interest

THE DIESEL ENGINE is an internal combustion engine which utilizes, directly in its cylinder, any heavy liquid fuel, ranging from kerosene to coal tar.

It requires neither carburetors nor ignition systems.

Pure air, with which the engine cylinder is filled, is compressed by the upwards-travelling piston to a pressure of 450 to 500 pounds. Its temperature increases, due to this compression, to approximately 1000 degrees Fahrenheit. At or near the upper dead-centre of the piston, the fuel is sprayed into the cylinder, gradually and in a finely nebulized condition. The fuel is gasified and ignited by the heat of the compressed air, without any supplementary means; it burns during the first part of the piston down-stroke, after which the hot gases in the cylinder continue to expand and perform work on the piston, until they are exhausted from the cylinder.

The rate at which the fuel is injected into the cylinder is so adjusted that its ignition and combustion take place without explosive violence, and with substantially no change of pressure; for which reason this type of engine is sometimes referred to as the "constant pressure" type, to distinguish it from the "constant volume" type, such as gas, gasoline, and hot bulb oil engines, and engines improperly designated "semi-Diesel," in which the combustion takes place substantially without increase in volume, and therefore with an explosion-like increase in pressure.

Diesel engines are built to operate on either the four-stroke cycle (briefly, "four-cycle"), or the two-stroke cycle (briefly, "two-cycle") system.

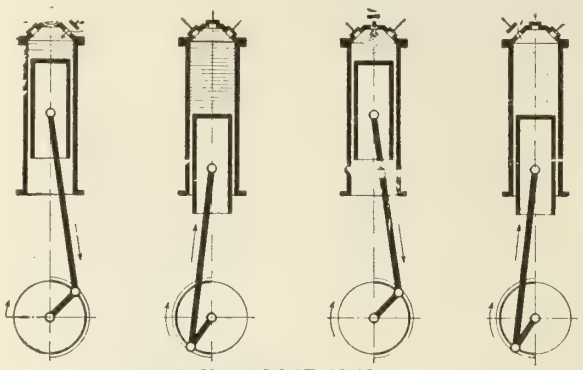
This article describes an American made Diesel Engine operating on the four-stroke cycle, a four cylinder vertical enclosed crank case Diesel Engine known as the "Busch-Sulzer-Diesel" and manufactured by the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., U.S.A. In a four-cycle engine, four strokes of the piston, or two revolutions of the crankshaft, are required to complete the cycle of operations. These operations are illustrated in Figures 1 (a) to (d), each of which is accompanied by a description.

(a) First stroke: (admission stroke); piston travels down; admission valve open; cylinder is being filled with pure air.

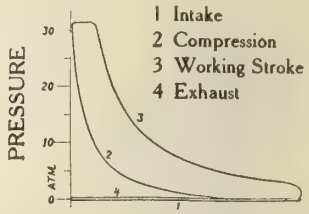
(b) Second stroke: (compression stroke); piston travels up; all valves closed; air in cylinder is being compressed.

(c) Third stroke: power stroke; piston travels down; fuel valve open at top dead center, but closed at fraction of stroke; gases expand.

(d) Fourth stroke: (exhaust stroke); piston travels up; exhaust valve open; burnt gases are being expelled from cylinder.



THE FOUR-STROKE CYCLE.
1st Stroke—Admission Stroke.
2nd stroke—Compression Stroke.
3rd Stroke—Power Stroke.
4th Stroke -Exhaust Stroke.



TYPICAL INDICATOR CARD

Figure 2 shows a typical indicator diagram from a four-cycle Diesel engine, on which diagram the lines representing the various operations are lettered to agree with Figues 1.

The fuels used in Diesel engines are crude petroleum and the heavier petroleum distillates or fuel oils. Kerosene and tar oils are but rarely used in this country for this purpose, because their relative cost is higher and their practical efficiency lower.

Efficiency

There is no other known method of generating power from fuel which can approach the Diesel in efficiency. By efficiency is here meant the proportion of the energy contained in the fuel which is transformed into useful energy; this is most readily compared on the basis of heat units.

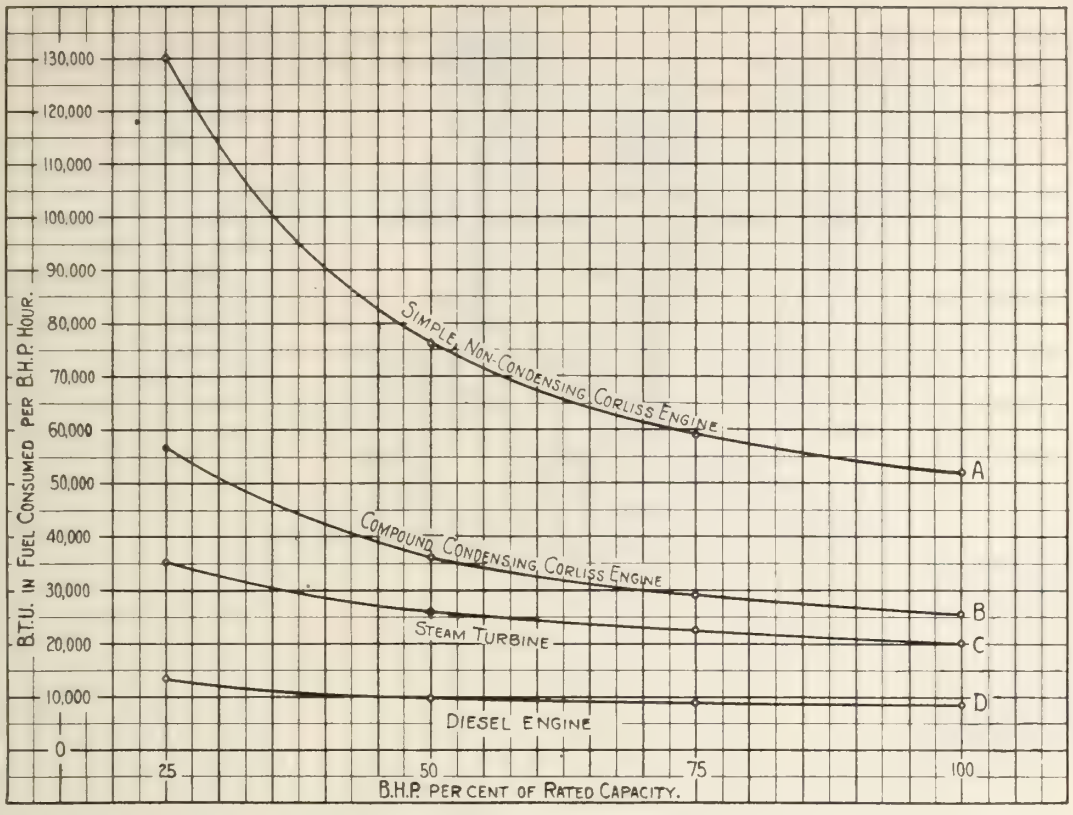
Bituminous coal, as ordinarily used for firing under steam boilers, contains 10,500 to 14,500 heat units per pound. The average is somewhat below 12,500.

Fuel oil, as used for firing under steam boilers and for combusion in Diesel engines, contains 18,000 to 19,500 heat units per pound. The average is about 18,800 heat units per pound, or 143,000 per U.S. gallon.

To compare the efficiencies of various prime movers, cognizance must be taken of the average power developed, and the normal operating conditions. Steam plants are subject to losses in the boilers, due to radiation and leakage; as also steam consumption by auxiliary apparatus, such as feed pumps and condenser pumps. The heat consumed by these does not decrease in proportion to the reduction in the power developed. Added to this, most steam plants must keep up steam during periods when the prime movers are not running; and steam in excess of the immediate requirements, during portions of the running periods;—these "stand-by" fuel consumptions will vary from zero in an ideal plant operating continuously at a constant load, to 25 to 30 per cent. of the useful consumption in a plant operating intermittetly or with variable load.

In the appended table are shown the heat units (B.T.U.) contained in the fuel consumed in plants of several types, per useful horsepower (B.H.P.) per hour, when the prime mover is operating at constant loads, for full-rated and fractional loads, and without any allowance for stand-by combustion. In the headings are stated the sizes of the units, their operating conditions, and the full-load steam consumption of the prime mover only. The heat consumption in all cases, include the auxiliaries and are based upon good ordinary operation as distinguished from test conditions. To obtain the pounds of coal, equivalent to the heat consumption, divide by 12,500; or to obtain the gallons of fuel oil, divide by 143,000. For example: at a constant load of 50 per cent. of its rated capacity the 400 I.H.P. compound condensing Corliss engine plant consumes 29,000 B.T.U. per B.H.P. per hour, which is equivalent to 2.32 pounds of coal, or 0.203 gallons of fuel oil; while the Diesel consumes 9,800 B.T.U., equivalent to 0.069 gallons of fuel oil. The steam plant, will, in addition, rarely consume less than 10 per cent. for stand-by; whereas the Diesel plant has no stand-by consumption. The actual comparison would thus be 0.069 gallons, or about 3 1-4 to 1 in favor of the Diesel.

When referring the tabulated heat or the resulting fuel consumptions to elec-



CURVES OF COMPARATIVE FUEL CONSUMPTION.

tric power, the actual consumptions must be corrected to allow for the losses in the generator; but the relation between the consumption will remain substantially unaffected. For example: At 50 per cent. of the prime mover power, the generator would have an efficiency of about 90 per cent., and the fuel consumptions per K.W. Hour, of the two plants above referred to would be equivalent to the fuel consumption per B.H.P. per hour, multiplied by 1.34 and divided by 0.90; i.e., 0.33 gallons of fuel oil per K.W. hour for the steam, and 0.102 gallons for the Diesel; (this would be equivalent to a consumption of 3.8 pounds of coal per K.W. hour, for the steam plant).

The curves in Figure 3 show graphically the average consumption of heat units in fuel, in ordinary land power plants, A being a simple non-condensing Corliss engine plant; B, a compound, condensing Corliss engine plant; C, a steam turbine plant; and D, a Diesel engine plant. Note the very flat curve of the Diesel, showing the maintenance of high efficiency throughout its load range, which is characteristic of this type of prime mover.

In all of the foregoing comparisons it has been assumed that the boiler-room force is intelligent and conscientious.

The results obtained in a steam plant depend considerably upon this condition, and are likely to be materially poorer than our figures indicate; while the defective conditions may not become apparent until heavy losses have been incurred, and even then the fault will be difficult to locate because there are such various types of appartus and so many to be considered. The efficiency of a Diesel engine plant is much less affected by the character of the personnel, and negligence is immediately and readily detectable.

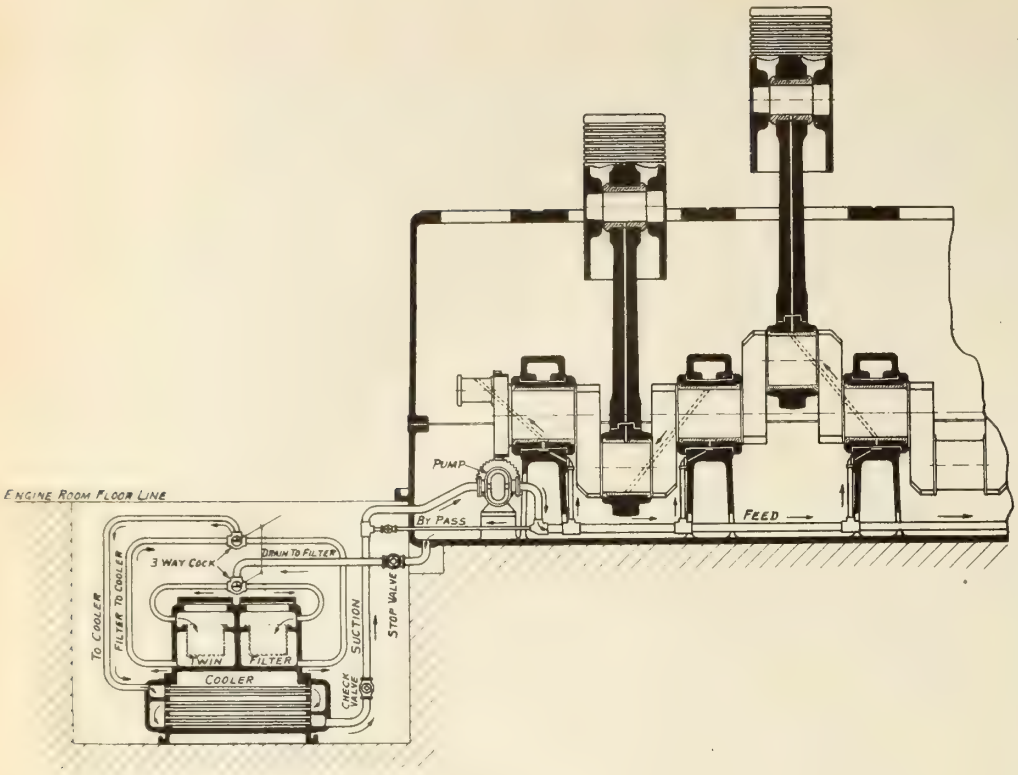
Figure 3. General Description of Busch-Sulzer Type B. Four Cycle Engine

The Busch-Sulzer Type B Diesel is of the vertical four cylinder single acting, four cycle enclosed crankcase design. The standard speeds have been selected with reference to the speeds of alternating current generators and the engine is built for heavy duty service with all parts accessible for inspection and adjustment. The bed place is made in once piece with saddles or bridges, between each pair of cylinders which are bored to receive the main bearing shells.

HEAT UNIT IN FUEL, CONSUMED PER BRAKE HORSEPOWER PER HOUR.

Load Per Cent. of Rated B.H.P.	Simple Non-condensing Corlis Engines		Compound Condensing Corliss Engines		Triple Expansion Steam Engines		Steam Turbines		Diesel Engines		
	Engine rating 100 I.H.P. Boiler Pressure 100 lbs. Steam per I.H.P. hour 28 lbs.	Engine rating 500 I.H.P. Boiler Pressure 150 lbs. Steam per I.H.P. hour 24 lbs.	Engine rating 200 I.H.P. Boiler Pressure 125 lbs. Vacuum 25 inches Steam per I.H.P. hour 15 lbs.	Engine rating 400 I.H.P. Boiler Pressure 150 lbs. Vacuum 27 inches. Steam per I.H.P. hour 13 lbs.	Engine rating 400 I.H.P. Boiler Pressure 180 lbs. Vacuum 27 inches Steam per I.H.P. hour 12.5 lbs.	Engine rating 1000 I.H.P. Boiler Pressure 200 lbs. Superheat 100° F. Vacuum 27.5 inches Steam per I.H.P. hour 10.5 lbs.	Rating 500 K.W. Boiler Pressure 150 lbs. Vacuum 26 inches Steam per K.W. hour 21 lbs.	Rating 5000 K.W. Boiler Pressure 200 lbs. Superheat 150° F. Vacuum 28 inches Steam per K.W. hour 14 lbs.	Engine rating 165 B.H.P.	Engine rating 520 B.H.P.	Engine rating 2200 B.H.P.
100	52,500	41,500	25,500	21,000	20,000	17,500	21,000	15,000	9,000	8,400	8,000
75	60,000	47,500	29,000	23,500	22,500	20,000	23,500	17,500	9,500	8,900	8,500
50	79,000	59,500	36,500	29,000	28,000	24,500	27,000	20,500	10,800	9,800	9,000
25	138,000	99,000	58,000	45,000	43,000	36,000	36,000	28,000	15,400	13,000	12,000

For steam plants add allowance for stand-by, according to character of load.



FORCED LUBRICATION SYSTEM.

The enclosed crank case is supplied with hinged doors for making inspection of the crank pins and moving parts and for making adjustments. The working cylinder is provided with a removable lier, the outer jacket carrying all axial stresses. The upper end of the cylinder liner makes a water tight shoulder joint with the jacket, the liner being free to expand downward, as it is supported in a fixed manner at one end only.

The cylinder heads are of symmetrical design and contain the pockets for the inlet valve, exhaust valve, fuel valve and air-starting valve, all of which work in a vertical position.

The inlet and exhaust valves are of the Poppet type, held on their seats by springs. The exhaust valve is provided with means for relieving the compression in the cylinder. When starting the exhaust valve levers are split to provide for the removal of the valve and cage with the least possible dismantling.

A shaft, carrying all the cams for operating the valves, extends along the top of the cylinders, in an entirely closed case, and is driven directly from the crankshaft, at half its speed, by a vertical shaft located at the fly-wheel end of the engine.

The spring-loaded, centrifugal type, enclosed and self lubricating governor, controls the amount of oil delivered to each cylinder by varying the time of closing of the suction valves of the fuel oil pump.

The pistons are of the long trunk type, and are water cooled by a system of telescopic tubes on engines of 500 horsepower and over. The crankshaft carries the four cranks for the working cylinder and the small crank for the compressor.

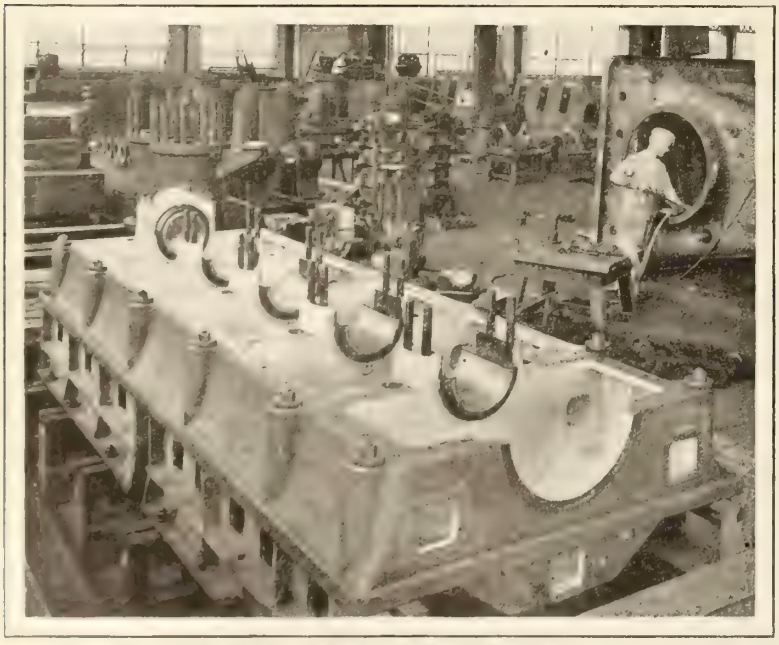
The main bearings are of cast iron shells, babbitt lined, and made in halves. The extension shaft is arranged to receive the flywheel and either generator or driving wheel between the engine and an out-board bearing.

The air compressor, for providing compressed air for fuel injection, is driven from the main crank shaft. It is a three-stage compressor and provided with adequate intercoolers and after-coolers to keep the air at a low temperature.

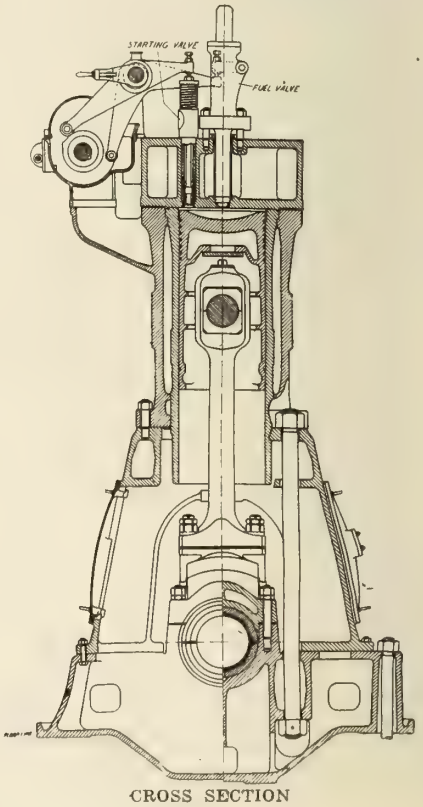
The engine is started with compressed air, furnished by the injection air compressor, stored in tanks so connected up with the compressor that they can be charged without in any way interfering with the operation of the engine.

All cooling water discharges into open funnels and individual pipes are provided from each cylinder.

The general lubricating system is a pressure system serving all main bearings, crank pin and piston pin boxes, vertical shaft thrust bearing, and all lower helical gears with a continual supply of oil under pressure. The oil, after passing through the bearings, is collected in



BEDPLATE FOR FOUR-CYLINDER ENGINE.



CROSS SECTION

the bed plate, returned to a twin filter and tubular cooler, from which it is taken by a gear driven positive displacement pump and again forced thru the bearings at a pressure of from 10 to 20 pounds.

A force feed oil pump is provided for lubricating cylinders. The engine presents a very finished appearance.

The Busch-Sulzer Bros. Diesel Engine Co. is the pioneer American Diesel engine builder, having completed, in September 1898, the first Diesel engine in the world to be placed in commercial service. During the past twenty-two years this firm has had experience in building over 500 Diesel engines, including both two and four cycle stationary and marine Diesels.

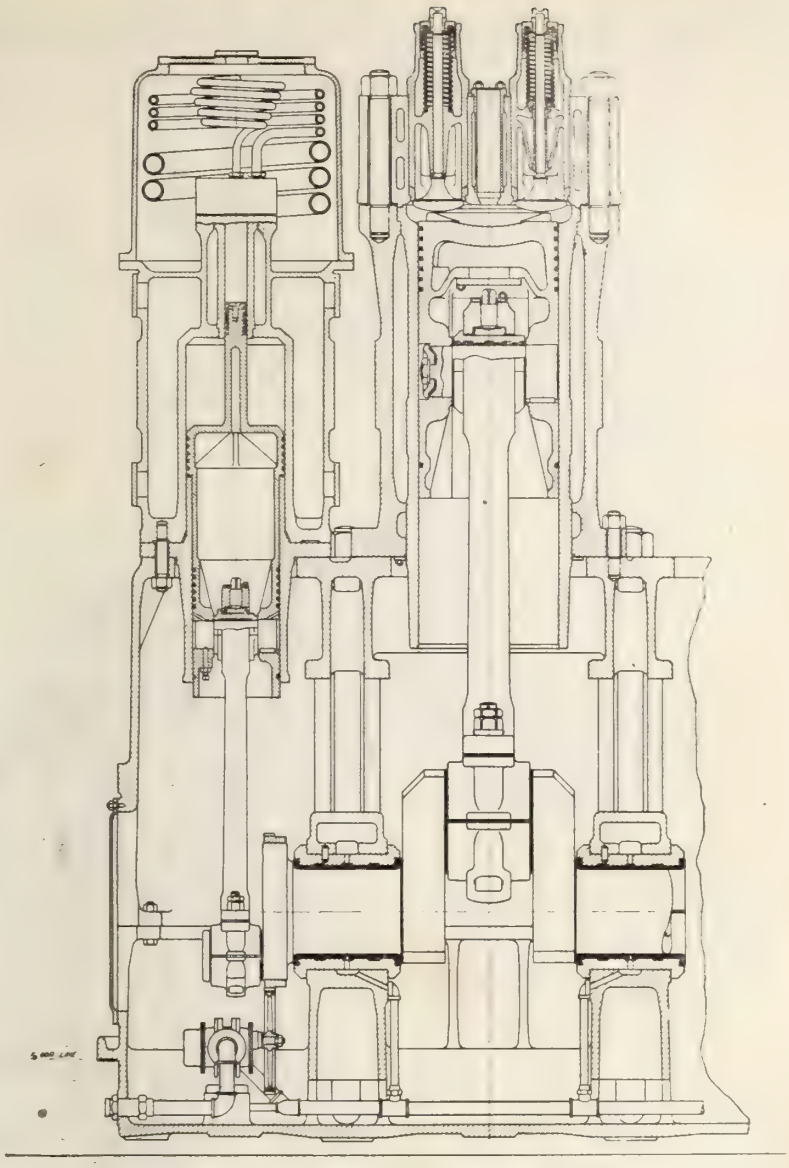
BOOK REVIEWS

We have received a copy of of the "Practical Electricians Pocket Book and Diary," price 2/6, published by S. Rentill & Co., Ltd., 36 Maiden Lane, Strand, London, W. C. The book covers a wide field, embracing every application of electricity to modern industry. All kinds of instruments are described, methods of testing, insulation, etc. Various features of the wireman's art are clearly described, including the various ways of making splices on cables. Fittings for indoor and outdoor work, both low and high tension, are dealt with. The various motive powers, steam engines, steam turbines, gas producers and gas engines, oil and petrol engines, and water turbines, each receive attention. The book is a very useful one to have for immediate reference and is interesting as comparing British practice with that on this continent.

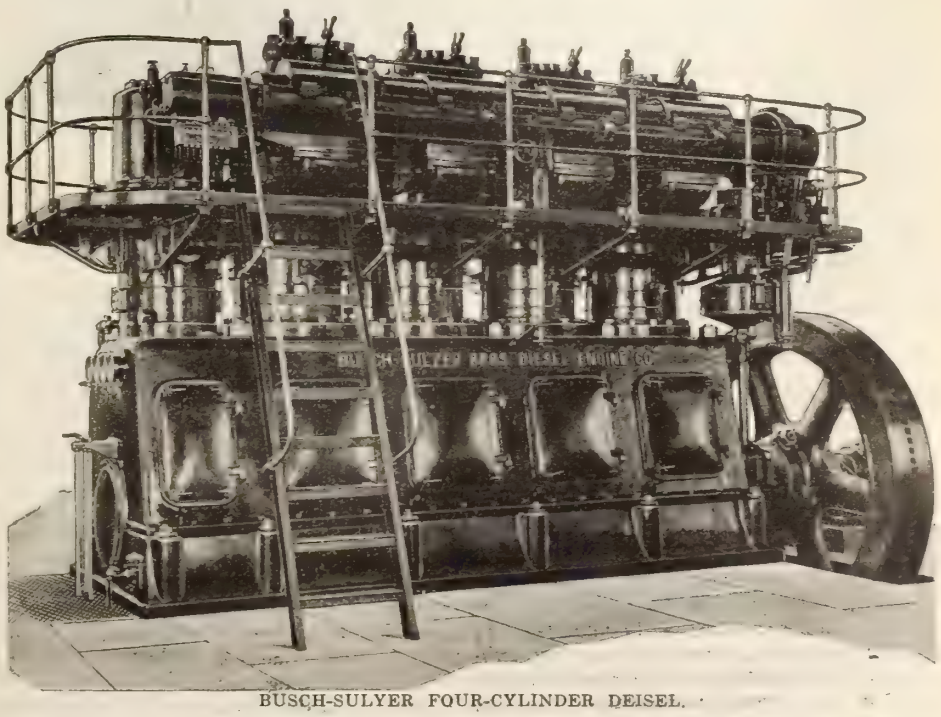
The Northern Electric Co. have issued a booklet dealing with electric power and lighting on the farm. The book gives a table of the various purposes to which electricity can be applied, and a description of the various sources from which electricity can be generated. Various installations are illustrated, as well as different types of engines and generators.

The Page Hersey Iron Tube and Lead Co., Ltd., have issued a hand book on the manufacture of wrought iron and steel pipe, giving a general description of the processes employed in each. A short history of the firm is included, tracing its development since its inception in 1902. Illustrations of the Company's mill at Welland are included showing various stages of the manufacture of both kinds of pipe.

According to a telegram received in the Department of Overseas Trade from His Majesty's Commercial Secretary to the British Legation at Warsaw, the opening of the exhibition of agricultural machinery, advertised to take place in Lemberg in June, has been postponed until the end of September.



SECTION SHOWING AIR COMPRESSOR.



BUSCH-SULYER FOUR-CYLINDER DEISEL.

The Radojet Air Pump and Its Operation

A Description of This Type of High Vacuum Apparatus is Given, as Well as a Problem Arising During its Operation, by Henry Wright

Chief Engineer Hochelaga Power House.

AT the present day when so many mechanical labor and steam saving devices are being placed on the market that the chief engineer who is trying to keep his plant up to date and save his employer money gets his brain in a swirl trying to solve the eternal problems, will its cost be too high? will its maintenance be out of reason and what place will it take in the operating field. Now, we all know that the prime cost of any article has always to be weighed in the balance of efficiency and maintenance. Some devices raise the efficiency but their maintenance is prohibitive and from an operating point of view are impracticable.

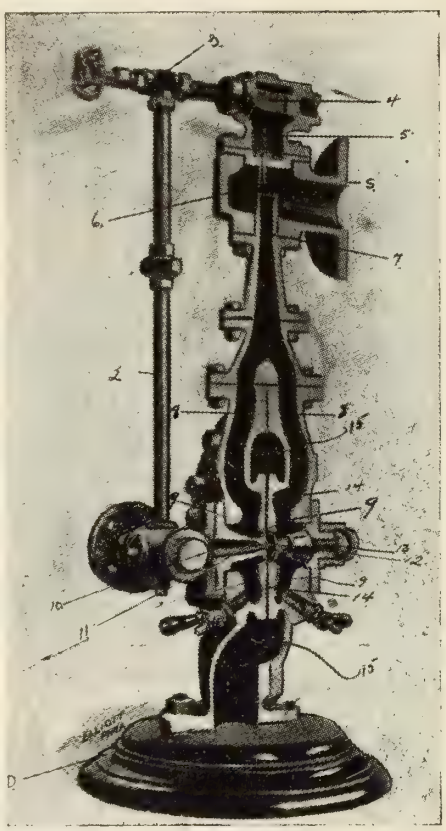
The principle of the jet is merely that of two ejecters in series, and like the ejecter may be looked upon from a Thermodynamical view as a perfect heat unit (less slight radiation losses.)

It is extremely simple in construction. There are no moving parts to be oiled, it takes little space, requires no foundation and is almost noiseless. It is quickly superseding the reciprocating unit or the old style of air pump and also the intrainment pump. I don't propose to enter into the great objection against the last mentioned pump because they are well known to all engineers. Removing air by steam was known and practised as early as 1868 but was never developed to produce the high vacuum commercially and has only become useful since turbines became the standard primo mover. The patent belongs to C. H. Wheeler of Philadelphia, who has, by numerous experiments brought it to the present state of perfection.

As the cut shows it consists of two steam ejecters in series. The upper is called the first stage by the makers but it is the second to come in operation and the lower is called the second stage and is the first to come into operation. The steam enters through the opening L through a strainer, this is seen more clearly by looking at the jet complete in Fig. 1, it then passes up pipe 2 to angle valve 3 through strainer 4, expansion 5, across suction chamber 6 of the first stage ejecter which is in communication with the condenser through the suction opening S.

The steam expands in the nozzles leaving with a very high velocity and when passing across suction chamber 6 entrains the air and vapors to be compressed. The mixture passes into the diffuser 7, from where it is discharged at higher absolute pressure than that of the air entering at S into a double passage 8 communicating with suction chambers 9 of the second stage. These two suction chambers 9 are annular and give the commingled fluid a large entrainment surface.

Steam is simultaneously delivered through the strainer 1 into passage 10 which communicates with the annular expansion nozzle formed between two circular dises, 11 and 12, Disc 12 may be adjusted towards or away from disc 11 by the adjusting screw 13 to vary the cross section of the nozzle passage this will change the expansion ratio of the steam. The steam delivered radially by the annular nozzle 11 and 12 expands. leaving it as a jet of very high velocity in the form of a sheet and in passing across suction chamber 9 entrains the air and steam coming from the first stage and carries them into the annular diffuser 14 thereby compressing the mixture to atmospheric pressure and discharging it into casing 15 which has the discharge opening D.



SECTIONAL VIEW

On looking at the Photos 1, 2, and 3, a clearer understanding may be got. First in the double passage 8 this is belonging to the casting but outside the casing and enters the casing behind the nozzle 1 and 1 in looking over Figure 1 and Print 2 and 3, it will be observed that these nozzles consist of two discs one with a passage through, the other with a slight cone projection, this is where the steam from the second stage begins it operation. The first stage steam is discharged from behind these discs. I may say that these discs are of very highly tempered steel with no mark of wear after two years service. No. 2 and 2a in the Prints are the annular diffuser and are part of the casing and simply machined at the back to a depth of 2 inches. At the bottom of Print 2 is the discharge D and a baffle plate is seen here. The reason is obvious, if one will think of the characteristics of the steam. Print 3 is a photo of the back plate and is bolted on to the section shown in print 2. Print 1 is the whole section with the back plate taken away.

The sections when bolted together leave a space between the annular diffusers of .30 of an inch. The lower nozzles 11 and 12 are regulated according to pressures and superheat.

With 150 lbs. pressure and 190 deg. Fahr. superheat, they are about 3-16 of an inch apart. Now from the operators' point of view they are exceedingly good and once set require no attention. We have them about 10 ft. from the main floor with 3 gauges attached; the Boiler pressure, the Reduced pressure, and the vacuum guage. They work most economically and steady at about 150 lbs. This allows for a variation of 20 per cent. fluctuation of Boiler Pressure, should priming take place in steam line they recover themselves readily. I should have mentioned that a reducing valve is placed in the steam line, attached to the jets.

Before entering into the steam consumption and efficiency of these jets, I would like to give a little experience that befell me about 6 weeks since.

This jet belongs to a pair connected together and attached to our No. 1—12,500 K.W. Curtiss Turbine during a heavy load the vacuum was observed to suddenly fall from 29.4 to 24 inches, in a large unit of this class, one can readily see how the steam flow meter would climb up, and the operating engineer get very busy with a torch looking for trouble. After an hours careful survey everything seemed O.K. so back to the jets. Here every valve strainer etc., was tested to see if it was an obstruction, again the O.K. so we reduced to ¾ load and shut one jet down when up went the vacuum gage to 28.5. (At the end of my article I will give a few words on correction of absolute back pressure and mercury columns of vacuum guage corrected to temperature of atmosphere). The other jet was put in service and the second one shut down. Down went the mercury to 24 inches again. with a relieved "Oh!" the chief operator (engineer) smiled and said "found," and the offending unit was placed in the repair shop and opened up. The closest scrutiny was given to every movable part, and we discovered a slight crack on the inside of casing which is shown on Print 3 but after test this only proved to be a surface rupture and under 30 lbs. steam test proved tight. The nozzles were readjusted but all to no purpose after a lot of head scratching we decided to ask the outside advice, a man came down and after advising, testing, etc., walked away disgusted. My chief operator and myself looked at one another, each trying to read the others mind, and we both hit the mark with the same idea. Were the diffusers correct?

We set to work with surface guage on the test plate and found the back annular dif-

user was sunk down 1-32 of an inch as shown in Print 3—3 and 4 to prove our theory was correct we took the back plate of one of our other jets, bolted it up in place of the suspected one, and tested. Good vacuum to standard, and the other back plate condemned. Now here is a nice problem touching on Dynamics and Physics for some one to try and work out, however space won't allow here, but try and find the cause why one should do the work and yet when the other one was put in they both failed. One jet is really sufficient for a .80 load factor, why should this not have kept the other to the same vacuum when both are connected to same steam pipe and same exhaust. I have my theory which will be given with a later article on Thermodynamics.

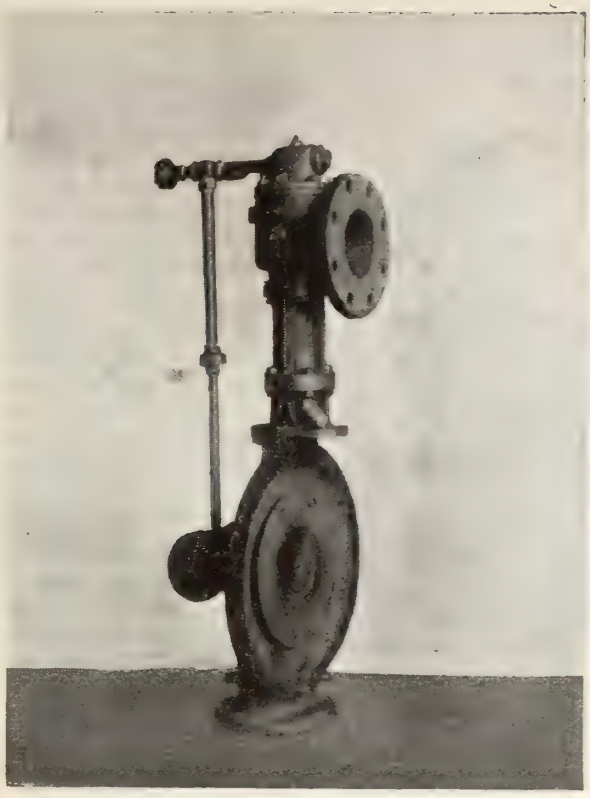
Now we will compare this unit with the ordinary reciprocating fly wheel air pump of air pump of the Blake class.

The ejecters together will use 3,000 lbs. of Boiler Steam per hour, at 150 to 190 lbs. pressure per sq. inch, at 190 deg. Fahr, superheat and the back pressure about ½ lb., at 1 inch total pressure. These pumps together will remove 13 cubic feet of free air per minute (or 13 ÷ .225=58 lbs.) orifice test room conditions 70 deg. Fahr. This works out (allowing for 25 per cent. over load) at 1 1-3 per cent. of total steam consumption. Now the usual practice of reciprocating air pumps is to allow .00024 h.p. per lb. of exhaust steam, this with a 60 per cent. efficiency works out at 1 per cent. of total steam, but weigh in the balance the maintenance cost, space and attendance and the jet has the balance in its favor. Before concluding this article I would like to place a few formulae that are not as seriously studied as they should be considering the price of coal, at present time.

Condensers

The primary object of a condenser is to reduce the back pressure on the piston although the recovery of the condensate is of great importance. A great many engineers are led to think that the air pump creates the vacuum, this is an error. The air pump merely removes the air which leaks in or carried in with the condensed steam and so preserves the vacuum already formed from being impaired gradually. If a dry air pump, handling air and vapour alone is shut down, a tight condenser will operate for a considerable length of time with no change except a slight drop in vacuum. We all know that air in a condenser is bad, it not only causes work for its removal but cuts down the efficiency owing to the low thermal conductivity of the air. But on the other hand when the pump is removing the air it necessarily removes the water vapour with the air. We don't benefit the vacuum by pumping out the vapour as the pressure of the vapour in the condenser is determined by the temperature and any vapour removed is instantly replaced. But we can't remove the air without handling the vapour. In studying the design of condensers always keep in view that the air and vapour are taken from the coldest part of the condenser, this lessens the work of the air pump by reducing the tension of the vapour and removes the air in a less rarefied state.

A great many engineers are not thorough enough in studying their mercury column attached to the condenser. Some time ago I was in a plant when the engineer pointing out his mercury column remarked good vacuum. I asked him, "What is the correct reading?" He looked at me then at the column and then said, "That is," pointing to the column. I asked for the barometer. I looked at it and at the Thermometer and remarked, "I am afraid not." "Well! show me how it is not," he answered.



RADOJET WITH BACK PLATE REMOVED.

Now with water as cooling medium the minimum temperature to which vapour can be reduced is 32 deg. Fahr. This corresponds to a pressure of .0886 lbs. per. sq. in. or 0.1804 inch of mercury. This represents the lowest possible pressure in practice in a condenser.

We all know that vapour condensed in an air tight vessel results in reduction of pressure but if open to atmosphere condensation will continue, but the pressure will remain at atmospheric level. The standard atmospheric pressure at sea level and at 45 deg. latitude is 14.6963 lbs per sq. in. corresponding to a mercury column of 29.921 inches in height the temperature of the mercury 32° Fahr. all steam tables are based on this but read of tests and statistics with the words refer to a 30 in. Barometer. I am giving two examples to show how the engineer can correct his mercury column and obtain the true reading. The formula or equation for correction to any temperature is:

H. Freight of mercury column corrected to temperature t.

h = observed height of mercury.

t_1 = observed temperature of mercury column.

t = temperature to which column is to be referred.

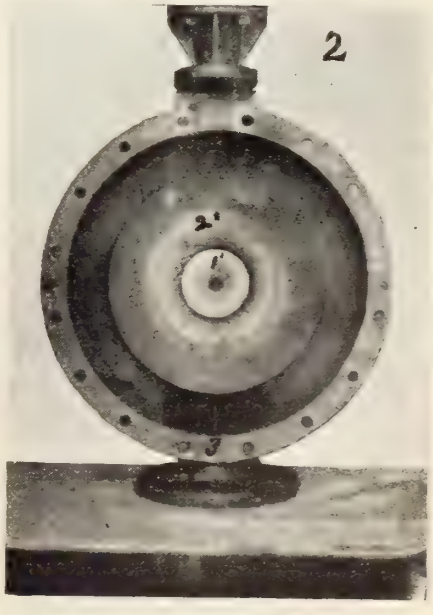
Now we will see more clearly if we take an example. Suppose our vacuum gauge reads 28.52 inches and the temperature is 80° F., then we look at the barometer and read 29.85 inches, the temperature there is 62° F. we will now transfer the readings to a 32° F. standard:

$H = 28.52\ [1 - 0.000101\ (80 - 32)]$
$28.52\ [1 - 0.000101 \times 48]$
28.52×0.995152
$H = 28.38$ for the vacuum gauge.
$H = 29.85\ [1 - 0.000101\ (62 - 32)]$
$H = 29.77$

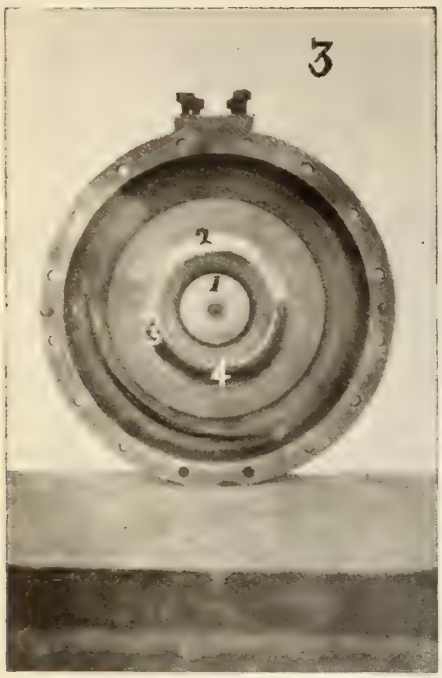
The absolute back pressure = 29.77 — 28.37 = 1.40.

1.40 absolute back pressure

Vacuum referred to a 32° standard =



SHOWING DIFFUSER DISC.



29.92 — 1.40 = 28.52

We will now transfer it to a 30 inch barometer. To do this, we must increase the temperature of the mercury, the height of the mercury must be increased from 29.921 to 30 inches by increasing the temperature of the mercury from 32° to 58.15° F. Then if the barometer and vacuum gauge readings are corrected to this temperature, the difference between the figures will give the absolute pressure in inches of mercury. According to the A. S. M. E. Power Code, a 30 inch barometer refers in round numbers to standard atmosphere with mercury at a temperature of 78°. We will use the same readings as before except we use 42° F.

H = 28.52 [1 — 0.000101 (80 — 58.15)]

H = 28.46. Readings for vacuum gauge.

H = 29.85 [1 — 0.000101 (42 — 58.15)]

H = 29.9. Reading for barometer.

29.9 — 28.46 = 1.44. Absolute back pressure.

30 — 1.44 = 28.56. Vacuum referred to a 30 inch barometer.

Editor's Note

This is an interesting case of trouble, and we invite our readers to forward their opinion of the cause. Those who have had no experience with the actual operating should be able to form an idea from the description. Let us hear from you on the matter.

A BOILER TUBE FAILURE

In a recent issue of the Journal of the South African Institution of Engineers, Mr. T. G. Otley described a case of boiler tube failure. The tube in question was in a bottom row of a water-tube boiler and was 3¼in. outside diameter and No. 7 gauge. The tube opened out for a length of about 10in., and as a result of the burst a large proportion of the fire was blown out of the furnace and the boiler house was filled with smoke and steam.

The failure, said Mr. Otley, is of more than usual interest, insofar as it very clearly illustrates a theory which he has held for some considerable time. When the burst occurred the furnace was fired and with a high quality Wetbank district pea coal with high furnace temperature —approximating, he judged, to about 1,350 deg. Cent., and no doubt the boiler was doing something more than its full load output. The calculated output was about 46,000 lb. per hour. It is, of course, well-known that in boilers heating surface nearest to the furnace does a disproportionately large fraction of the work. The botton row tubes in water tube boilers are worked very hard, but under normal working conditions they come to no harm, because the water is in contact with the inside surface of the tube and the metal cannot be overheated. Assume that the furnace temperature is, say, 1,300 deg. Cent., the temperature gradient across to the wall of the tube is a very sharp one—i.e., down, to say, 200 deg. Cent. the temperature on the water side—but further assume, as is reasonable under certain conditions of working, the steam bubbles attach themselves to the wall of the tube, then the temperature gradient is altered, and while remaining the same on the furnace side, the temperature may easily rise to 700 deg. Cent. or 800 deg. Cent. on the steam side, under which condition dissociation of the steam will occur and the metal on the steam side will become oxidised, forming thin layers of oxide. With the bursting of the steam bubble, water at approximately 200 deg. cent. temperature comes in contact with the tube, which contracts and the oxide cracks away. One can imagine this process being repeated until the sound metal is reduced very much in thickness until finally it is unable to resist the pressure combined with the temperature, and it then opens ont and bursts. Careful measurements of the burst tube showed that it had stretched very little, but the thickness of the tube nearest the fire, where it burst, came down almost to a knife edge. On the other piece of tube adjoining the burst an incipient blister was forming, and iron oxide on the steam side was clearly in evidence. It was also clear that some of it must have been cracked off and swept away by the rush of steam and water. The trouble cannot be accounted for by the quality of the material, which was excellent in every respect. The moral to be drawn is that when boilers are to be worked very hard it is of the first importance that the feed water should be of excellent quality, and that the lower tubes should be cleaned at fairly frequent intervals to prevent anything except the slightest scale adhering to them. As a matter of general practice Mr. Otley said that he put the turbine cleaner through the three bottom rows of the tubes every 1000 to 1500 hours.

ANNOUNCEMENT

The Worthington Pump and Machinery Corporation announce that in addition to their general line of hydraulic machinery, which they have manufactured since 1840, they have now undertaken the manufacture of all kinds of water-power machinery. This will include apparatus for low, medium, and high head service, including oil pressure system, water wheel governors and other auxiliaries. They will also manufacture hydraulic turbines, from their own designs. The Worthington Co's office is at 115 Broadway, New York.

In a recently published report upon the possibility and desirability of installing an industrial electrical network in Spain a scheme is outlined in which the main source of supply would be the waterfalls of the country, especially those of high head. The country is especially favored in this direction, because high water prevails at different seasons in different parts of Spain—in the Pyrenees in spring and summer, and in other parts of the country in winter. A careful investigation of the water power resources available has shown that a total of 2,000,000 kilowatts could be generated—excluding from the calculation falls yielding less than 2000 kilowatts. The proposed network, would, as far as convenient, join up the main centres of production and consumption, with Madrid as the centre of consumption. The total length of lines to be constructed would be 4810 kiloms. The report recommends the preliminary construction of a network for 300,000 kilowatts, which is about the power already available from other sources. The old systems would be joined up to the new one, thus giving initially an amount of 600,000 kilowatts available for consumption.

BILL

An Act to Amend the Stationary and Hoisting Engineers Act

His Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:—

Short Title

1. This act may be cited as The Stationary and Hoisting Engineers Act, 1920.

9 Geo. V., C. 37, Repealed

2. Section 4 of The Stationary and Hoisting Engineers Act, 1919, is repealed and the following substituted therefor:

Board of Examiners

4.—(1) The Lieutenant-Governor in Council may appoint a board of examiners consisting of three or five competent and independent engineers practically conversant with the construction of boilers and the operation of steam plants, who shall hold office during pleasure, and, subject to the regulations mentioned in the following section, shall prescribe the subjects in which candidates for certificates of qualification as stationary or hoisting engineers shall be examined, and shall conduct or provide for and supervise the examination of candidates and report thereon to the Minister.

Staff of Board

(2) The Lieutenant-Governor in Council may appoint such examiners, officers, clerks and servants of the board as may be deemed necessary.

A Discussion of the Uniflow Steam Engine

A Paper Read Before the Manchester (England) Association of Engineers, by Mr. Henry Pilling, M. I. Mech. E., Goes Fully Into the Principles of This Engine.—Part I.

THE uniflow steam engine includes the characteristic feature of one double-acting cylinder, fitted only with one steam inlet valve at each end and no exhaust valves.

The exit of steam at the end of each working stroke is very simply brought about by the following ingenious device. The cylinder is made long enough to accommodate a piston, which has a total length of nearly equal to the stroke of the piston, usually about 10 per cent. less. The cylinder barrel is prepared with exhaust ports or slots round its circumference at about the centre of the length of the barrel. These slots have a length, in a longitudinal direction, equal to about 10 per cent. of the piston. The three factors, i.e., one cylinder with inlet valves only, a piston a little shorter than the stroke of the piston, use of exhaust slots in the centre of the barrel, form the distinctive constructional features of the uniflow engine.

The sectional drawing—Fig. 1—shows that while the inlet valves provide for the admission of steam in the usual way, the necessity for exhaust valves has entirely disappeared owing to the piston just before the end of its stroke in either direction, uncovering the barrel slots which lead to the condenser. Consequently, a free and ample opening is provided for the exit of steam and for the rapid reduction of pressure in the cylinder to the condenser pressure. On the return stroke, the piston promptly covers and closes the slots, compression begins, and because of this prolonged compression which lasts nine-tenths of the stroke, the characteristic indicator diagram of the uniflow engine is obtained.

The question will now be asked, But why is a single-cylinder uniflow condensing engine more economical than a compound two-cylinder condensing engine? The cause of the improvement is to be found in reduced loss of heat to the walls of the cylinder, and in reduced heat losses to the condenser. In other words, the uniflow engine condenses less steam inside the cylinder while working than does a compound engine. With an ordinary compound engine using superheated steam, the steam would enter the high-pressure cylinder at a pressure of, say, 175 lb. absolute, and at a temperature of about 520 deg. Fahr. It would leave the high-pressure cylinder at about 45 lb. absolute pressure, and temperature 275 deg. Fahr. During the exhaust stroke the pressure would average 35 lb. absolute, and temperature 260 deg. Fahr.

In the low-pressure cylinder the inlet pressure would average 30 lb. and temperature 250 Fahr., at exhaust opening 10½ lb. and temperature 196 deg. Fahr., and during exhaust stroke, say, 3 lb. absolute with a temperature about 142 deg. Fahr. Now note:—In a compound engine, fitted with inlet and exhaust valves at each cylinder end, the steam enters, pushes the piston down the cylinder, retreats when its work is done along the same path back to the inlet end, and finally is all swept out by the returning piston through the exhaust port, which is open the whole time of the return stroke. In such an engine steam enters both high-pressure and low-pressure cylinders, only to find cylinders cooled during the previous exhaust stroke by the presence of the comparatively low pressure, low temperature exhaust steam, and doubly cooled by the fierce rush of this cooling vapour against the walls and passages, which presently admit the next charge of hotter inlet steam. Obviously, then, condensation is bound to be great.

In a uniflow engine, on the other hand, how changed for the better are the termal conditions. The steam retraces its path. It keeps on in the same direction. The current is "one direction flow," i.e., "Uniflow." When the steam has done its work it is rapidly exhausted through the opened slots, which remain open to the condenser temperature on-

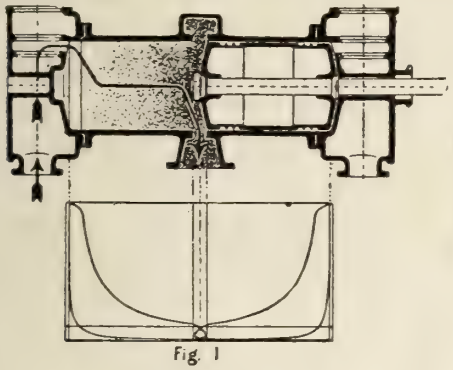
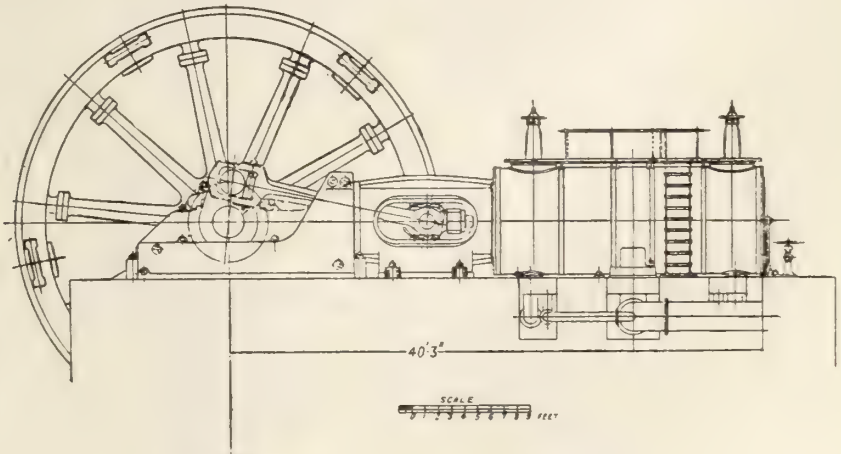


Fig. 1



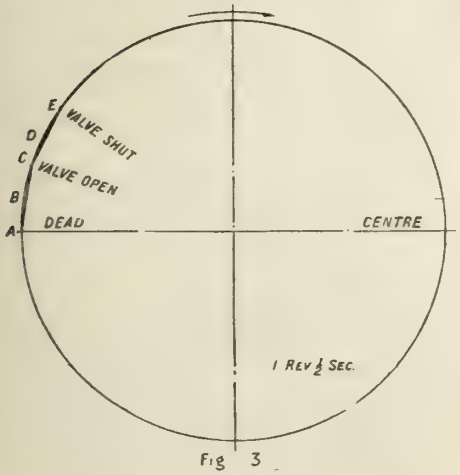


Fig 3

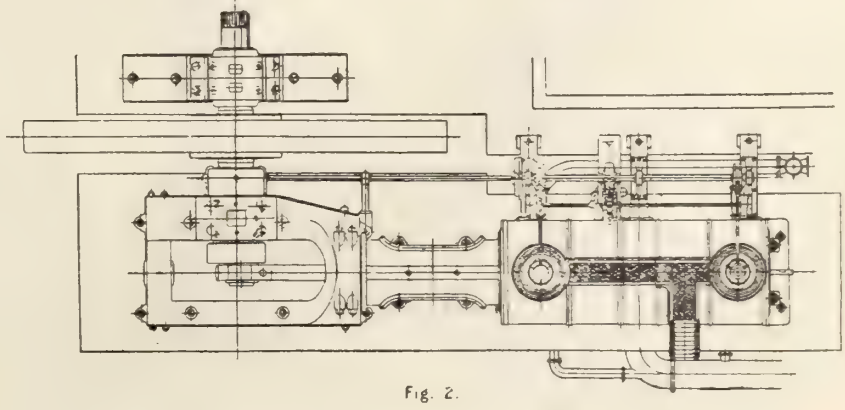


Fig. 2.

ly one-third of the time required in a compound engine. In no manner does it rush past, scour or sharply abstract heat from the hot surfaces at the inlet end of the cylinder. Such an abstraction of heat in the compound engine is loss, and the avoidance of such loss in the uniflow engine constitutes profit.

That these statements are well based may be proved by touching a uniflow cylinder when at work. The cylinder will be found hot at the two ends—i.e., full original steam temperature—and cool at the centre of the barrel—i.e., condenser temperature only. The cylinders of a compound engine, on the other hand, are uniformly hot all over, but at a temperature less than the inlet steam temperature, and therefore subject to the condensation evils. This gain is accentuated by the simplicity of the means by which it is achieved. The following is a comparison of the parts required in the types of engine referred to:

Uniflow Engine

One piston.
Two inlet valves and mechanism.
One piston-rod.
One piston-rod packing.

Compound Engine

Eight inlet and exhaust valves and mechanism.
Two piston-rods.
Four Piston-rod packings.
Two back slides.

It is important, however, that the exact sphere of usefulness of a uniflow engine should be rightly apprehended. It is the best type of engine, and is recommended for those conditions where condensing water is available and assured, and where the direction of rotation is continuous. For permanent non-condensing working, the choice will be according to circumstances. For reversing engines, winding engines and the like, other types of engines are usually to be preferred.

Thus, the "Uniflow" is especially suited for the driving of textile mills, paper mills, tin-plate mills, sheet mills, continuous-running non-reversing rolling mills of all kinds, timber mills, dynamo driving and all similar purposes, and the largest sizes required can be made. For example, I have on hand at the present time what I believe to be the largest uniflow engine in the world, i.e., with cylinder 60 in. diameter, 6 ft. stroke. A drawing of this engine is given in Fig. 2.

Valve Gears

One of the characteristic features of the uniflow engine is a normal working cut-off ranging from 5 to 10 per cent. of the stroke. This is in marked contrast to the cut-off in compound engines, which ranges normally from 25 to 50 per cent. of the stroke. In the uniflow engine the normal period available between the opening and closing of the steam inlet valve is thus from one-fifteenth to one-tenth of a revolution, and in the compound engine one-sixth to one-fourth of a revolution. In compound engines earlier cut-off than one-sixth give trouble with Corliss valve trip gears, and consequently the use of this class of gear and valve for very variable loads frequently requiring zero cut-off has been gradually abandoned.

With uniflow engines the mechanism adopted for opening and closing the valves in the exceedingly small time available is usually of the percussion or positive type; that is to say, the valve is pressed open by some form of cam gear and forcibly closed by means of a strong following-up spring. The word "percussion" is used advisedly in order to draw careful attention to the fact that with fast-running engines the operating valve forces are apt to be in the nature of a hammer blow. Consequently, if noisy working, severe wear and tear, and working troubles generally are to be avoided, the design must be theoretically sound, the proportions adopted must be ample, the workmanship and material of the very highest grade and the lubrication perfect.

As an example of the method of approximately calculating the inertia forces involved, both on piston and valve, we will take the case of an engine 3 ft. stroke running at 120 revolutions per minute, with a cut-off of 10 per cent. and a valve lift of 3/16 in. at this cut off. At 10 per cent. cut-off the movement of the crank pin from the dead centre is—very nearly—one-tenth of the crank-pin circle. The crank pin velocity is 18.85 ft. per second. The

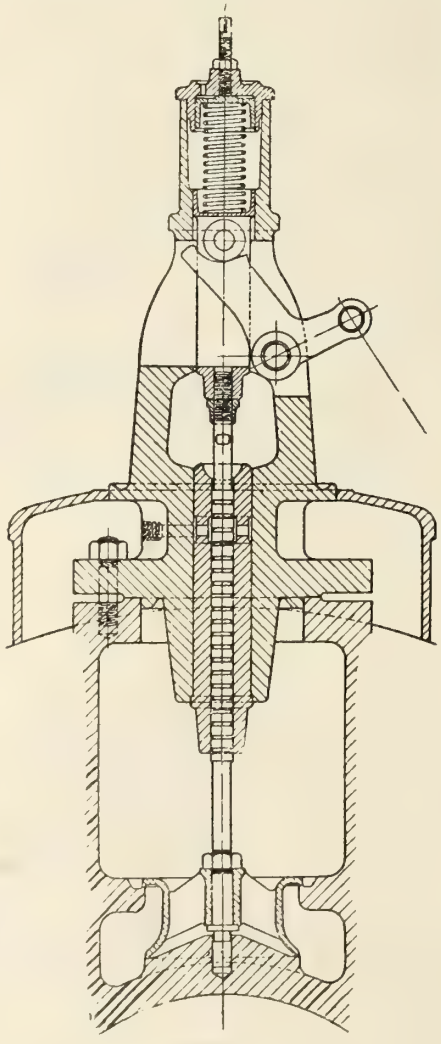


FIG. 6.

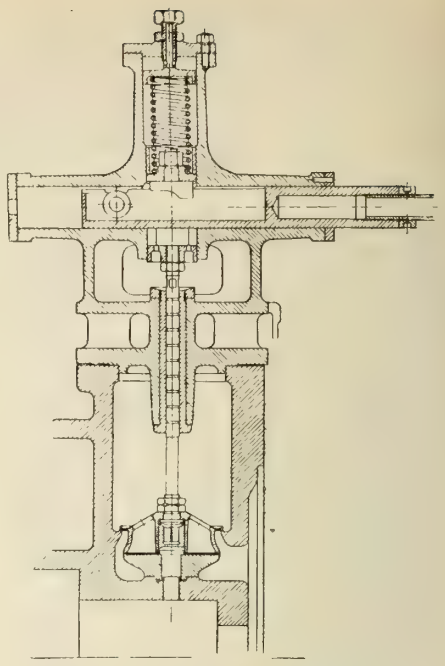


FIG. 7.

time for each revolution is half a second. The time available for opening and closing the steam valve is 1/20 sec.

To compute the forces necessary to start a piston and rod into motion from the end of the stroke at the velocity imparted by their connection to the crank pin, it is customary in drawing-offices to assume that the weights are tied to the crank pin and to calculate the centrifugal force they would there exert. This force is equal to the "dead-centre" inertia force we are seeking.

The usual formula is used as follows:

$$F = \frac{W v^2}{g r}$$

F = centrifugal force per pound of revolving weight.
W = unit weight, 1 lb.
v = crank pin velocity in feet per second.
g = 32.2.
r = crank pin radius in feet.

Then for the case cited:

$$F = \frac{1 \times 18.85^2}{32.2 \times 1.5} = 7.4 \text{ lb.}$$

This 7.4 lb. is the force required to overcome the inertia of each pound weight of reciprocating parts affected. It is a considerable amount, and a designer must not be ignorant of it or ignore it when fixing the strength of parts.

Now, let us assume the same formula is applied to calculating the inertia resistance of a valve. In our particular case the lift is 3/16 in., and the total time for opening and closing is 1/20 sec. The opening and closing movements are equivalent in character to the outward and inward strokes of a piston which jointly take one revolution. Next, we will imagine the valve is opened and closed by the action of a crank of 3/32 in. radius (1/128 ft.), i.e., 3/16 in. stroke, making its complete revolution in 1/20

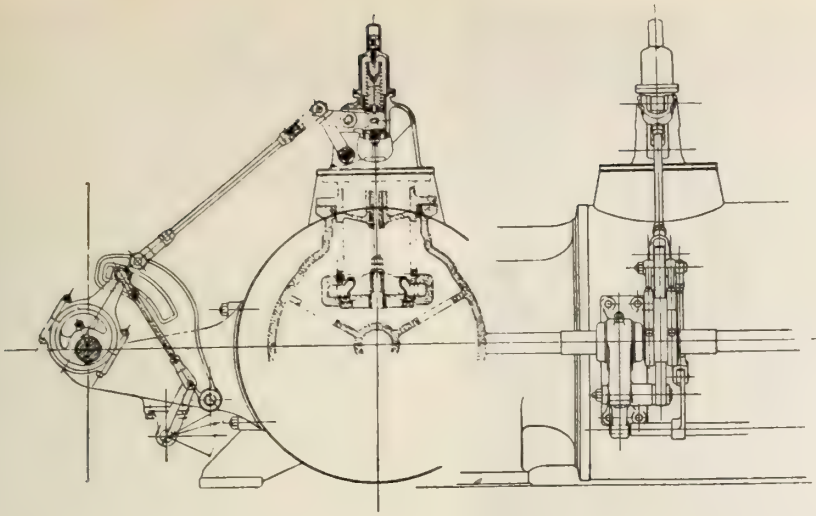


FIG. 4.

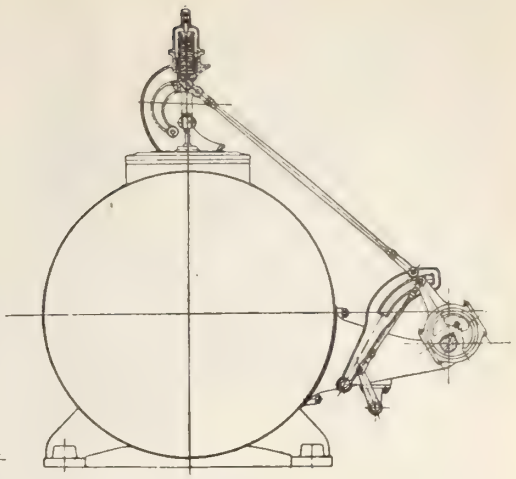


FIG. 5.

sec. The crank pin velocity is therefore:

$$\frac{3}{16} \times \frac{3.1416}{12} \times 20 = .98 \text{ ft. per second.}$$

The inertia resistance of the valve line for each pound weight moved is found exactly as in the case of the piston, thus:

$$F = \frac{W\ v^2}{g\ r} = \frac{.98^2}{32.2 \times 1/1=28} = 3.82 \text{ lb.}$$

This also is a considerable amount and must be taken careful note of by valve gear designers.

The preceding calculation for the valve assumes that the valve is moved at a variable rate of acceleration, as though worked by a crank. In actual practice the valve would not be so moved. The actual rate would depend on the type of valve gear, on the form of any cam or contact surfaces, and so on. It will, however, be useful to consider the case of a valve opening at a uniform rate of acceleration, as though moving freely under a steadily applied uniform force analagous to the action of gravity. Assume that the valve acceleration is uniform, while the velocity increases from zero at the beginning of the lift to a maximum velocity at half lift, and that half lift occurs midway in point of time between the beginning of lift and full lift, i.e., that the times for the first half of the lift and the second half are the same. Referring to Fig. 3:

A = valve begins to open, rest position.

C = valve full open, rest position.

E = valve shut, rest position.

B = assumed point of maximum velocity of valve when opening.

D = assumed point of maximum velocity of valve when closing.

A to E = one-tenth revolution = 1/20 sec.

A to B = one-fortieth revolution = 1/80 sec.

The time for half lift is then a quarter of the time from beginning of opening to closing of valcve:

$$= \tfrac{1}{4} \times 1/20 = 1/80 \text{ sec.}$$

Hence the valve, moving with uniform acceleration, travels:

3/32 in., or 1/128 ft. in t = 1/80 sec.

The acceleration is then given by the usual formula:

$$a = \frac{2\ s}{t^2} = \frac{2 \times 1/128}{1/80 \times 1/80} = \frac{6400}{64} = 100 \text{ ft.}$$

per sec. per sec. and the inertia force for each pound of the valve:

$$= \frac{100}{32.2} = 3.1 \text{ lb.}$$

This compares with the 3.82 obtained by the first calculation. The designer is now aware that if his valve and spindle, etc., weigh 30 lb., his applied forces during opening must be, under the assumptions chosen, of the order of 3.82 × 30 = 114 in the one case and 3.1 × 30 = 93 lb. in the other. But a similar force has to be impressed during closure, and if the valve is closed by spring action, the resistance of which opposes the ascent of the valve, there is a total resistance to opening of 114 + 114 = 228 lb. in the one case, or 93 + 93 = 186 lb. in the other. (The weight of the valve has been ignored in the above, as the spring may be correspondingly weaker and the total resistances are unaltered.)

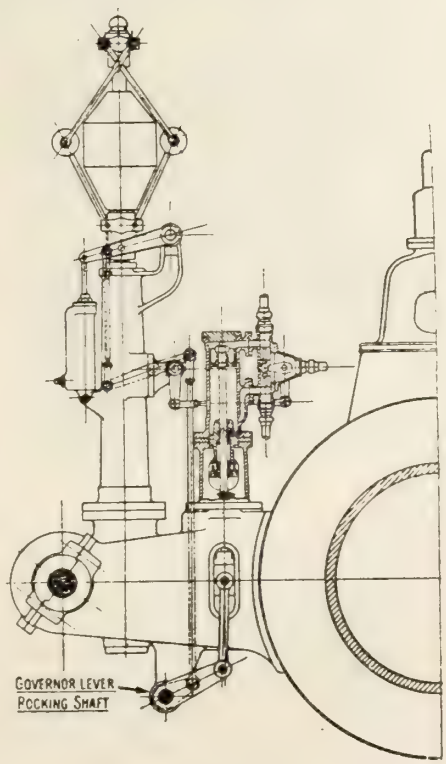


FIG. 8.

These figures, though based on assumptions which are modified in practice, nevertheless demonstrate in unmistakable manner the paramount necessity of keeping the valve lifts and weights moved as small as possible. Ignorance of the theoretical principles involved or failure to observe them in the design has caused many failures. In the actual design, in order to avoid initial hammer blow when, say, an operating cam or roller first comes into contact with the parts to be lifted, it is obvious that it will be best to bring the full force into action gradually rather than suddenly. This is usually done by suitably shaping the cam surfaces. The number of joints should be as few as possible, and the construction should be such that all slack is taken up before the real load comes on. It must not be the serious force required for lifting the valve which jams all the slack parts together.

The practical design has, of course, to be tempered to suit such factors as temperature effects and movements, elasticity and yielding of the mechanism under load, provision for rendering unavoidable wear and tear innocuous as far as possible, cost of manufacture and so on.

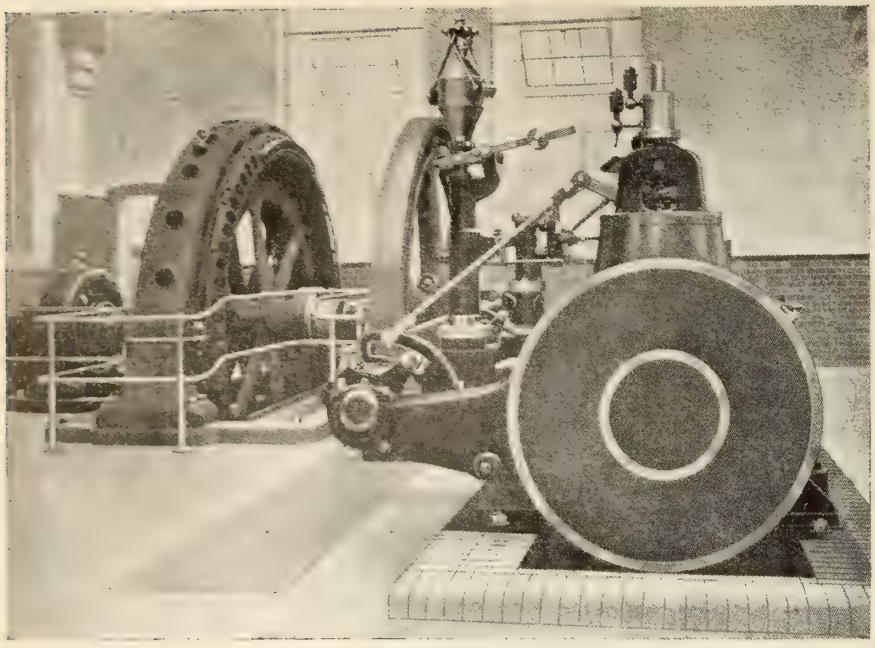
One gear is illustrated in Fig. 4, and in the half-tone engravings on page 454, which represent views of a 500 horsepower engine with cylinders 27 in. by 2 2 ft. 6 in.

This had the defect that wear caused slackness of a kind which absorbed part of the motion of the roller before lifting took place. Hence heavy knocking developed in due course due to the profile of the cam not being effectively used.

A solution to overcome this is given in Fig. 5. In this design the wear does not cause such disturbance. Other gears are shown in Figs. 6 and 7.

Governors

Hitherto the majority of uniflow engines have been made with layshaft



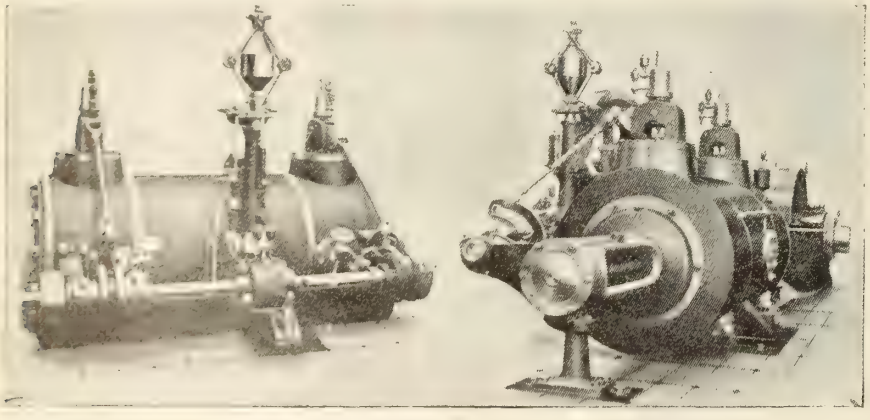
UNIFLOW ENGINE DIRECT CONNECTED TO ALTERNATOR.

governors. Governors of this class involve, as a rule, the use of two hinged weights, which, under the restraint of powerful springs occupy various positions according to the speed of the engine. Such governors are suitable for high speed, but are totally ineffective at slow speeds. Makers of uniflow engines have therefore found their principal market in engines with quick speed of rotation, such as, for example, 160 revolutions at 2 ft. 6 in. stroke.

There are many cases, however, for which uniflow engines are suitable, provided the speed of rotation can be made quite slow. For example, slow-speed pumping, slow-speed compressors or blowing engines, slow-speed direct-coupled rolling mill engines. In such cases it is not convenient to provide the necessary powerful governing force by means of a layshaft governor; some other type must be adopted.

My personal preference is for a frictionless governor of small power adapted to control the valve gear, not directly, but through a powerful servo-motor and oil relay. Such a device is shown in Fig. 8 and in the upper left-hand view on page 454.

By its use the powerful forces necessary for operating the valve gears of large engines are readily obtained. Such governors are also well adapted for use with speed variation devices to cover a wide range of speed.



SIDE AND REAR VIEW OF ENGINE.

WORKING TO MAKE USE OF LIGNITE

U. S. Department of Marines Has New Scheme Under Way to Use Large Deposits

Washington.—Efforts to make the lignite or brown coals of Texas, North Dakota, and other Western States so serviceable to that part of the country that will be unnecessary in the future to ship in other coals at great expense are to be inaugurated immediately by the Bureau of Mines, Department of the Interior, at New Salem, North Dakota, in co-operation with a company there.

Immense quantities of these lignites, constituting one-third of the fuel resources of the nation, are available in these states, but have been little used because of the great amount of moisture in them, their tendency to disintegrate when dry and their liability to spontaneous combustion. In fact, the difficulties have been so great in burning the lignite that the people have preferred to buy their coal in Illinois, Indiana, West Virginia, Kentucky, and Pennsylvania, bringing into their localities several million tons of coal that had been hauled an average of 1,000 miles and at a cost of nearly $5,000,000 in freights. The Bureau of Mines proposes to carbonize and briquet this raw lignite and develop a smokeless domestic fuel that will do away with the importation of domestic coal into this section of the country. By heating the lignite sufficiently to drive off the moisture and a part of the gases a char is obtained, which, in heating value closely approximates anthracite coal. The briquetting of this makes a very satisfactory household fuel.

An appropriation of $100,000 was made by Congress a year ago for this purpose and the Bureau of Mines has, after a careful survey of the entire field in which a number of the cities in these states have offered their facilities, selected New Salem as the place best fitted for the investigations, which will begin at once.

It is claimed in this process of carbonizing the lignite and making briquets out of it that not only is a superior domestic fuel created, but that valuable by-products are made, such as enormous quantities of gas to be used for fuel or power purposes, and a great amount of oils and tars.

Sliding Wage Scale.—Judge McLellan, chairman of the conciliation board sitting on the Ottawa Electric Railway dispute, suggested a novel way of coming to an agreement regarding wages, which may be recommended in the board's findings. His idea is that an agreement should be made covering a long term. The rates of wages should be increased in proportion to the increase in the cost of living. Every six months there should be a revision, and if living costs increase or decrease wages will increase or decrease in the same proportion. The figures taken as a basis would be those published in "The Labor Gazette."

Trouble at Peterboro.—The Canadian General Electric machinists' at Peterboro offer to the company to abide by the recommendations of the Board of Conciliation authorized by Senator Robertson, Minister of Labor, brought the following reply from Senator Nicholls to Mayor McIntyre: "The company declines to be represented on a Board of Conciliation in connection with the strike in Peterboro, and must also decline to accept any award of such board if appointed. We are still willing to grant the increases which were offered to the men before going on strike. We have advised the Minister of our decision." It was followed by another telegram, which simply reiterated Senator Nicholls' determination not to yield to the demands of the men.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

BEFORE proceeding with some examples of compound fractions, a short explanation of the use of the various signs employed and the proceedure to be followed in solving fractional statements will be useful. There is a definite rule to be followed in working out solutions, and if this rule is not observed, the results will be far from correct.

The Use of Signs

The commonest signs, of course, are the plus +, and minus —. Plus before a number means that that number is a positive quantity. A minus sign means that the number following is a negative quantity. Where several numbers are involved with these signs between them it means that the sum of all the negative quantities must be deducted from the sum of all the positive quantities. The result may be either positive or negative, and here is where the man with no knowledge of algebra may be puzzled. However, if he just casts his mind to a very familiar phenomenon of our winter climate he will understand it easily. If he looks at the thermometer on his way to work he may find it reads 15 below zero, or as it is usually printed, — 15. By eight o'clock it has gone up to — 10, and by 9 it has reached zero. At 10 it reads 5 above, or + 5, and stays there till 1 o'clock p.m. Then it comes down 5 degrees every hour, till at 5 o'clock p.m. it reads 20 below, or — 20. Now, the average temperature for the 11 hours would be found by adding the reading at every hour and dividing by 11.

Now the sum will be $-15 + (-10) + 0 + 5 + 5 + 5 + 5 + 0 + (-5) + (-10) + (-15)$.

This will give $-55 + 20 = -35$

$\frac{-35}{11} = -3.18$, or an average temperature of slightly over 3 degrees below zero.

Now, if we imagine any other body or figure or scale beside the thermometer as having a positive value, a zero point, and a negative value, there will be no difficulty with the plus or minus.

The multiplication sign is occasionally a stumbling block to the novice, as, instead of using invariably the ×, the sign is omitted altogether, or a small dot, something like a decimal point, is used. Where the signs are omitted altogether is when a literary formula is used, but the dots are used between numbers. A figure before a bracket as 3(6x9), means that the product of 6x9 must be taken 3 times. Letters denoting values when placed together, as PLAN in the well-known formula for horse power, are read as P × L × A × N, and an expression like 323.4.64 would read 323 × 4 × 64. However, this latter method is not used very generally, either the × sign being used, or the sign omitted altogether.

The division sign is written in a variety of ways. The best known, of course, is the ÷ sign, which is the one we first become acquainted with. Then there is the line used as in fractional quantities, as $\frac{2}{4}$ which means that two is to be divided by four, or $\frac{8 \times 11}{6}$ which means that the product of 11 × 8 is to be divided by six. Again a line is sometimes used as 12/2, which means 12 is to be divided by 2.

These four are what might be called the cardinal signs. There are several others which must be made familiar to the eye, and their meaning to the memory, so that when they are encountered in formulae, there will be no difficulty in arriving at the correct solution.

Of these, the various forms of brackets are among the most important, and are often stumbling blocks to the tyro. Their meaning and the way in which they are used must be thoroughly understood, or correct solutions will be a matter of chance instead of certainty. Bracket signs are classified as follows: The parenthesis (), the bracket [], the brace $\left\{ \right\}$, and the vinculum ——. The generic term covering them all is "signs of aggregation", and the meaning conveyed by any of them is that the numbers enclosed between them are to be simplified before any other operation is performed.

Take an expression such as $A = \frac{1}{2}(h + b)$, substitute figures for the letters, say, $A = \frac{1}{2}(3 + 5)$. This means that the sum of 3 and 5 multiplied by ½ will give the value symbolized by A. Take another: $4 + 6(8 \times 4 + 5) - 2 = A$. Now, here is where a very important rule is illustrated, in connection with the multiplication sign. Two numbers connected together by a multiplication sign must be simplified before those connected by any other signs. In this case the solution step by step is, taking inside the brackets first, the product of 8 and 4, added to five, multiplied by 6, plus 4, — 2.

The work is

$4 + 6(8 \times 4 + 5) - 2 =$
$4 + 6(32 + 5 - 2 =$
$4 + 6 \times 37 - 2 =$
$4 + 222 - 2 =$
$226 - 2 = 224.$

Now if the rule as to multiplying is not observed, the result will be entirely different. Suppose we were in simplifying the term in the brackets to add 4 and 5 before multiplying by 8, see what we should get.

The work would then be:
$4 + 6(8 \times 4 + 5) - 2 =$
$4 + 6(8 \times 9) - 2$
$4 + 6 \times 72 - 2$
$4 + 432 - 2$
$436 - 2 = 434.$

Now, when simplifying a formula in which several terms are bracketed, always simplify the terms in the inner brackets first.

Take the formula for finding the area of a segment of a circle, or rather one of the formulae, of which there are several.

$A = \frac{1}{2}[lr - c(r - h)]$

Substituting figures $A = \frac{1}{2}[8 \times 4 - 3(4 - 2)]$.

Simplifying $A = \frac{1}{2}[8 + 4 - 3 \times 2]$
$= \frac{1}{2}[32 - 6]$
$= \frac{26}{2} = 13$

Take another a little more complicated, as follows:

$$x = 4\{3 + [6 \times 9 - (2 + 4 + 3 \div 3)]\}$$
$$x = 4\{ + [6 \times 9 - 3]\}$$
$$= 4\{3 + [54 - 3]\}$$
$$= 4\{3 + 51\}$$
$$= 4 \times 54$$
$$= 216.$$

The rule to observe always is to simplify the expression in the innermost bracket first of all and when simplifying any expression to perform the indicated multiplication first, and the addition and subtraction afterwards. We have not dealt with the last sign of aggregation, the vinculum, because it is not used as a rule except in connection with the root or radical signs.

Having made clear the method of using the various signs, a few examples of complex fractions will be given, after which it will be possible to give the decimal system a little study.

Some Examples of Fractions

In example, the first step is to add the first terms of the numerator, 7-16 and 3-8 together, invert the fraction 9-27 and prefix the multiplication sign. Then proceed to simplify the denomina-

$$\frac{\frac{7}{16}+\frac{3}{8}\div\frac{9}{27}\div\frac{3}{4}}{\frac{5}{32}\times\frac{7}{8}+\frac{1}{2}}=$$

tor. It will be seen that there is a multiplication sign between the first two terms, followed by a plus sign. Following the rule, the multiplication is performed first, and then the addition. This brings the whole compound fraction to its simplest form, which shows that 39-16 is to be divided by 163-256, and the quotient divided by 3-4, or multiplied by 4-3. The various steps necessary are shown in the accompanying cut.

$$\frac{\frac{7+6}{16}\times\frac{27}{9}}{\frac{35}{256}+\frac{1}{2}}\div\frac{3}{4}=$$

$$\frac{\frac{13}{16}\times\frac{3}{1}}{\frac{35+128}{256}}\div\frac{3}{4}=$$

$$\frac{\frac{39}{16}}{\frac{163}{256}}\div\frac{3}{4}=$$

$$\frac{39}{16}\times\frac{256}{163}\times\frac{4}{3}=$$

$$\frac{13\times64}{163}=\frac{832}{163}=5\frac{17}{63}$$

Let us now take another example:

$$\frac{\frac{4}{3}\left\{\frac{5}{8}+\left[\frac{5}{16}-\frac{2}{3}\times\frac{1}{4}\left(\frac{3}{8}+\frac{7}{16}+\frac{3}{4}\right)\right]\frac{1}{2}\right\}}{\frac{4}{5}+\frac{3}{8}+\frac{1}{2}+\frac{3}{4}}$$

$$\frac{16}{24}+\frac{7}{32}$$

The first thing to do here is to simplify the expression in the inside brackets. The expression will then be:

$$\frac{4}{3}\left\{\frac{5}{8}+\left[\frac{5}{16}-\frac{2}{3}\times\frac{1}{4}\left(\frac{25}{16}\right)\right]\frac{1}{2}\right\}$$

Next, take the figures included in the second bracket which become 5-16 — 2-12, which gives 7-48. Taking off the inside brackets the expression now is:

$$\frac{4}{3}\left\{\frac{5}{8}+\left[\frac{7}{48}\times\frac{25}{16}\right]\frac{1}{2}\right\}$$

The next step will be to eliminate the remaining inside brackets, and as these contain only multiplication operations, it is simple and we can put the expression as follows:

$$\frac{4}{3}\left\{\frac{5}{8}+\frac{7}{48}\times\frac{25}{16}\times\frac{1}{2}\right\}$$

The remaining steps are obvious and can be easily followed. The product of 7-48 × 25-16 × 1-2 is added to 5-8, and the resulting sum is multiplied by 4-3, the final result being 1135-1152. This is the numerator of our compound fraction reduced to its lowest form.

$$\frac{4}{3}\left\{\frac{5}{8}+\frac{175}{1536}\right\}$$

$$\frac{4}{3}\left\{\frac{960+175}{1536}\right\}$$

$$\frac{4}{3}\times\frac{1135}{1536}=\frac{1135}{1152}$$

The denominator is also a compound fraction and must be simplified completely to obtain a solution. Thus:

$$\frac{\frac{4}{5}+\frac{3}{8}+\frac{1}{2}+\frac{3}{4}}{\frac{32+15+20+15}{40}}$$

$$\frac{16+7}{24+32}=\frac{64+21}{96}=\frac{85}{96}$$

making 82-40 as the numerator, and 85-96 as the denominator of the divisor of the whole fraction. Our sum now appears like this:

$$\frac{\frac{1135}{1152}}{\frac{\frac{82}{40}}{\frac{85}{96}}}=\frac{\frac{1135}{1152}}{\frac{82}{40}\times\frac{96}{85}}=\frac{\frac{1135}{1152}}{\frac{984}{425}}$$

We can now simplify and solve the whole sum without difficulty.

$$\frac{1135}{1152}\times\frac{425}{984}=\frac{482375}{1,113,568}$$

This final result cannot be reduced.

The foregoing example should suffice to show how to go about the solution of any fraction. It is merely a matter of remembering the rules. First of all, bring every expression to its lowest possible form. Simply the expressions contained in brackets, starting with the innermost. Remember that two terms connected with the sign of multiplication must be solved before those connected by any other sign. Take the expressions on top of the line dividing denominator and numerator first, and simplify them. In fractions such as we have just illustrated, the line dividing denominator and numerator is always made heavy, so that no mistake can be made.

If there is anything not clear to the reader in this subject, the writer will be glad to further explain it.

Decimal Fractions

Decimals are much more commonly used than vulgar fractions on account of their convenience, and simplicity. Multiplication and division of decimals can be effected by merely moving the decimal point to right or left in many cases. A whole number can be divided into any number of divisions by vulgar fractions, but with the decimal fraction, the number of divisions can only be ten, or multiples of 10, that is tenths, hundredths, thousandths and so on.

To signify a decimal fraction, a small dot, called the point, is placed before the first figure of the fraction. Thus: .1, .01, .001, etc. Following the decimal point the figures read to the right in descending value, just as in ordinary numbers they ascend in value, reading to the left. For instance, in the numeral 1234, the figure 4 on the right is a unit number. The next, figure 3, has ten times the unit value, that is, it is read as 30, the two figures together reading thirty and four, or thirty four. The next figure has 100 times the unit value, and the first figure 1000 times. Now if we place a decimal point after the last figure and set the same figures down again, we will get 1234.1234. The first figure will represent one-tenth part, the second figure 2 one-hundredth parts, the third figure 3 one thousandth parts, and the last figure four ten thousandth parts. Expressed in words, the number would be one thousand two hundred and thirty four, and one thousand two hundred and thirty-four ten thousandths. Expressed as a whole number and a vulgar fraction it would be $1234\frac{1234}{10000}$.

From this we can follow out the rule for decimals. A decimal we have seen is a 1-10th part. Now instead of writing it in fractional form, as 1-10, we write it .1. The point conveys the meaning that the figure following it is the numerator of a fraction having 10 as its denominator. If we wish to write 1-100 we prefix a cipher to the numerator, thus .01, which means that the denominator of the fraction is 100, the numerator still being 1. The addition of a second cipher as .001 means that the denominator is 1000, and so on, each cipher in the numerator adding a cipher to the denominator. Thus $\frac{1}{1,000,000}$ will be written .000001. The denominator is always understood, but need not be written, and never is.

Decimal fractions can be added, subtracted, multiplied and divided, and the operations are performed much easier than with ordinary fractions.

Addition of Decimals

In order to add together decimal fractions, all that is necessary is to set them down as one would any ordinary sum in addition, care being taken to keep them in their correct relative position to the point. For instance, in add-

ing .5 to .05, the figures must be set down thus:

.5
.05

and the addition then performed in the ordinary way. That is .5 + .05 = .55. This really means that to $\frac{5}{10}$ has been added with fractions: $\frac{5}{100}$, the result being $\frac{55}{100}$. Try this with fractions

$$\frac{5}{10} + \frac{5}{100} = \frac{50+5}{100} = \frac{55}{100}$$

Again add .345 to .123. We get

.345
.123
.468

Now take .75 + .25. This is

.75
.25
1.00

Here we have a sum which gives a whole number. Whenever the sum of the two first figures is more than 9, then the unit figure is set down and ten carried over, as in the ordinary way, but to the left of the decimal point. Let us take some whole numbers and decimals, to illustrate this point. Take 2.75 + .5. We have 2.75

.5
3.25

or again 1.25 + 2.75 = 1.25 + 2.75 = 4.00

Another example: 2.34 + 1.25 + 2.68 = 2.34
1.25
2.68
6.27

Add 2.3456, .0031, 1.002, 4.106, 5.00005. We have 2.3456
.0031
1.0020
4.1060
5.00005
12.45675

Subtraction of decimals is performed in the same way. The figures are set down with due regard to the place of the decimal point and subtraction performed just as with whole numbers.

Thus .123 — .016.

We have .123
.016
.107

Or 2.345 — 1.203
2.345
1.203
1.142

Subtract 346.007 from 458.0103
458.0103
346.007
112.0033

Subtract 369.0035 from 461.0045
461.0045
369.0035
.92.0010

The result of this would be written 92.001, the cipher at the end being left off. A cipher after the last significant figure in a decimal means nothing, but a cipher before a significant figure alters its value by ten times. This must be carefully remembered. Thus .1000 is only .1, or $\frac{1}{10}$, but .001 is not $\frac{1}{1}$, but $\frac{1}{10000}$.

Multiplication of Decimals

In multiplying decimals the same rules apply as in ordinary multiplication, the only precaution necessary being the placing of the decimal point in its correct position in the product. The sum to be multiplied is set down in the ordinary way, and after the multiplication is performed, the position of the decimal point is determined by counting the number of figures after the decimal point in both multiplier and multiplican. This can easily be understood from an example.

Multiply .25 by .75.
.25
.75
125
175
.1875

There are two figures in the multiplier after the decimal point, and two in the multiplicand, making four altogether. Then count from the right to the left four figures, and place the decimal point before the fourth figure. There are one or two points to watch in multiplication of decimals, which are very simple, but have a large effect on the result if not observed.

Take .555×.004
.555
.004
2220

Here we have only four figures in the product, and six figures after the decimal point in the multiplier and multiplicand. We must therefore add enough ciphers to the left of the first figure to make up the necessary number. We then have .002220. However we have already said that the cipher at the right hand has no value, so we can leave it off, and the product is .00222. The important point to remember is, do not take off any ciphers at the right hand end until the decimal point is fixed. They must be counted in when finding the place to put the point. Supposing the cipher had been cancelled before fixing the decimal point, the product would have been:

.555
.004
2220,

and taking away the cipher at the right, and adding the necessary ones to the left would have made .000222 instead of .00222. This would have made the product $\frac{222}{1,000,000}$ instead of $\frac{222}{100,000}$ It is easy to see the importance of this point.

That is all there is to multiplication of decimals. A few more examples will be sufficient to make it quite clear.

Take 2.789×1.234:
2.789
1.234
11156
8367
5578
2789
3.441626

Now unless great accuracy is required, there is little use in carrying the decimal places more than four figures from the point so we would eliminate the last two figures, and make the answer 3.4416. Leaving out the last two figures makes an error of $\frac{26}{1,000,000}$ which is not very serious.

Multiply .0078 by 2.25
2.25
.0078
1800
1575
.017550 say .01755

Mutliply 6.25 by 25.75
25.75
6.25
13875
5150
15450
161.0375

Division of Decimals

When we come to the division of decimals we find it just as simple. To divide decimals, proceed in the ordinary manner, except that there must be as many figures after the decimal point in the divisor as in the dividend. The position of the decimal point in the quotient is

determined in a somewhat different manner than has been used for the other operations. Take a simple case. Divide .4 by .2, we have .2).4(.2. Now the answer is two whole numbers, not .2 or any fraction. How is this result arrived at? Well, let us try it another way $\frac{4}{10} \div \frac{2}{10} = \frac{4}{10} \times \frac{10}{2} = \frac{40}{20} = 2$. It means simply that 2 tenths are contained in 4 tenths twice. Now let us divide .2 into 4. Here we have one figure after the decimal point in the divisor, but no decimal point in the dividend. We must add a decimal point and a cipher and we then have .2 divided into 4.0. Now we may neglect the decimal points altogether and simply make our sum 2)40(20. Let us now reverse this sum and make it 4 divided into .2. Here we have a figure after the decimal in the dividend, and none in the divisor. We must add a cipher and a decimal point to the divisor. We then have 4.0 divided into .2. Again leaving the points out now that the number of figures following them is the same, we get 40)2. This of course will not go. What must be done to make it possible? The first thing to do is to put a decimal point in the quotient, at the same time adding a cipher to the dividend, thus: 40)20(. Still 40 will not go into 20. We add another cipher to the dividend and a cipher in the quotient. We now have 40)200(.0 This will now go 5 times and we have 40)200(.05 the answer

```
200
---
...
---
```

being .05. Let us try this out by fractions just to show it is correct. We will have $\frac{2}{10} \div 4 = \frac{2}{10} \times \frac{1}{4} = \frac{2}{40} = \frac{1}{20}$. Now $.05 = \frac{5}{100} = \frac{1}{20}$.

Suppose we have to divide 2.25 by 1.005. We have one figure more after the decimal point in the divisor than in the dividend so we must add a cipher to make them even, making the statement 2.250÷1.005. Then proceed as in ordinary division leaving out the decimal points:

```
1005)2250(2
     2010
     ----
      240
```

We have a remainder. In order to proceed we must place a decimal point after the 2 in the quotient, and add a cipher to the remainder and then go ahead.

```
1005)2250(2.2
     2010
     ----
      2400
      2010
      ----
       .390
```

Add a cipher to this remainder and divide again

```
1005)2250(2.23
     2010
     ----
      2400
      2010
      ----
       .3900
       3015
       ----
        .885
```

Keep on adding a cipher to the remainder and divide till the answer has been carried to four figures after the decimal point, which will be accurate enough for most purposes.

```
1005)2250(2.2388
     2010
     ----
      2400
      2010
      ----
       3900
       3015
       ----
        8850
        8040
        ----
         8100
         8040
         ----
          60
```

In this case, when the cipher is added to the last remainder, the dividend will not go into it. If we wish to carry on the sum we must add another cipher, at the same time placing a cipher in the quotient, as shown

```
1005)2250(2.238805
     2010
     ----
      2400
      2010
      ----
       3900
       3015
       ----
        8850
        8040
        ----
         8100
         8040
         ----
          6000
          5020
          ----
           975
```

There are some cases known as recurring decimals, or repeating decimals which occur in division. This means that it is impossible to ever reach an even quotient without a remainder. For instance $100 \div 3$ gives $3)100.00000$ ——— and 33.33333 so on for ever. In these cases the recurring figure is set down with a small dot on top and this shows that it is repeating.

In the case of a decimal fraction of 4 or more figures, it is quite easy to shorten it without affecting the accuracy to any material extent. Of course, it must be understood, that sometimes accuracy to seventh place is necessary, but one can always judge when a statement can be shortened for the sake of simplicity. Take a fraction like .4985. This can be made .5, the error being only .0015 or $\frac{15}{10{,}000}$, which is negligible in most cases.

If the fraction were .428 it could be made .43, and so on.

We have shown that a decimal fraction is easily convertible to a vulgar fraction. The reverse is the case also. To convert a vulgar fraction to a decimal fraction, the denominator is divided into the numerator. For example, to convert ¾ into a decimal fraction:

```
4)30(.75
  28
  --
   20
   20
   --
   ...
   ---
```

Four will not go into 3, so a cipher is added to the dividend, and a decimal point in the quotient, division then proceeding in the ordinary way. Convert 3-64 to a decimal.

```
64)300(.046875
   256
   ---
    440
    384
    ---
     560
     512
     ---
      480
      448
      ---
       320
       320
       ---
       ...
       ---
```

Convert 15-16 to a decimal

```
16)150(.9375
   144
   ---
    60
    48
    --
    120
    112
    ---
     80
     80
     --
     ..
     --
```

Convert .825 to a vulgar fraction

$$\frac{875}{1000} = \frac{175}{200} = \frac{35}{40} = \frac{7}{8}$$

Convert .875 to a vulgar fraction

$$\frac{875}{1000} = \frac{175}{200} = \frac{35}{40} = \frac{7}{8}$$

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

THE greater portion of the electrical industry of to-day has been built up around the use of electricity in the transmission of energy. Its use is only a means to an end and makes possible the development of waterpower and their use in furnishing cheap power to industries in towns and cities remote from the waterpowers themselves.

Other means of transmitting power are used and examples will occur to any one, compressed air, steam and hydraulic systems are all used to advantage under certain conditions.

In all of these as in electrical engineering three things are essential, means for generating power, means for its transmission and means for its utilization. The air compressor changes the physical state of the air being worked upon and in so doing does work upon it thus storing up energy in it. The pipe line merely serves to convey this air to the point where it is to be used and at the end of the line where the air-drill or other machine is located, the air is allowed to expand and in doing so gives out energy.

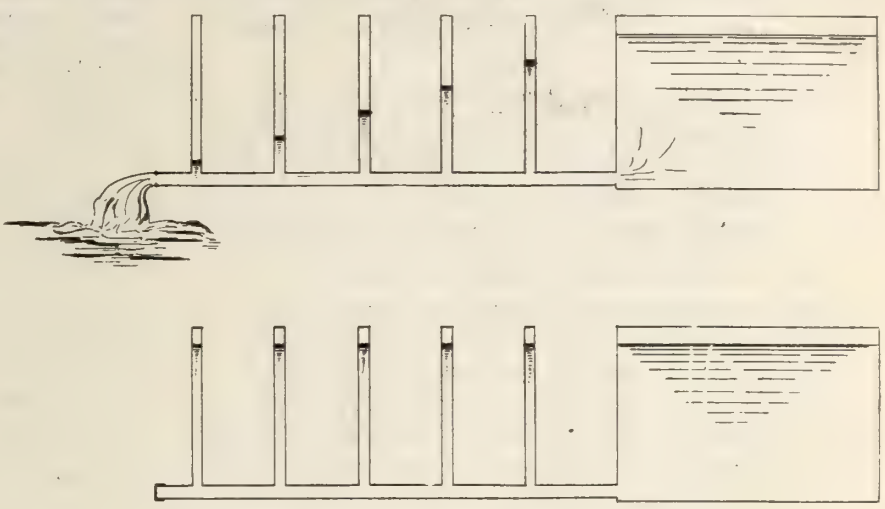
In the steam boiler energy in the form of the heat given off by burning fuel serves to increase the energy of the water evaporated for every pound of steam contains considerably more energy than the water from which it was made. The pipe-line here too serves merely as a means of conveying the steam from one place to another and in the engine by expansion the steam gives out some of its energy, its pressure being lowered and some of it being converted back into water.

With a hydraulic power installation such as seen at Niagara Falls a different form of energy is employed, that due to the elevation of a body of water over a lower pool. A hydraulic power plant makes use of potential energy the same form that is stored in a weight on a table by viture of its height from the floor.

Since the flow of water is relatively simpler than the flow of either steam or air and since many of the facts relating to it can be usefully used in the study of electrical phenomena it will be well to devote a little time to its study and to reason out some of the facts relating to it.

In Fig. 2 we have a reservoir or tank filled with water and having a pipe leading away from it near the bottom. This pipe is shown closed and five vertical pipes or glass tubes can be imagined opening into it. If as supposed the cap in place on the end the water will stand in all the tubes at the same level and at the level of the water in the tank.

If now the cap be removed and water permitted to flow out a change will be observed in the level of the water in each of the tubes. That nearest the tank will drop slightly that next to it, more so, and so on until the last tube is inspected when it will be seen that the water level in it is very little if any above the level of the horizontal tube itself.



HEAD OF WATER STILL AND FLOWING.

The height of the top of the water in the tank over that in the reservoir below is called the head. This is only another name for pressure and it is seen that while this head or pressure is uniform in the tube while no water is flowing, it changes with the distance away from the reservoir when a flow is established. It is of interest to find out how this loss of head is used up and it may be briefly stated that the major portion of it is used up in doing work on the walls of the tube. When the water flows through the tube friction is set up between it and the tube. This friction uses up energy and the result is seen in the generation of heat.

In Fig. 4 a diagrammatic view of a power plant is given with a dam and impounded water behind it, a penstock, turbine and powerhouse. From the pen-stock glass water gauges may be imagined much as shown in the picture. When the turbine gates are shut off the water in all of these would rise to the level of that behind the dam but when the turbine is running these levels would drop much as shown in the diagram. In this case the pressure due to the total head, or height between the dam and the tail race below the power house, is not all used up in overcoming friction but only a small portion of it as shown by the empty portion below the top of the gauge tube.

That is of the total energy available a certain amount is used up in overcoming friction throughout the system while the remainder does useful work in rotating the moving element of the generator.

In obtaining data on the flow of water and its relation to the power which can be developed from the flow three things must be taken into consideration, the quantity of water, the time in which it flows and the pressure or head under which it flows. The first two of these give the rate of flow, thus when we speak of gallons per minute we are dealing with a compound unit which simply means that a certain number of gallons or a definite quantity of water will flow, possibly through a pipe, in one minute.

If a stream has a flow of say 1,000 cubic feet per minute and in going over a fall has a drop of 100 ft. we can figure the amount of power available from its use. One cubic foot of water weighs 62½ lbs. and 1,000 would weigh 62,500 lbs. In falling 100 ft. energy would be available and work could be done to the extent of $62{,}500 \times 100 = 6{,}250{,}000$ ft. pounds. This is equal to $6{,}250{,}000 \div 33{,}000 = 189$ horse-power nearly.

In electrical engineering we have a number of similar quantities although in this case we are measuring energy directly and not physical substances such as water. We have a unit of quantity since a certain definite amount of electrcity will always produce the same effect, we have a unit denoting rate of flow on the quantity flowing in unit time and we have another unit by which we measure what may be termed electrical head or pressure causing flow. There are also names given to the power or capacity of a generator or other machine for doing work and finally a unit by which the amount of work can be done.

The Unit of Quantity

Unlike material things, electrical energy cannot be measured directly. We cannot speak of it in terms of cubic feet, pounds or gallons, but it can be measured by the effects produced by its presence or flow, and in this respect it is like all other forms of energy.

A definite amount of electrical energy will always produce the same effect or do the same amount of work under the same conditions and this renders it easy to define a unit of quantity measurement.

To the unit denoting quantity the name of coulomb is given after one of the famous electrical physicists who was responsible

Continued on page 270

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone 8971 Rector. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, JUNE 5, 1920 Vol 11

PRINCIPAL CONTENTS

The Hot Process Boiler Feed Water Softener	245
A Description of the Busch-Sulzer Diesel Engine	250
The Radojet Air Pump and Its Operation	254
A Discussion of the Uniflow Steam Engine	257
A Course of Instruction	261
Editorial	266
Developments in New Equipment	268

Varieties of Prime Movers

THERE are described in this issue of POWER HOUSE two widely different types of prime mover, while an article sent in by a contributor deals with the operation of an auxiliary to a third type. There is a great difference now to the days not so very far past when a stationary engineer was called upon to deal with either one of two types of engine, the slow speed Corliss of the high-speed automatic. Nowadays the prime mover may be any one of several types of turbines, a Diesel or Semi-Diesel engine, a gas engine with its own gas producer, high speed direct connected engines of the vertical or horizontal enclosed type, or the heavy duty Corliss type, or some one of its variations, such as those with poppet valves, or the more common gridiron valves.

It is hardly possible for any man to have a practical acquaintance with all these various types of prime movers, but there is nothing to prevent him being acquainted with their general principles and operating features. He is then in such a position that with a short actual experience of handling, he will become familiar with their characteristics. The man who knows how a machine should function, and the principle of its design, is in a better position to get results, even though inexperienced, than he who knows the apparatus from an operating view point alone. It all comes down to the same old point. Eternal study is the price of competence in these days of engineering development.

Hydraulic Testing

NOTWITHSTANDING all that has been written and spoken from time to time on the purposes and functions of the hydraulic test as applied to boilers, it would seem as though there was still a widespread misunderstanding as to these important matters. There are frequent enquiries coming into this office, asking our advice as to what percentage of the hydraulic test pressure should be allowed as the working pressure, and in conversation with a gentleman who has had wide experience all over the country, we find that there are still many men who entertain very hazy notions as to the purpose of the hydrostatic test.

Personally we believe that many unexplained failures and explosions of boilers could be traced back to an unwise application of hydraulic pressure and we believe that there is no greater potential source of damage than by the injudicious application of high water pressure. The purpose of the hydrostatic test is purely to determine the excellence or otherwise of the workmanship, and to show up any weakness in the material or design that may have escaped notice up till that time. The hydraulic test pressure is based on the safe working pressure of the boiler as found by calculation of the various parts of the shell, heads, stays, joints, furnaces, combustion chambers, etc., according to the type of boiler. The ultimate strength of the whole boiler is determined by the ultimate strength of its weakest part, and the safe working pressure is determined by taking a factor of safety found by experience to be suitable to various conditions, and dividing it into the previously determined ultimate bursting pressure. This factor of safety varies from 4 to 6, according to the type of boiler and the workmanship put into it, or if preferred, the methods of manufacture. The hydraulic test pressure is from 1½ to 2 times the safe working pressure as found by calculation, when the boiler is new. Supposing we have a new boiler, built of plates with a tensile strength of 60,000 pounds per square inch. The factor of safety we will say is 5, which allows a safe working stress of 12,000 pounds per square inch. The initial hydraulic test will be then 24,000 pounds per square inch, which will be well in the elastic limit of the material. Generally speaking, the limit of elasticity is reached at about one-half or slightly more than half the ultimate breaking stress. In plain language the limit of elasticity means that point at which the metal ceases to return to its original form after stressing. When a boiler is new, the metal of which it is built is ductile, and possesses resiliency. That it, although it may be distorted by high pressure, as long as that pressure is under the elastic limit of the material, it will resume its form. After being in service some time, the metal loses some of this elasticity. It tends to crystalize or becomes brittle, and acts exactly the same as an elastic band which has been used so often that it eventually becomes as inert as a piece of string. If you try to stretch this old elastic band over the bundle of papers it originally covered, it will break. This loss of elasticity in the metal of a boiler, is of course a long and slow process, unless the conditions are very favorable to it, such as occur in careless operation. Suppose the boiler we have just been considering has been in service ten years, and has had reasonable usage during that time. It will probably be found on inspection to be free from corrosion internally and externally, clean, and free from leaks. The inspector will take all these facts into consideration, and allowing the same working pressure, will probably test to 1½ times that pressure, to make sure everything is tight, and there are no weaknesses that he has overlooked. That means that the stress on the plates will be 18,000 pounds per square inch, considerably below the original elastic limit of 30,000 pounds. Here the hydraulic test has been used in a perfectly proper and safe manner. Now suppose that the very same boiler has been working for ten years, and has been subjected to careless operation, and general neglect which sometimes happens, or perhaps we should

say too often happens. Careful examination would show that the condition of the boiler was such that the factor of safety should be raised to probably 8 which would reduce the safe working stress on the plates to 7,500 pounds per square inch. The hydraulic test pressure would then be such as to put a stress of only 11,250 pounds per square inch on the metal. This is only a little over one-third of the original elastic limit, and leaves an ample margin of safety. On the other hand suppose an exponent of the hydraulic test, pure and simple comes along, and after enquiring what the working pressure of the boiler is from anyone he sees around, proceeds to apply it without any further thought. This is not a wild exaggeration, because this very thing has occurred many times both in Quebec and Ontario, and probably in other parts of Canada also. The working pressure as originally found, was, say 150 pounds per square inch, and as the owner wishes to continue at this pressure, a test pressure of 300 pounds per square inch is decided upon. Now this is what happens. We have just seen that owing to the condition of the boiler, the factor of safety should be raised, or in other words, the working pressure reduced. The original factor of safety of 5 gave a working pressure of 150 pounds, therefore the new factor of safety of 8 will allow a working pressure of only 94 pounds. The hydraulic pressure of 300 pounds to the square inch is over three times the allowable working pressure as determined by actual examination. This is bad enough, but what happens to the elastic limit of the metal? It is safe to say that if the material has deteriorated sufficiently to make a large reduction in working pressure necessary, the elastic limit has correspondingly decreased. In putting a pressure of double the original working pressure on the boiler, the original elastic limit is nearly reached. If the elasticity has decreased only 10 per cent. the boiler is stressed very nearly to its present limit, while if it has decreased much more, the elastic limit is passed. This may not be discernible, but the fact remains that the boiler is left in such a condition that the slightest shock may result in a failure of the metal, and this shock might be only the sudden opening of a valve, or even the sudden release of pressure due to the safety valve opening. After a test of this kind on an old boiler, without previous examination, and no allowance of any kind being made for age or condition of the material, anything may happen, and not infrequently does. The unfortunate part of this indiscriminate use of the hydraulic test is that it is too often resorted to by those who ought to know better, and the results accepted as satisfactory by those most immediately concerned. There is no excuse at this time and date for anyone to be ignorant of these most important facts, and it should be made an indictable offence for anyone to put an hydraulic test on a boiler before previously ascertaining all the particulars and condition of the boiler, and basing the test pressure on the results of this investigation. Basing working pressure on hydrostatic pressure is turning things topsy-turvy with a vengeance.

Cheapening Propulsion

THE progress that has been made in increasing the efficiency of ship propulsion, is well pointed out in connection with the launching of the Cunarder Scythia, at the yards of Messrs. Vickers, Ltd.

The old Scythia, which was in use in 1875, required 17 pounds of coal to move 100 tons of cargo one mile, whereas the new vessel burns only four pounds of coal or three pounds of oil while conveying the same weight at the same speed for the same distance.

Sir James McKechnie, of Vickers, speaking at the launching, made it plain that he did not consider that the last improvement had been made. He looked to see the internal combustion engine used in large sea-going vessels, and cut the fuel consumption to 1½ pounds of oil per 100 ton miles at the speed of the old Scythia.

The great difference between the new Scythia and the one of 45 years ago, has been made possible by the greater size of the ship, the increased efficiency of high-pressure steam, and then by the geared turbine, which is giving greater efficiency than the former practice of direct connection between the turbine and propeller shaft.

If Sir James McKechnie is right—and it will take some considerable proving to show that he is not—it means that the internal combusion type of marine engine is destined to effect a saving of millions of tons of fuel every year.

Not So Eager To Join

AN attempt by John Fitzpatrick to organize the steel workers in the South Chicago district met with poor success in a meeting which he called recently. A year ago, before the steel strike, Lincoln Hall, Ninety-first Street and Commercial Avenue, South Chicago, was crowded with more than 2,000 enthusiastic workers. All joined the union.

On May 13 only 150 gathered there, although handbills had been distributed among 25,000 workmen. The bills announced that the meeting had been called by the National Organizing Committee of the Iron and Steel Workers of America. It was also stated that a succession of weekly gatherings would be held until the union included every man working in a steel plant in the district.

The steel workers have been tinkered with too much already. If sanity has returned to the point where the appearance of such men as Fitzpatrick and Foster get nothing but an indifferent reception—then so much the better for the steel trade.

Some Common Sense Needed

THE price deflation that has struck many lines in the States has not yet reached the industries of Canada, and as far as many of the lines go, particularly iron, steel, or anything in these classes, the move is not likely to be generally effective.

The market is too empty to permit of much price deflation.

At the same time the trade ought to bear in mind that very serious thought should be given before deciding on more advances.

Unfortunately, there are some lines where the feeling seems to be yet maintained that "we had better get in on this good thing while it lasts."

Reasonable profits should still be the standard of business, rather than maximum exactions.

Firms that are building for the future are well advised if they consider the service they can give to their customers, rather than the money they can wring out of them.

Don't be devoured with over anxiety lest some of the new taxation shall hit you, and that you shall not be able to pass it all along to the next man down in the line toward the ultimate consumer.

If you have an honest case, where your costs and expenses have gone to the point where you must increase, do so openly and honestly.

If you can still do business at present prices, then keep out of the procession leading toward higher costs.

Business is at a point now where a little encouragement and added stability means a great deal. There are projects held in abeyance, because those behind them will not go forward if they think that costs are going to continue upward.

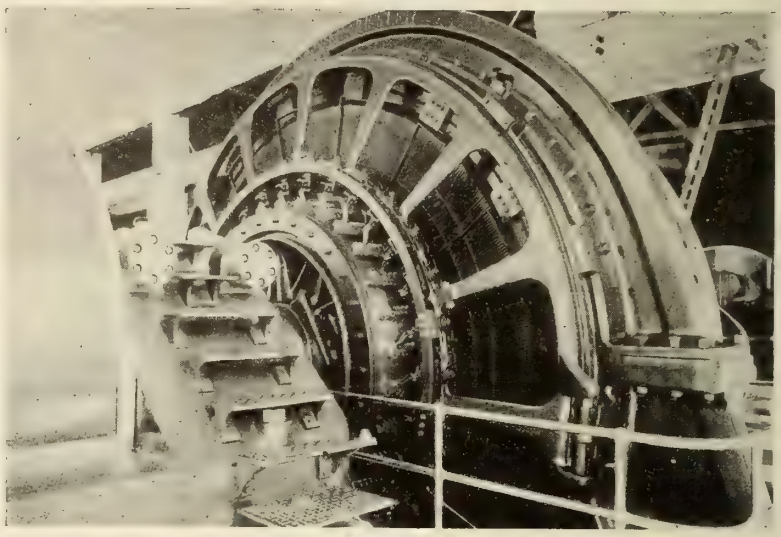
The beating down of all talk of depression and falling-off in trade rests in part with those who are in business themselves.

Progress in New Equipment

The Trueing of Commutators

An Article Descriptive of a New Type of Commutator Grinder Which Possesses Many Features of Interest

By W. F. Sutherland



IN the November 5 issue of POWER HOUSE an article appeared descriptive of various methods of commutator resurfacing. This present article presents some additional material of interest bearing on the same subject.

War activities were responsible for many new devices in almost all lines of mechanical endeavor, and it is interesting to note that the submarine, developed to such a high state of perfection, was responsible for the invention of a new commutator grinder for machines of large size. The grinder illustrated and described herewith was adopted by the United States Navy in all yards and on repair ships after exhaustive tests. For work of this nature, and particularly on the larger sizes of commutators, a machine possessing considerable rigidity and a wide adaptability is desired and the Shafer-Decker Co., Rochester, have given considerable attention to these details.

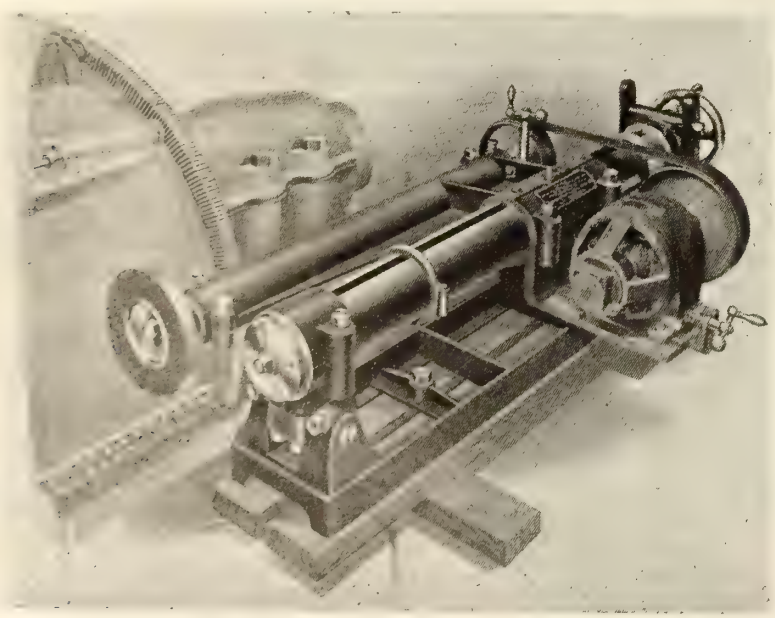


FIG. 1—GENERAL VIEW OF GRINDER IN POSITION.

For satisfactory results the commutator to be trued up should revolve at its normal speed, thus taking care of strains resulting from centrifugal force. The commutator, when thus trued up, will run truly circular at its operating speed, even it it should be out of round when at rest.

The cutting and grinding wheels used should be of a special character and combination of materials. Those used by this firm are entirely free from clogging with particles of copper or mica. The wheels are perfectly balanced and operate at a peripheral speed of about 6,000 feet per minute. A coarse wheel is used for cutting irregular commutators to a true surface and a fine wheel for final finishing.

The skilled mechanic will realize that there is needed a nicety of adjustment and sensitiveness of touch for working at the same time on two such vitally different substances as soft copper and hard mica. Every precise adjustment, direct, vertical, horizontal or longitudinal, is available by reason of the general design of this machine, of which a good conception may be gained through the inspection of the accompanying engravings.

The grinding wheel shaft is supported in a hollow casting provided with coned bearings at each end. It is driven by means of a belt from a motor on the op-

posite side of the supporting arm upon which the whole rotating mechanism is carried. This arm is pivoted in two planes at one end so that it can be swung through a small arc in a vertical plane for levelling and through a similar arc in a horizontal plane for lining up.

The feeding of the wheel into the work is accomplished by means of a supporting sleeve with eccentrically placed bearings supporting the sleeve. This sleeve is rotated by means of the worm wheel (89) shown in the line drawing.

The wheel with its drive motor is fed along the face of the commutator by means of the wheel 46 and the feed screw which engages in a nut on the wheel carriage. The feed screw moves the carriage with motor and driven pulley, including the driven shaft which carries the grinding wheel along the tubular sleeve. The distance of travel is thirty inches.

In setting up the grinder one complete brush holder with its brushes is removed at the position of the horizontal diameter where the grinding wheel is to be applied. All other brushes are raised from the commutator. Having marked

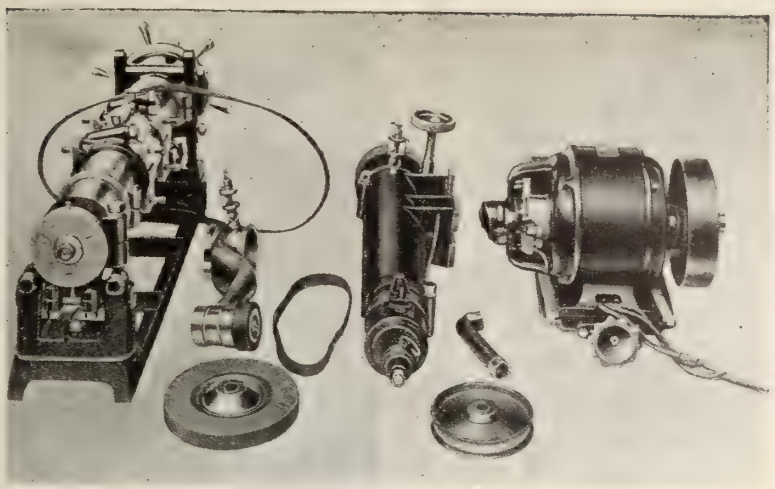


FIG. 2—VIEW OF NAVAL GRINDER PARTLY KNOCKED DOWN.

position the carriage is then moved to the extreme inward position with the grinding wheel as near to the risers as can be safely operated, and the stop ring is set for this position, then, by the use of inside calipers or micrometers between the commutator and straight edge

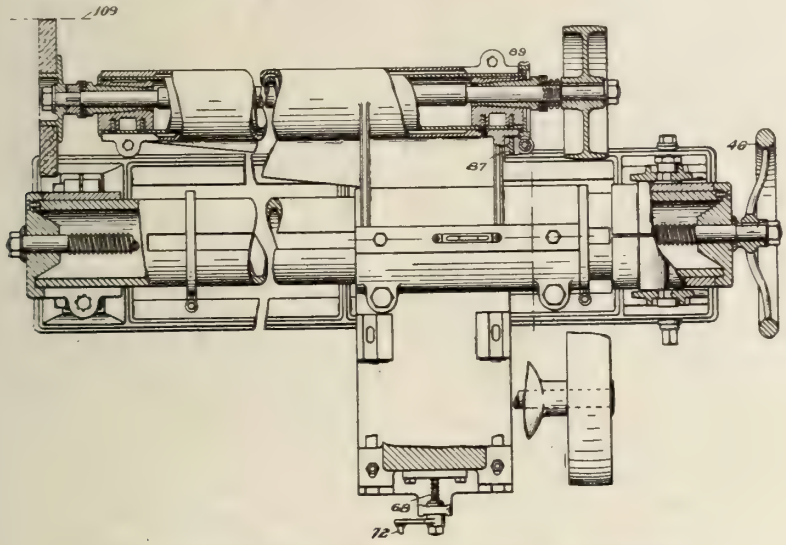


FIG. 3—PLAN VIEW OF GRINDER PARTLY IN SECTION.

the lines of horizontal diameters of the commutators to be treated, the surface grinding machine is securely mounted on substantial blocking to such an elevation as will permit the application of the grinding wheel at the correct location of horizontal diameters and also allow freedom of horizontal travel of the grinding wheel from end to end of the commutator.

A good way to set up the blocking is to clamp the 3 by 6 timbers of sufficient length on each side of the pedestal at commutator end of generator or motor and bolt these firmly in position. To these can be bolted two shorter timbers extending for the length of the commutator inward toward the fields. These timbers to be of sufficient outboard length to receive and support the surface grinder. All this set up blocking requires is to be securely bolted to avoid slipping from position during grinding operations.

After the device is clamped firmly in on spindle barrel, the machine can be brought in exact parallel position with the commutator by adjustment of a hand screw after the grinding wheel has been run back to the extreme position of grinding at opposite end and the stop ring set; the wheel can then be adjusted to the commutator by turning the hand wheel No. 87 for such a cut as will demand three to four amps. on the motor circuits; at no time should the cut of the grinding wheel be such as to exceed 4 amps' draw on the motor circuit.

After the machine has been set up the armature should be slowly turned and a straightedge used to find and mark all the high and irregular spots on the commutator. When these are determined the grinder wheel should be adjusted to first take these down.

The coarse wheel should be used for first or rough grinding, and gentle, moderate cuts are much to be preferred to heavy ones. The armature is rotated at full speed and the grinding wheel should also be driven at the correct number of revolutions per minute.

When a true, accurate circumference and face are obtained on the commutator the coarse grinding wheel is removed and the fine one substituted for finishing the surface. The work, by this means, can be performed with such skill and accuracy as to secure a finish superior to that usually given to commutators on new generators or motors.

No definite time is given by the makers for the refinishing of commutators. It is obvious that when new com-

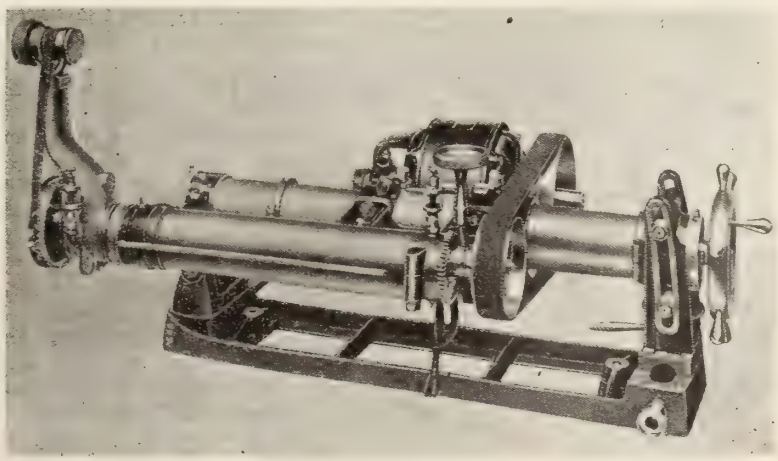


FIG. 4—GRINDER WITH EXTENSION ARM.

mutator bars are set in an old commutator these must be dressed down by filing or otherwise to the surface of the commutator. This requires time, and where a commutator is seriously grooved or seriously out of true, a considerable amount of copper and mica must be cut away to dress the high and irregular parts down to the true surface. According to conditions these jobs have taken from 4 to 60 hours.

This grinder is made in a naval type also for use on board ship, where lightness and extreme portability are desired. This latter type of machine weighs 325 pounds, and resurfaces commutators up to 16 in. in length.

The A. R. Williams Machinery Co., Ltd., are Canadian agents for this machine.

WATER LEVEL INDICATOR FOR BOILERS

The ordinary method of checking the water level in a steam boiler by means of test cocks has the disadvantage that with such pressures as are now in use the fluid issuing from the cocks, when they are open,, is in the form of a jet which is practically the same whether the water level be above, or below, the test cock. Partly in view of this it has

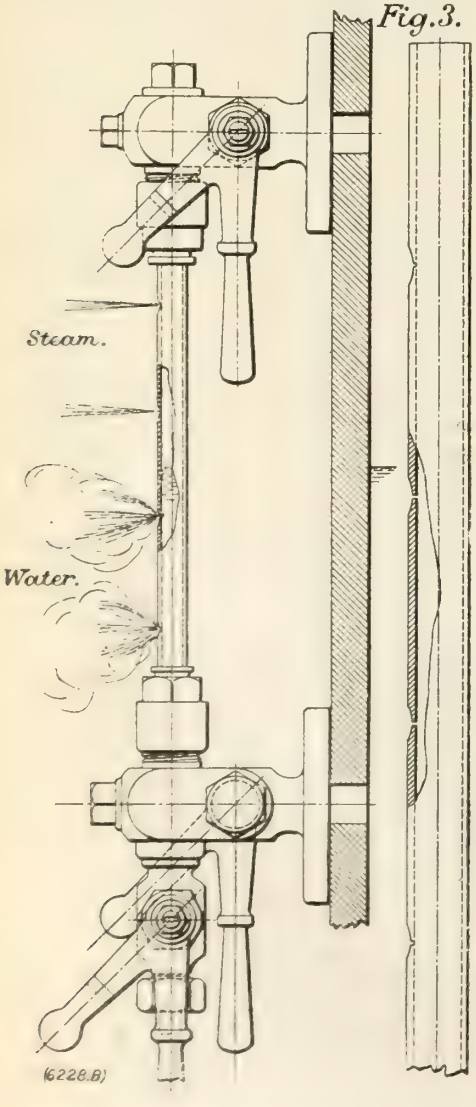


Fig.3.

long been usual in good practice to fit two water-level gauge glasses instead of one. Even so, however, it is possible that the two glasses may be out of action at once, and in some cases it is not always easy to distinguish between a full glass and an empty one. A simple and effective form of water-level indicator which has all the advantages of the test cocks in checking the water level, but does not suffer from their disadvantages, has been patented by Messrs. Cammell Laird and Co., Limited, and is being manufactured by Messrs. Bromel Patents Company, Limited, of 64, Darnley-street, Glasgow. It consists of a metal tube of external diameter and length such that it may replace the glass tube in any ordinary water gauge. The metal tube is drilled with a series of small holes about 1-32in. diameter, and at a pitch of a few inches apart.

When the tube is in position on a boiler and the gauge cocks are open so that it is put in communication with the water and steam spaces, it is found that the jets which issue from the holes which are below the water level are very distinct in character from those which issue from the holes above the water level. The steam jets issuing above the water level are barely visible and have a very small angle of divergence, while the jets below the water level are in the nature of a distinct white, cloudy spray, and have a wide angle of divergence. This is illustrated in Fig. 1 which shows an indicator in operation. It will be clear that this device enables a very close reading of the water level to be obtained with ease and certainty, and that there is nothing in it to go wrong. A hole may be stopped up, but if this happens it is at once evident and may easily be cleared. With the size of the holes used, 1-32in. diameter, this minor trouble is not very likely to occur. It is found that the best contrast between the jets is obtained when the length of the jet passage is equal to its diameter, and to obtain this proportion a flat is filed on the tube at the point where the hole is drilled. This is indicated in the general drawing, Fig. 2, and the detail of the tube, Fig. 3. It will be evident that these distinctive jets may be obtained by fitting suitable nozzles to ordinary test cocks, but the arrangement would not give the close reading of water level which is obtained with the indicator, unless an unusual and probably undesirable number of test cocks were fitted.

THEORY AND PRACTICE OF ELECTRICALS

Continued from Page 265

for the earlier advancement of the art. For practical purposes the coulomb has been defined as that quantity of electricity which when passed into an elecgro-plating solution will deposit 0.001118 grains of silver. This unit bears no relation to time for it does not matter how long it takes whether a minute or an hour. This unit the coulomb is exactly similar to others more familiar, the pound, the cubic foot, the ton except that it is a measure of a definite amount of energy and not of some physical thing.

It may be mentioned that the coulomb is very seldom used in electrical engineering under its own name but the idea of quantity is expressed by more familiar units as will be seen below.

The expression gallons per minute is a familiar one and its meaning is generally understood. A similar conception of flow is in use in electrical engineering but instead of saying so many units of quantity per second or per minute a name is given to the whole phrase and the rate of flow is called an ampere. Thus while we might speak of so many coulombs of electricity flowing during a period of one second we simply say that the current has a strength of so many amperes. This is a point which often confuses those beginning the study of electricity and it must always be remembered that the term amperes implies two distinct ideas that of quantity and that of time. It will further be of much assistance to remember that it is exactly analogous to gallons per minute or some similar expression.

The quantity of electricity conveyed by a current of one ampere flowing for the time of one second is called one amper—second (never one ampere per second) and is equal to one coulomb. Thus we might in an exactly similar manner say that the quantity of water conveyed by a current or flow of one gallon per second for one second is one gallon.

To make the meaning of the term ampere more definite and concise it may be well to dwell upon it a little longer. It may be asked why do we not say so many amperes per second? The answer is, as before mentioned, that the term ampere includes within itself the idea of time and instead of amperes per second the correct term would be coulombs per second. Coulombs per second and amperes mean exactly the same thing.

Amperes per second is a term which is analogous to saying feet per second per

second and when an expression such as this is used it expresses a change in velocity or acceleration. Later on when the study of alternating current is taken up it will be seen that amperes per second means the rate of increase or decrease in the current flowing and not the measurement of a steady rate of flow.

Unit of Pressure or Potential

We have seen in the hydraulic transmission of power that a certain element existed which was termed pressure or head and that it was this element which caused the flow of water from one reservoir to another. For if we had two small jars joined with a rubber tube entering at the bottom of each and filled them with water, we would find if the jars were placed on a level, flow of water from one to the other would cease when the water came to the same level in each. If one jar was lowered water would flow and the more it was lowered the faster would the water flow.

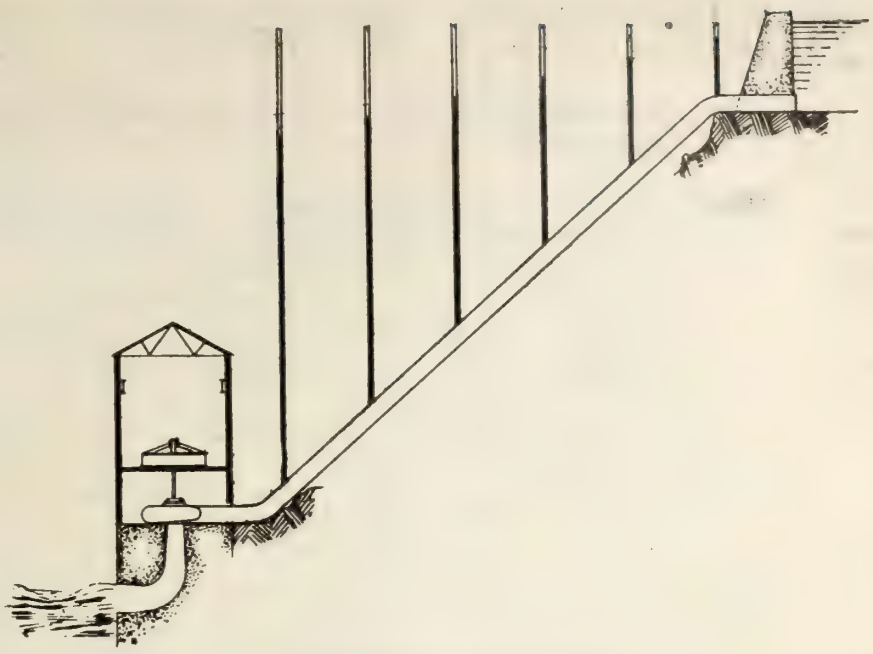
In like manner a similar quantity exists in electrical engineering and it is the electrical pressure which causes or tends to cause a flow to exist. Tends to cause, because the pressure can exist whether any current flows or not. In Fig. 4 the outlet is stopped by a cap and the pressure still exists and in fact is greater at the outlet than it was in Fig 3 where flow of water was permitted.

To the unit of electrical pressure the name of volt is given, after one of the earlier investigators into electricity "Volta". The word volt implies in electrical matters just what either so many feet head or pounds per sq. in. do in hydraulics.

In Fig. 5 we have a source of electrical pressure, the generator which takes the place of a dam on an elevation in hydraulic practice and we have also a line which is supposed to be grounded at the far end. The other generator lead is also grounded as are the bottom terminals of the volt-meters b, c, d and e. We have in this case used only one line so that the diagram shall be, as far as possible, similar to Figs. 2 and 3.

We can thus neglect the return circuit which is made through the earth. It must always be remembered however that an electrical circuit must be closed on itself and have neither beginning or end for the current which flows out must return. A hydraulic power plant has the same return system in effect although pretty well disguised, for water must be continually raised from the lower level to that of the dam above by the sun's energy. The water which finds its way to the oceans and lakes through the waterwheel is evaporated, forms clouds and these in turn through rain keep the reservoir full.

If we start the generator in Fig. 5 it will be noticed that the volt-meter e will register the greatest amount that next to it a smaller amount and so on until we come to b which will register scarcely anything at all. The indications of these instruments will correspond exactly to the height of the water in the gauges of Fig. 3. Volt-meter a will register the drop in head between the beginning and end of the line and its reading will correspond very nearly to that of meter e. This reading corresponds to the difference in the heights of the water in the right and left hand gauges of Fig. 3.



HYDRO-ELECTRIC POWER PLANT.

If the switch shown in Fig. 5 be opened we will have a similar case to that shown in Fig. 2. Where neither electricity or water will flow. All the meters B, C, D and E, will show the same valve which will be that of the generator causing current to flow. As in Fig. 2 where no difference exists in the level of the water in the gauges so in Fig. 5. gauge A will show no reading whatever.

From this similarity it may be argued that there is some property of the electric circuit which tends to impede the flow of current through it. This property is called the resistance of the circuit and is measured in a unit called the ohm. This resistance increases as the length of the circuit, decreases as the area of the conductor is made greater and varies with the different materials of which the conductor is composed

Those materials which offer a relatively low resistance, such as the metals are said to be conductors; while those which offer a relatively high resistance such as glass, rubber, dry paper, etc., are called insulators.

The Unit of Power

When speaking of engines, water-power and other apparatus the term horse-power is very commonly used. Electrical apparatus can be so rated and in the case of motors which deliver mechanical power this is done, but when speaking of generators, transformers and other apparatus the term is never used since it is more convenient to use another definite unit which is connected to the electrical units of pressure or potential and curent flow by a very simple relation.

When we speak of the power of a waterfall we have two things associated together in our minds, first, the amount of water flowing over it in a definite time interval and secondly the head or height of the fall. Likewise when the power generated by an electrical machine is considered we have to think of the amount of electrical energy it can generate in one second and secondly the pressure or voltage at which it is generated.

The amount of energy or the number of coulombs of electricity generated in one second is expressed simply by the one word ampere and the pressure by the number of volts. So we can say that the power generated will be equal to the product of the number of amperes flowing by the number of volts at which it is generated. To the unit of electrical power the word "Watt" is given and the following equation connects the three units Power equals current multiplied by voltage or Watts=amperes x volts.

(Continued on page 46)

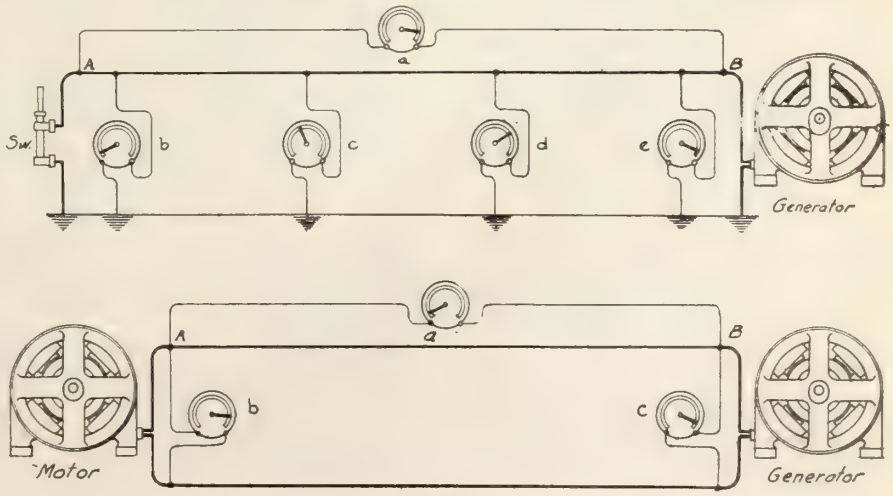


FIG. 5.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
⅛	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Put a Farnsworth System to Work in Your Steam Plant

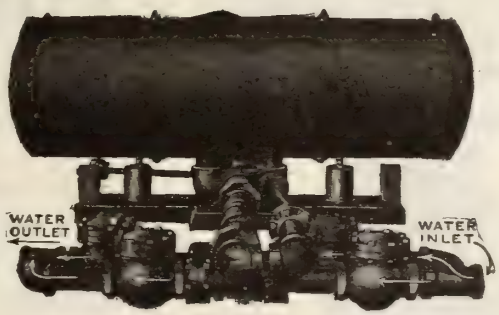
Farnsworth-equipped plants produce more steam with less fuel and less expense than other plants. Thousands of dollars are being saved by the Farnsworth System, not alone in Canada and United States, but in all countries of the world, wherever steam is used for heating or manufacturing process work—its value is thoroughly proven!

When the amount of expense saved by Farnsworth equipment is taken into consideration the question of installation costs is eliminated. It quickly pays for itself. It is a safe and profitable investment. Experience proves that in the majority of cases only three to six months' operation is required to return first costs.

These are facts. Plant owners have nothing to lose and everything to gain by investigating the Farnsworth System and the engineering staff of The Canadian Farnsworth Co. will be glad to advise and co-operate with them in solving steam line drainage and boiler feeding.

The Farnsworth Automatic Duplex Boiler Feeder

The "Farnsworth" should not be confused with ordinary steam traps. It is a machine built for Boiler Feeding. Note the cushioned dashpots, a feature which provides against shocks and ensures smooth operation.



The Sign of Coal Saving

No leaky steam valves with the Farnsworth in your plant; no constant waste of steam to the outside air; no springs to loose their tension; no levers to jump out of place; no weights to cause poundings, and no trunnions to bind and stick, or leak water and steam.

The Duplex feature of construction ensures a continuous flow of feed water to the boiler. Then, the machine being always equalized with the boiler provides against sudden shock or jar in the feed lines. There is no hold-up on the return lines as is the case with ordinary return traps, as the feeder is constantly receiving the water.

Our expert steam and condensation engineers are at your service. Have them investigate and make reports.

THE

Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

Your enquiries are solicited. Send for our Bulletins on Steam and Condensation — they are interesting and instructive.

THEORY AND PRACTICE OF ELECTRICITY

Continued from Page 271

The watt is a pretty small unit and when dealing with large apparatus another term is used—kilowatt. A kilowatt is simply 1,000 watts and the prefix kilo is the Greek word for one thousand.

One horsepower equals 746 watts or 0.746 kilowatts and it is thus an easy matter to convert horse-power into kilowatts or vice versa.

Electrical Unit of Work

In the first article of this series we dealt with the mechanical units of work energy and power and it was seen that work was measured in foot-pounds. It is possible to find the amount of work done by an engine of so many horse-power quite simply if we know how long it has been working, for every minute and for every horse-power, 33,000 ft. pounds of work have been done and it is simply a matter of multiplication. Another unit of work is quite frequently used—the horse-power hour and this is equal to 33,000x60=1,980,000 foot pounds.

The kilowatt is the electrical unit of power and as has been seen is exactly similar to the horsepower in meaning differing only in size. If we take the kilowatt as the electrical unit of power and the length of time in hours that the power has been exerted we can derive an electrical unit of work similar to the horse-power hour. In this case it is called a kilowatt hour and some-times the smaller unit the watt-hour is used.

The idea of work may also be explained from another aspect. The coulomb is the unit of electrical quantity and if the number of coulombs of energy transmitted per second is multiplied by the total time then we have the total number transmitted in any given interval. If this in turn is multiplied by the pressure or voltage we arrive at the work done.

Coulombs per sec. × number of seconds = total energy transmitted. But coulombs per sec. × amperes.

Therefore—

Amperes × time = energy transmitted.

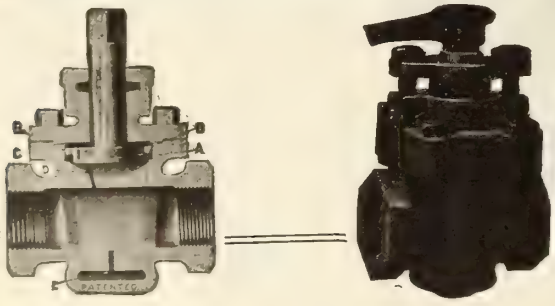
Amperes × time × volts pressure = work done.

Amperes × time in hours × volts = watt hours, or

Units of	Mechanical	Electrical
Pressure	Feet head or pounds per sq. in.	Volts.
Quantity	Pounds or cubic feet, etc.	Coulombs.
Rate of flow	Gallons per min., cubic ft. per min., etc.	Ampere.
Power rate of working	Head in feet × rate of flow in pounds per min., or foot pounds per minute The horse power = foot pounds per min. ÷ 33,000	Rate of flow × the pressure or amperes × volts = watts. Watts ÷ 1000 = kilowatts.
Work	The foot pound. Force by distance. Rate of working by time = horse power hour.	Quantity of energy by potential Rate of energy flow by potential by time = kilowatt hours.

The Norton Company, of Worcester Mass., U.S.A., have established a factory at Hamilton, Ontario, which will be known as the Norton Company of Can- Ltd. Here they will manufacture a complete line of grinding wheels, for the Canadian market. The management will be in the hands of Mr. Robert C. Douglas. The Norton Co., of Canada will be represented by the Canadian Fairbanks Morse Co., Ltd., through out Canada, and in Quebec by F. H. Andrews & Son, and in Vancouver, B.C., by Simonds Canada Saw Co., Ltd.

HOMESTEAD
Quarter-Turn Valves



For Quick Action!

A quarter turn, and the Homestead is opened to fill area; a quarter turn back and it is closed absolutely tight by a patented wedging cam that automatically forces the plug downward.

Use them for your blow-offs, throttles, tank valves and every other service where the duty is exception ally severe and frequent opening and closing is required.

Homestead Valve Mfg. Company

Pittsburgh, Pa. Works: Homestead, Pa.

POWER HOUSE
SOLVES THE PROBLEM

It is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

As to Feed Doors

Ask any steam engineer to look at the above illustration and tell you which feed door opening will save labor, time and fuel. His answer will be the Betson monolithic one-piece.

The wide flare of the Betson door opening makes it easy to spread the coal over the fire clear back to the bridge wall without the use of the hoe.

Betson's Plastic Fire Brick is the ideal material for back or front arches, complete boiler settings or for repairing linings. It is readily put in place by any practical man. No forms or special tools required. It will outlast any other boiler furnace linings. Air tight — jointless — free from expansion and contraction and will not spall.

Send for pamphlet, showing how to use Betson's Plastic Fire Brick in your boiler room.

BETSON PLASTIC FIRE BRICK CO., INC.

P. O. Box 386-6 Rome, N.Y.

Canadian Distributor: INTERNATIONAL CHEMICAL CO., 44-H Lombard St., Toronto, Ont., Canada

NON-CORROSIVE

CYLINDER OIL

MANUFACTURED ONLY BY

E. H. KELLOGG & CO.

NOS. 242 TO 248 SOUTH ST. NEW YORK, U.S.A.

FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,

New York, U.S.A.

ENGINEER WANTED

WANTED—July first, engineer for Montreal with first-class certificate, competent to take charge of large heating, electrical and refrigeration plant.

Apply stating former experience and give reference to Box 3120, Montreal.

(P.H. 6-5)

When writing Advertisers kindly mention this paper

American Manufacturer Wants Representation in Canada

Our proposition should interest an established machinery supply house now calling on steam power plants in Canada. For particulars, write Box 518, Power House.

(H) P.H.

Use The LONG STEAM *for* TRAP SATISFACTION

kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with great success. **Read this letter.**

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson,
Superintendent

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

J. T. LONG

48 ADAM ST.

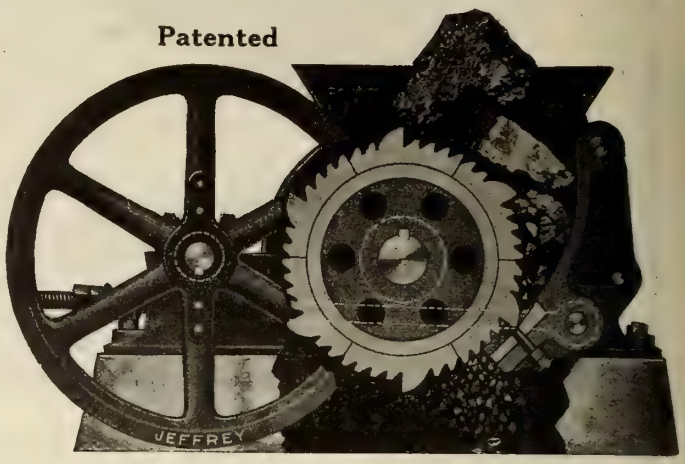
MONTREAL - CANADA

If your dealer does not sell it, write direct.

Upper Run of Pivoted Bucket Carrier over coal bunkers.

Lower run of Pivoted Bucket Carrier.

Patented



Single Roll Crusher for reducing coal to stoker size.

Jeffrey Equipment

Is Adapted For Handling Coal And Ashes In All Sizes Of Power Plants

Your requirements can be economically met by some of our standard types of Pivoted Bucket, V-Bucket, Chain Scraper, Belt, Steel Apron or Drag Chain Conveyers, Bucket Elevators or other types of equipment.

Engineers with years of operating and field experience will make a study of your individual problems and recommend the "right equipment" to place your coal and ash handling on an economical basis. Send for latest catalogs.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms, MONTREAL

V-Bucket Elevator—Conveyer over bunkers.

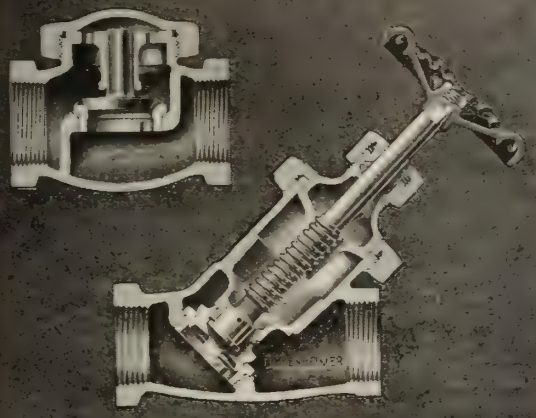
Steel Apron Type Conveyer handling coal from track hopper to boiler house.

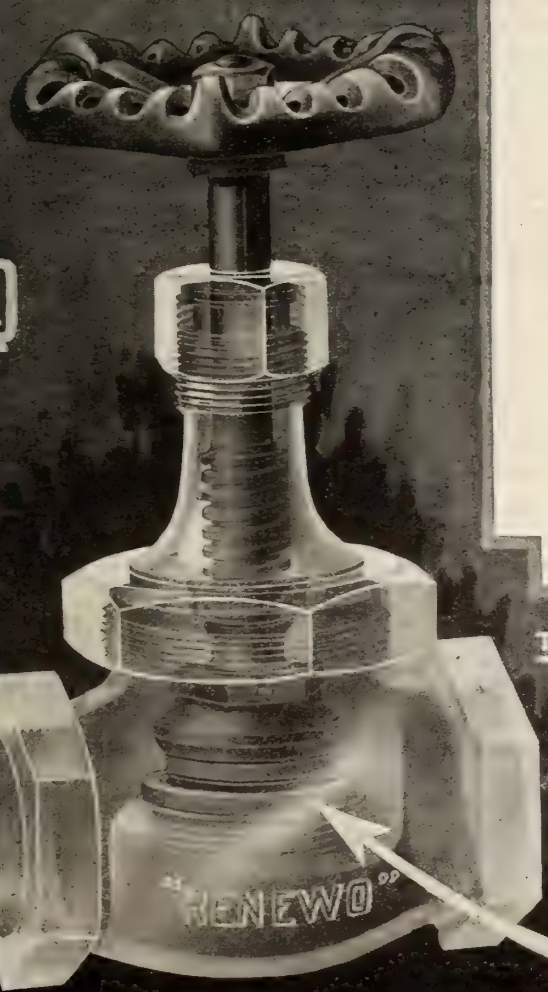
Chain Scraper Type Conveyer over bunkers.

Belt Conveyer and Tripper distributing coal to bunkers

—made to last a long time

LUNKENHEIMER "RENEWO" VALVES





Have achieved an enviable record for economy in steam service. They represent the highest development in valve construction, incorporating all the good features discovered and developed in over half a century of valve manufacture.

Their installation means permanence in the line, because they are as near wear proof as can be attained, and to further enhance their durability all the parts are interchangeable and can be replaced should necessity require.

"Renewo" Valve parts are made of materials best suited to the duty the part performs.

The ***Renewable Seat*** and ***Disc*** are made of Lunkenheimer "Valve-nickel," a material having exceptional wear-resisting qualities; the Disc is provided with the celebrated Lunkenheimer "Seat-guard" which aids in preserving the seating faces and keeping them clean, and the seating surfaces are regrindable. The stem is made of a special bronze; the thread is extra long and has full contact when valve is opened or closed.

The union bonnet connection with outside protected threads; deep stuffing box with gland follower, and the self-cooling malleable iron handwheel are other points of merit.

Globe, Angle, Cross, Straightway or Y and Horizontal and Angle Check Patterns for 200 and 300 pounds working steam pressures. Specify LUNKENHEIMER "RENEWO" and insist on having the genuine.

Write for descriptive booklet F 535— DC

THE LUNKENHEIMER CO.
—"QUALITY"—
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
CINCINNATI
NEW YORK
CHICAGO
BOSTON
LONDON

AMERICA'S BEST
LUNKENHEIMER
—QUALITY—
SINCE 1862

MACGOVERN & COMPANY LIMITED POWER MACHINERY

Turbo Generator Units

25 Cycle

1—8000 K.W. (Normal rating) Allis Chalmers Turbo-Generator, 3 phase, 4 pole, 6600 volt, rotating field, condensing high pressure 175-lb. gauge at throttle, 28-in. vacuum. Will not exceed 18-lb. dry steam per K.W. when working under full load. Condenser: 16,000 sq. ft. surface Condenser with auxiliaries. Will sell with or without Condenser.

1—6000 K.W. General Electric-Curtiss Horizontal Turbo Unit, 3 phase, 6600 volts. 1500 R.P.M., non-condensing, with exciter, expansion joint, etc., 170-lb. steam pressure.

1—2500 K.W. Westinghouse-LeBlanc Turbo Unit, 3 phase. 2 pole, 2400 volts, 1500 R.P.M. Condensing, 150-lb. pressure, dry and saturated steam, 28-in. vacuum. With Condenser.

1—2500 K.W. Westinghouse-Parsons Turbo Unit, 3 phase, 2200 volt. 1500 R.P.M. 150-lb. steam pressure.

1—2500 K.W. Westinghouse-LeBlanc Turbo Unit, 3 phase, 2400 volt, condensing 150-lb. steam pressure. 28-in. vacuum.

1—2000 K.W. General Electric-Curtis Vertical Turbo Unit, 3 phase, 2200 volt, 750 R.P.M., 4 pole, 150-lb. steam pressure. 6750 sq. ft. Surface Condenser with auxiliaries.

1—850 K.W. Westinghouse-Parsons, horizontal Turbo Unit. 3 phase, 380 volt, 1500 R.P.M., 150-lb. pressure, 3000 sq. ft. Surface Condenser with auxiliaries.

1—750 K.W. Westinghouse-Parsons, mixed pressure Turbo Unit, 3 phase, 380 volt, 1500 R.P.M. Steam conditions 15.5-lb. absolute, 28-in. vacuum, with condenser.

1—750 K.W. Westinghouse Turbo Unit, 2 phase, 440 volt, 1500 R.P.M. Condensing. With Condenser and auxiliaries.

1—500 K.W. Westinghouse-Parsons Horizontal Turbo Unit, 3 phase, 2 pole, 370-400 volt, 1500 R.P.M. Condensing. 150-lb. steam pressure, no superheat. With Condenser and auxiliaries.

MacGOVERN & COMPANY, Inc.

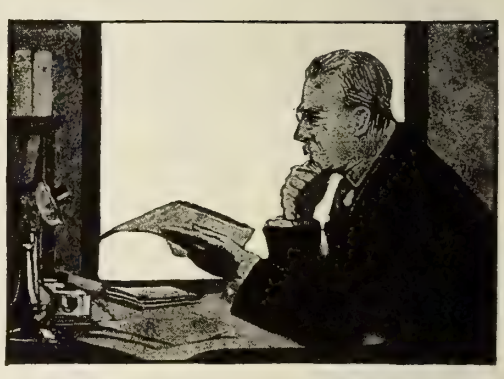
285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, Seattle **Plants: Lincoln, N.J., and Linden, N.J.**

Buyers and Sellers of New and Used Machinery

A Continent-Wide Service

Tell it to the front office



Tell the boss that you are tired of fussing with troublesome traps that waste your time and his money. Send him that new book we have for you—and let him see why the Dunham Trap has been installed in so many prominent residences, public buildings, apartments and industrial plants.

Tell him that the Woolworth Building and many of the largest office buildings in Canada use Dunham Traps exclusively. Remind him that it was the first thermostatic disc trap; has been standard since 1903 ; has only two parts ; is permanently adjusted at the factory; makes jet water unnecessary.

First, send for the book, "Data on Dunham Heating." It's worth having.

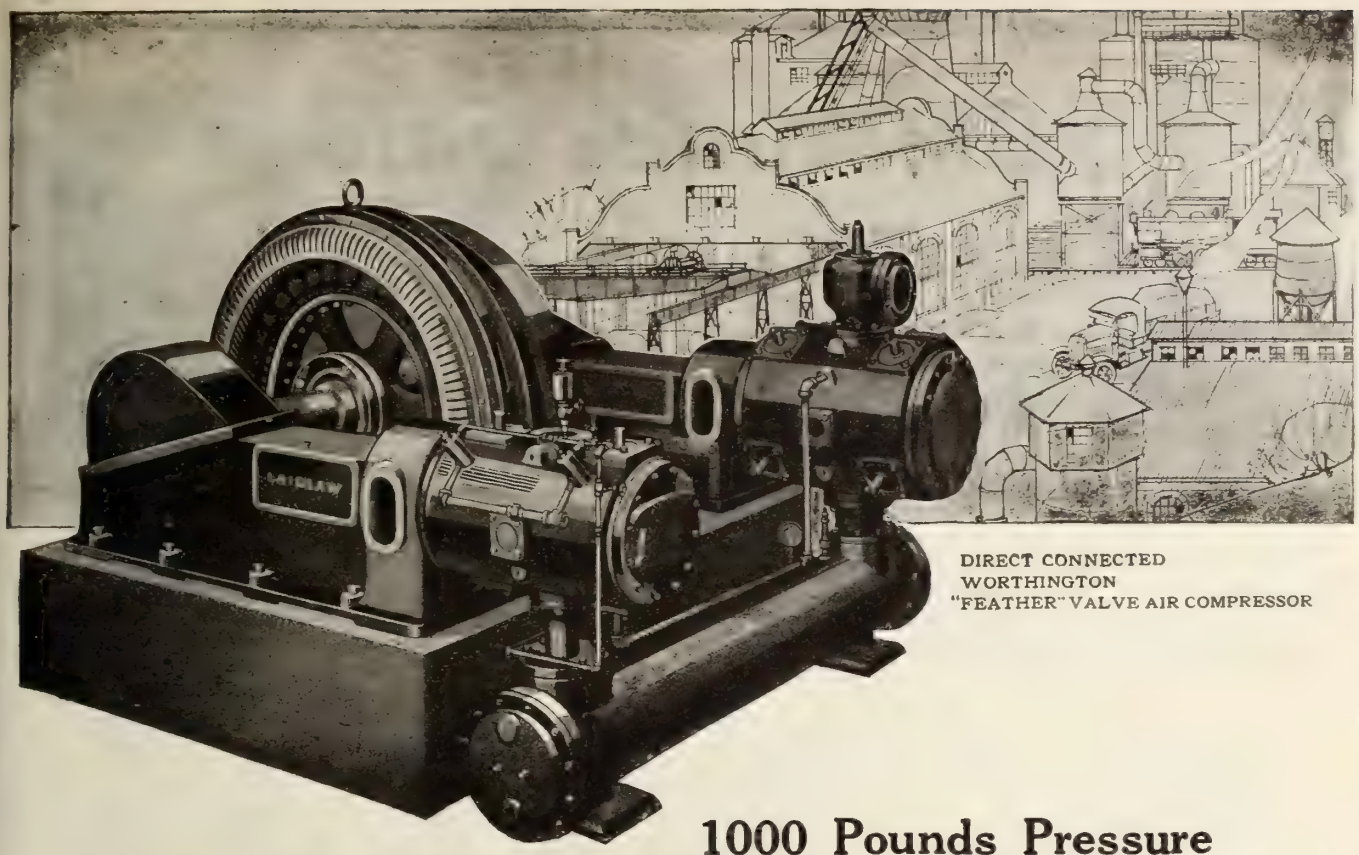
The DUNHAM HEATING SERVICE

Made in Canada

C. A. DUNHAM COMPANY, Limited, Toronto, Canada

HALIFAX OTTAWA VANCOUVER MONTREAL WINNIPEG CALGARY

London: 64 Regent House, Regent Street, W. 1



DIRECT CONNECTED
WORTHINGTON
"FEATHER" VALVE AIR COMPRESSOR

1000 Pounds Pressure and the "FEATHER" Valve

(REG. U. S. PAT. OFF.)

THE "FEATHER" Valve in Worthington Air Compressors, which successfully stands pressure up to 1000 pounds, is a thin strip of ribbon steel.

The "FEATHER" Valve is the strongest, most simple, long-lasting valve in service. It has but one moving part—"a ribbon of steel," which weighs less than one ounce, and functions by bowing in center against slotted curved guards to permit passage of air or gas and closes by gently straightening into place on ground face slotted seats. There is no friction or hammering action as with many other types of valve.

The "FEATHER" Valve, because of its efficiency, prevents fluctuating pressures and guarantees an always ready, reliable air service for Shop, Foundry or Mine.

Here again is proved the worth of Worthington's 80 years' experience in designing and improving pumps and pumping machinery. The advice of our engineering experts is to be had for the asking.

Other Worthington Products:

Steam, Power, Centrifugal and Water Works Pumps. Meters Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

Worthington Pump and Machinery Corporation
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

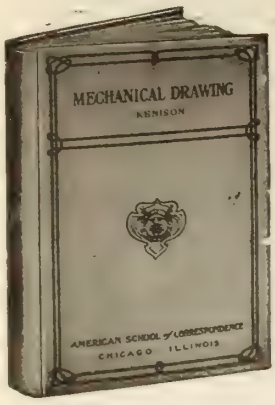
PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.

Epping-Carpenter, *Pittsburgh, Pa.*

Laidlaw Works, *Cincinnati, Ohio.* Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.



Clearance Sale of High Grade Technical Books

FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

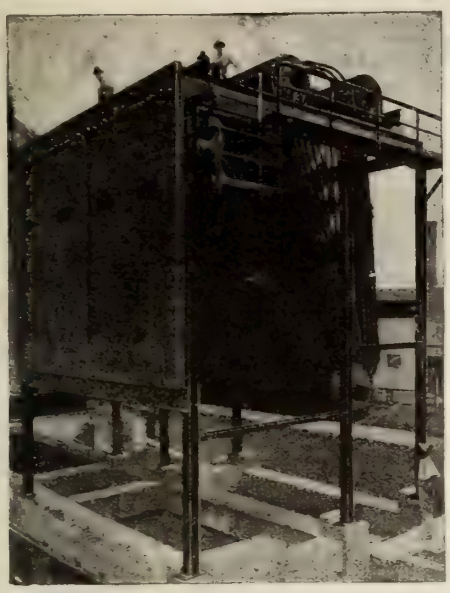
Title of Book.	Name of Author.	Binding	Number of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	....
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	275	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Gas and Oil Engines	L. E. Brookes	Cloth	192	Yes	.85
Ford Car	V. W. Page	Cloth	288	Yes	....
New Catechism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Setting Valves of Canadian-made Engines	G. C. Keith	Paper	31	Yes	.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
How to Run Gasoline Engines	C. Von Culin	Paper	144	Yes	.50
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkin's Indicator	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Aids to Engineers Examinations	N. Hawkins	Cloth	222	No	1.50
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy of $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

153 UNIVERSITY AVENUE, TORONTO, ONT.



Connelly Water Tube Boilers (Patented U.S. & Canada)

are of the 4 drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. Leonard & Sons Ltd. Head Office & Works
LONDON, CANADA

Branches:
1790 St. James St., Montreal, Que. 62 Water St., St. John, N.B.

AGENTS
E. J. Philips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. Johns, Nfld.

Established 1834

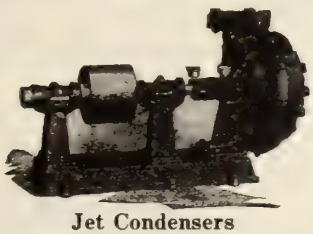
LEONARD

AMERICAN-MARSH PUMPS

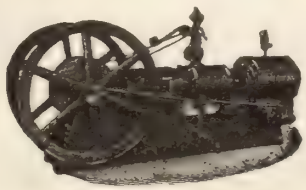
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

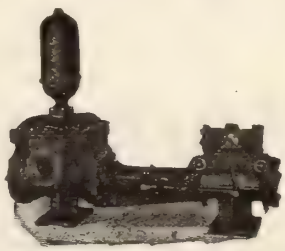


The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN



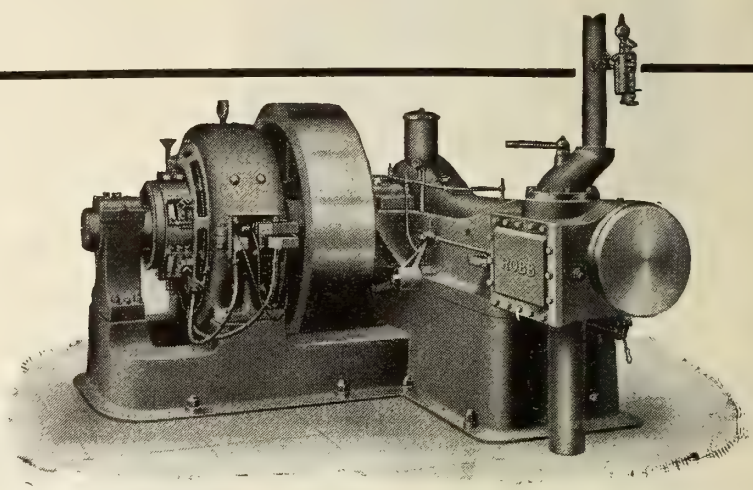
CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



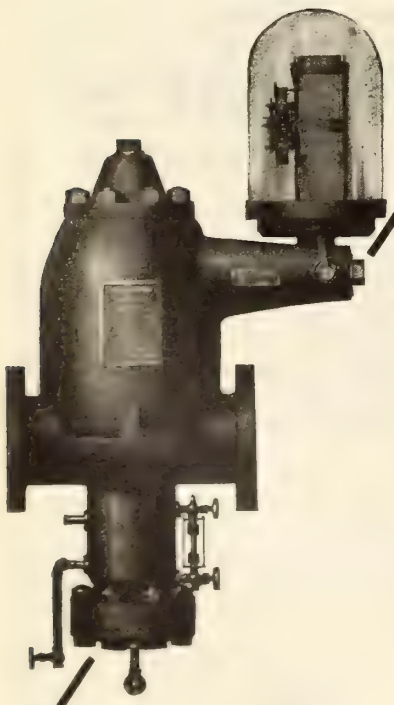
Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office: Phone Westmount 6800

Toronto Office: 20 Victoria Street



KNOW

How much steam you use for each different purpose

St. John Indicating and Recording Steam Meter

TO know costs, you must be able to determine the exact quantity of steam used in the operation of your engines, pumps, blowers, laundries, steam kettles, heating systems, drying rooms, or for other purposes. The St. John Meter measures the flow of steam at all pressures and under varying loads.

It gives you a graphical minute-by-minute record, on a paper ribbon, of the exact number of pounds of steam used during any period of time. Guaranteed accurate to within 2 per cent.

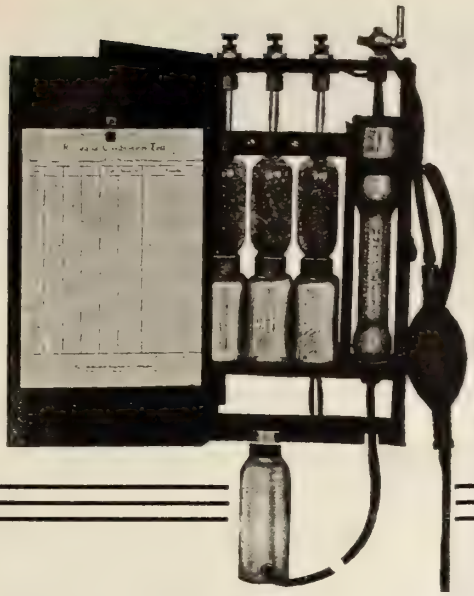
Write for Bulletin No. 146-P.H.

AMERICAN DISTRICT STEAM COMPANY

General Office and Works: NORTH TONAWANDA, N.Y.

Representatives: A. R. Williams Machinery Co., Ltd., Toronto, Ont., and Branches

When You Buy Hays Equipment You Buy Hays Equipment



The Hays Improved Gas Analizer

From Guess Work to Exact Knowledge

FUEL is scarce and high in price; you can't afford to waste it. Excess or insufficient air, leaky boiler setting, leaky baffles, holes in the fire, fires too thin or too strong—these are some of the conditions which waste your fuel. You can't locate them by guesswork.

Hays' Combustion Efficiency Appliances indicate **exactly** how the waste is occurring. Your engineer is then in a position to stop it.

Small plants as well as large ones greatly benefit from Hays Equipment. Just what it can accomplish in **your** plant, our service department will tell you. Put it up to them—their service costs you nothing.

Let us send you a copy of our book, "How to Build Up Furnace Efficiency." You will find it of absorbing interest.

Hays Automatic CO_2 and Draft Recorder awarded Certificate of Merit by the Franklin Institute.

The Jos. W. Hays Corporation

MICHIGAN CITY - - INDIANA, U.S.A.

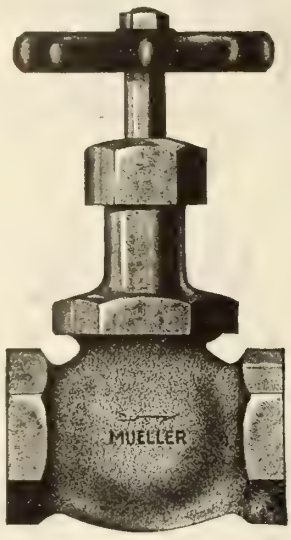
General Representative for Canada: Stephen H. Payne, 30 Church St., New York

Representatives in Canada:

Arthur S. Leitch Co., 1002 Kent Bldg., Toronto **Edward A. Robinson Co., Ltd., 228 Craig St. W., Montreal**
Wm. Gould, 701 Merchants Bank Building, Winnipeg

MADE IN CANADA

MUELLER
BRASS GLOBE VALVES



Registration Numbers:

Province of Ontario No. 1780
for 175 lbs. pressure.

Province of Alberta No. 1116
for 150 lbs. pressure.

MUELLER Brass Globe Valves are recommended for a working pressure of 125 lbs. The special features appended justified voluntary registration for working pressures of 175 lbs. and 150 lbs. by the Chief Boiler Inspectors of Ontario and Alberta respectively:

DESIGN
Special barrel shaped body. Female thread on bonnet.

METAL
High copper and tin content giving a tough, close grained casting with pressure resisting qualities.

PACKING
Special packing composed of asbestos and graphite with lead core wire to resist high pressure.

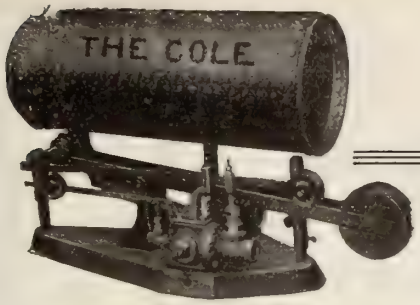
MUELLER Globe Valves are being substituted for competitive patterns of composition disc Valves.

Samples on Request

H. MUELLER MFG. CO., LTD.

SARNIA CANADA

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS



We would like to have every Engineer, Power Plant Superintendent, Owner, to See Our Exhibit and talk over conditions with our Expert Engineers at the

Annual Convention of the

Canadian Association of Stationary Engineers

To be held at Woodstock, Ontario

June 22, 23, 24—1920

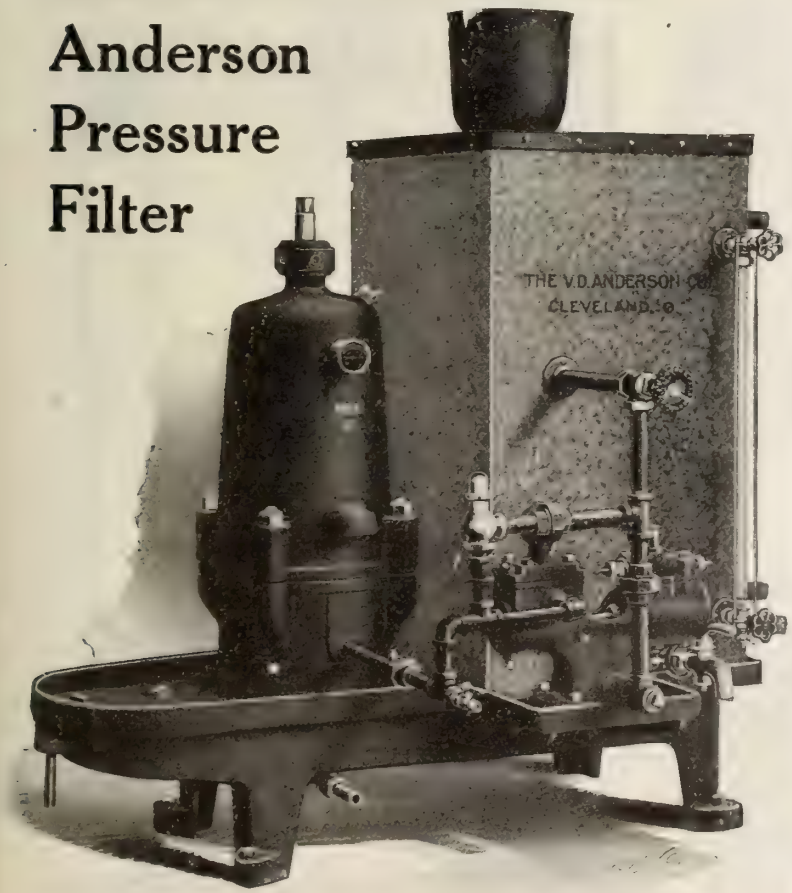
IT WILL PAY YOU

Western Representative:
Geo. A. Young,
203 Scott Block,
Winnipeg, Man.

Geo. W. Cole, Limited,
2002 Dundas St., W.,
Toronto.

Eastern Sales Office:
76 St. Gabriel St.,
Montreal.

Anderson Pressure Filter



Get Twice the Use from Your Oil

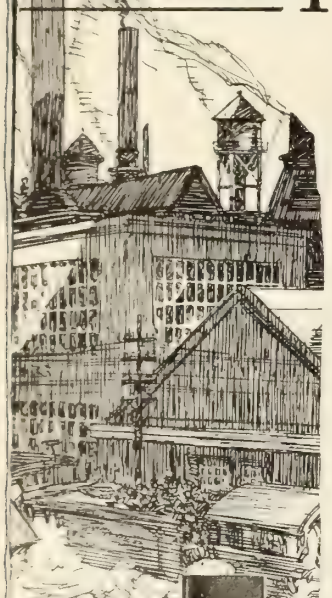
Put your drip-pan collected oil through the Anderson Pressure Filter. It goes through a cleansing and purifying process identical to that of the refiners. It comes out suitable for use on the finest bearings.

Without the Anderson your expense for oil is double what it should be. To get the benefit of that other 50% the first step is to send for our catalog. It explains in detail just how the Anderson Pressure Filter prevents waste.

The V. D. Anderson Co.
West 96th St., Cleveland, Ohio

Where every Working minute means money, blown fuses cut profits unless electrical circuits are protected by

ECONOMY *renewable* FUSES



INDUSTRIES using electrical energy operate most efficiently when delays in machine operation are unnecessary while blown fuses are being replaced.

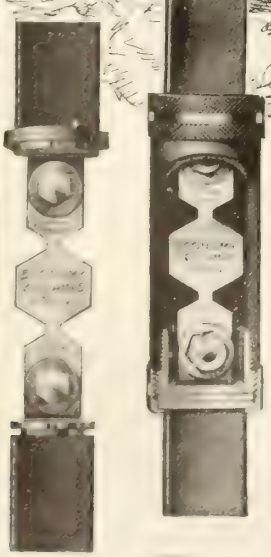
Economy Fuses are used by thousands of industries because they permit of renewal in minimum time at minimum cost.

Where greater efficiency is required a reserve stock of fuses is kept on hand and used in case of blowouts. The blown fuse is then restored to duty at leisure by simply inserting a new Economy "Drop Out" Renewal Link.

Economy Fuses cut annual fuse maintenance costs 80% as compared to the use of "one-time" fuses.

The fibre cartridge, the winged washers which lock the fuse, and the threaded end caps which complete the assembly are virtually indestructible and are used over and over again.

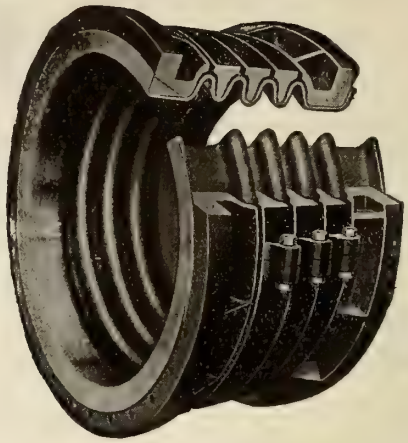
Economy was the first line using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be *Approved In All Capacities* by the Underwriters' Laboratories.



For sale by all leading electrical jobbers and dealers

Economy Fuse & Mfg. Co.
Chicago - U. S. A.

Economy Fuses are also made in Canada at Montreal.



BADGER
SELF-EQUALIZING EXPANSION JOINTS

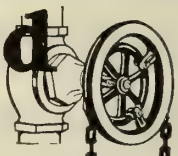
are the best joints for absorbing pipe expansion—Note the corrugations that expand and contract, thus preventing leakage.

Write for our new book today

E. B. BADGER & SONS CO.
81 PITTS ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

Banished



Wherever efficiency dictates power plant activities, no longer is the ladder used to operate overhead out-of-reach valves. With all its delays and dangers it has been relegated to the discard. In its stead is the new time, trouble and labor saving

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

-a simple, safe, practical and economical device which makes easy and rapid the operation of all inaccessible valves—FROM THE FLOOR.

Your supply house has them.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass.

Western Representative:
Jenkins Bros., 360 W. Lake Street, Chicago, Ill.
Canadian Agents:
Engineering Specialties Co. Ltd., Toronto, Ont., Can.

Simple and Practical Vacuum Pump

The fact that Nash Hytor Vacuum Pumps are in extensive use in many of the largest engineering plants is sufficient evidence of their superior qualities.

These pumps are manufactured on the limit system, with Johansen measuring blocks as a reference. Interchangeability of all parts is assured. Each pump is tested for capacity, vacuum and horse power before it leaves the factory.

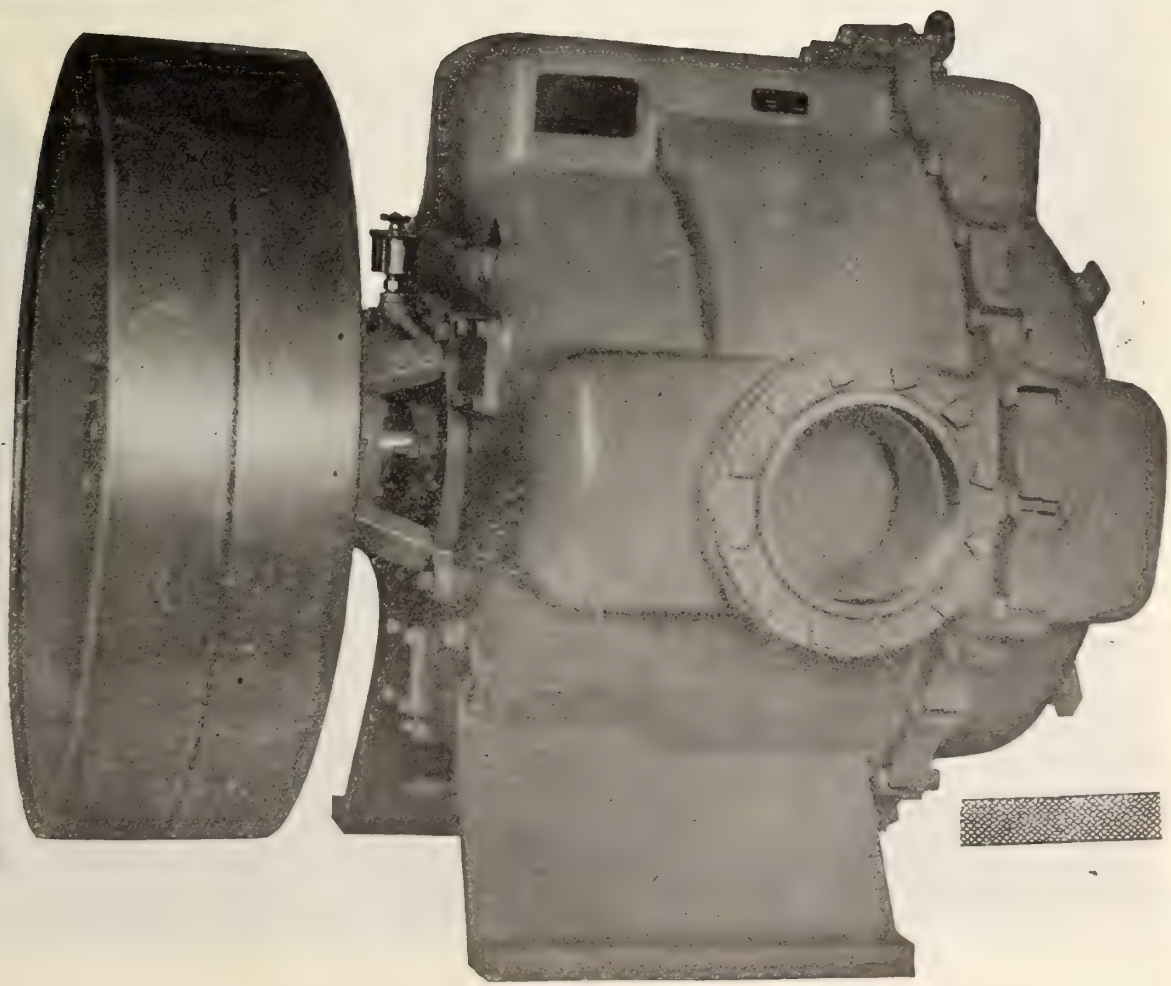
Nash Hytor Vacuum pumps have only one moving part, the rotor, supported on a very heavy, carefully proportioned shaft. All valves, sliding vanes, pistons, gears, crank shafts, cams or rubbing surfaces are eliminated.

If you are interested in learning more about the many valuable features of these pumps. Write us. All enquiries will have immediate attention.

THE
Arthur S. Leitch Co.
1001-2 Kent Building
TORONTO - ONT.

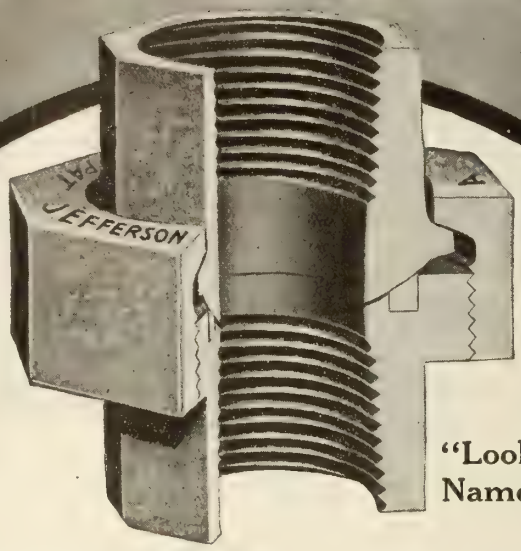
Nash Hytor

Vacuum Pump for Air or Gas



Size No. 7, capacity 1,350 cubic feet per minute at a vacuum of 12" mercury.

JEFFERSON



"Look for the Name on the Nut"

EVERY practical engineer will recognize the value of a **brass-to-iron** joint in pipe Unions. Jefferson Unions have a brass seat ring embedded into the malleable iron by exerting enormous pressure—up to 40 tons. This does away with the possibility of corrosion and the seat ring cannot become dislodged under any conditions. This seat ring is ground accurately to fit the spherical face of the other part of the union, thus insuring a tight joint even though the pipe is slightly out of line. The uniform perfection of JEFFERSON UNIONS insures against breakdowns and dangerous steam losses. Your Jobber has them in stock. You've nothing to loose by giving them a trial.

We would like to tell you of the many other Jefferson strong points—these are covered in detail in our new catalog. Send for your copy to-day.

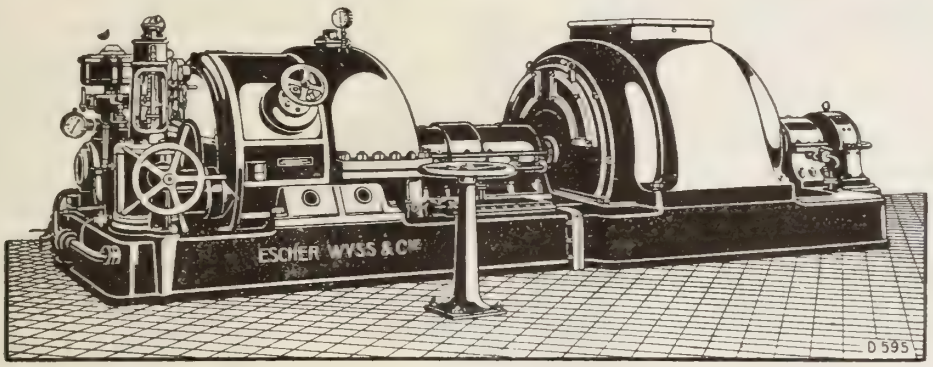
The Jefferson Union Co.

Lexington, Mass.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

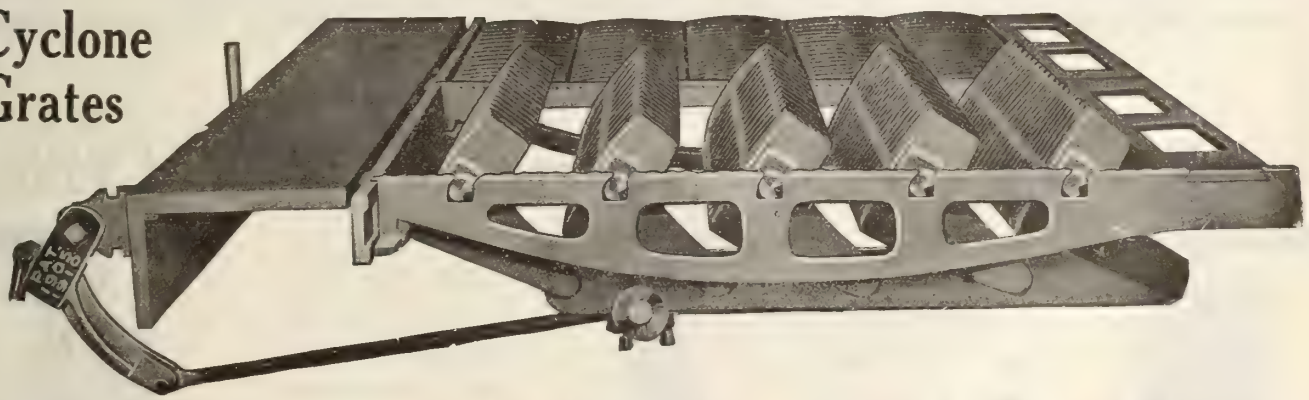
Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

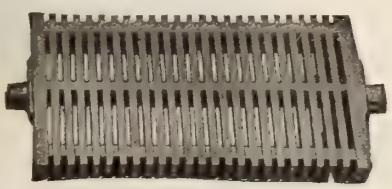
9/20

Cyclone Grates



No Strings to This Proposition

To prove to you that CYCLONE GRATES are easy to install and when installed will save you a lot of fuel expense and give you the best furnace satisfaction you have ever had we are prepared to make you a 30-day trial offer. Why not investigate?



Solve the Fuel Problem

You can burn any grade of hard or soft coal or screenings and get maximum results with CYCLONE shaking and Dumping Grates. Their 60% air space and 90 % under-draught insures perfect combustion. No fuel in ashpits where they are installed; no clinker formations either. In these days of coal scarcity and high prices Cyclone Grates prove a splendid investment. Get in touch with us.

The Canadian Steam Boiler Equipment Co., Ltd.

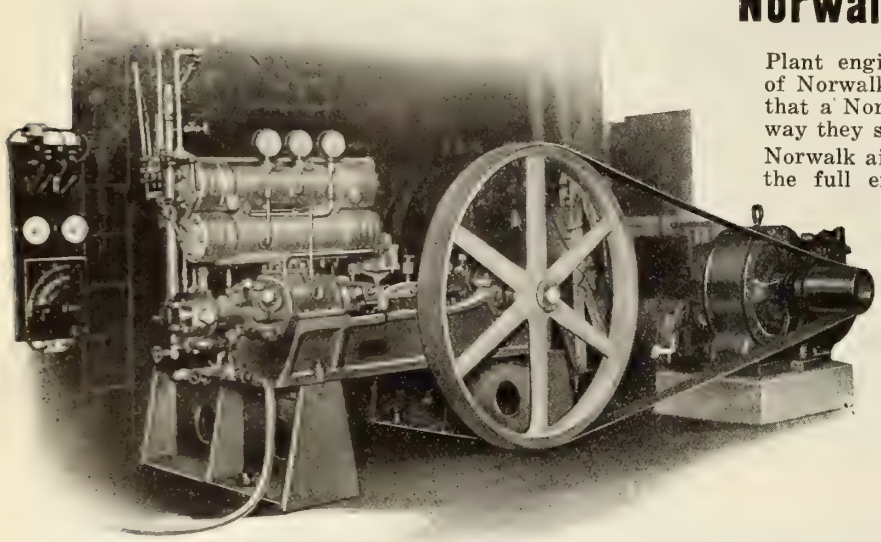
Sole Makers for Canada

20 McGhee Street Phone G. 2660 Toronto, Ont.

AGENTS:

Ottawa—J. W. Anderson, Room 7, Bank Street Chambers. St. John, N.B.—F. W. Blizard, Limited, 331 Charlotte St. Montreal—Mason Regulator Co., Ltd. Hamilton—Robt. Fitzsimmons, 8 Grove St. Winnipeg—Vulcan Iron Works, Ltd.

NORWALK
AIR & GAS · COMPRESSORS



A Norwalk Compressor on Testing Stand.

Norwalks Always Do Their Work

Plant engineers are liberal in their commendation of Norwalk compressors, because "you always know that a Norwalk is going to do its work," That's the way they sum up the situation.

Norwalk air and gas compressors have been meeting the full expectations of critical engineers for so many years that their reliability is unquestioned. Every Norwalk is thoroughly tested for more than specification pressure before leaving the plant. It never goes out until it has passed the efficiency test.

Norwalk bulletins describe and illustrate Norwalk compressors for air, oxygen, hydrogen, carbonic acid, gas and acetylene. Sent on request.

THE NORWALK IRON WORKS CO.

Pioneer Builders of Compressors

South Norwalk, Conn.

A. S. LIETCH COMPANY, TORONTO
Canadian Sales Representative

ANY·CAPACITY ANY·PRESSURE

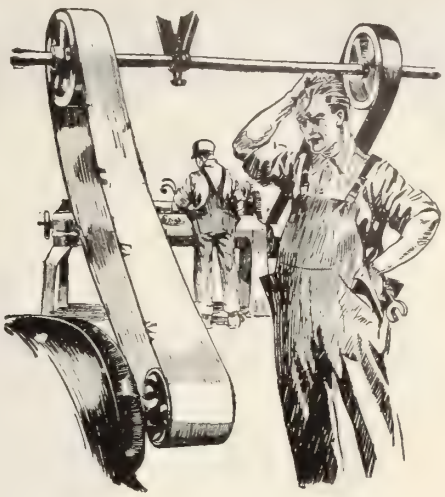
KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**



Curing a Mean Drive

Practically every factory of any size has one or more mean drives which seem to defy all attempts to correct them.

Up to date you're beaten—but that's because you want to solve the problem yourself.

Our transmission experts take more real satisfaction in solving mean drives than in selling belts.

Dominion Friction Surface Belting

has helped to solve many transmission problems, and we have yet to find a drive where it will not provide efficient, satisfactory service.

It will cost you nothing to have one of our belting experts study your problem.

If he can't help you he will tell you so. If he can help you it will cost you only the price of a belt that will give you a longer and more satisfactory service than any other belt has given on that particular drive.

The first step to that satisfactory service is a 'phone or wire to our nearest service branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the same high standard as Dominion Friction Surface Belting.

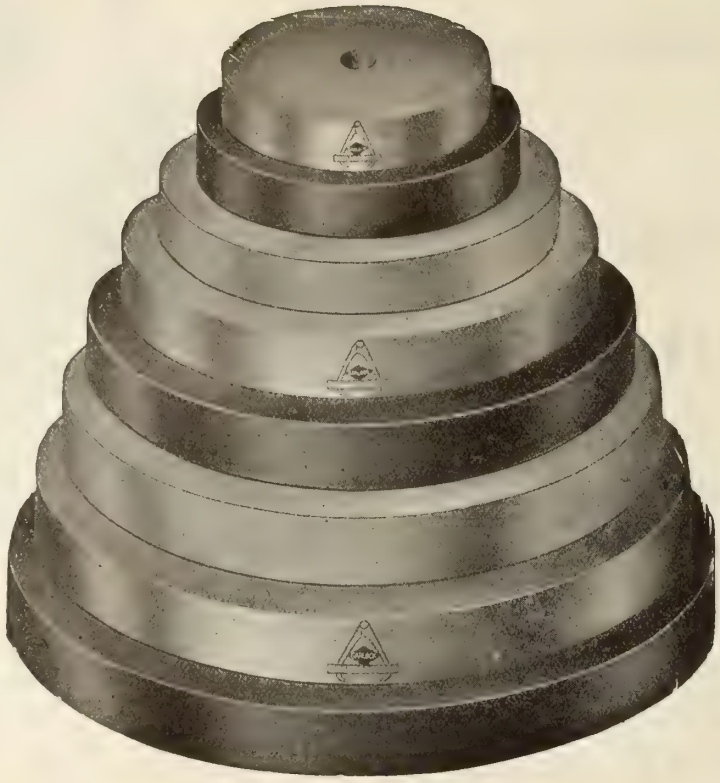
Dominion Rubber System Service Branches

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

90

GARLOCK

PUMP



VALVES

The service of pump valves depends upon the compounds as well as the consistency and cure of the valves. The compounds used in Garlock pump valves have been established after years of trial in actual service and under the most severe conditions. Pump valves should always be used for the purposes for which they are intended. The following are a few of our leading styles and grades of valves:

Style No. 139—For medium pressure cold water
" " 175—For high pressure cold water
" " 182—For warm or greasy water
" " 108—For hot water
" " 105—For boiling water
" " 154—For air compressors and condensers

We guarantee our pump valves to give satisfactory service when used under conditions for which they are intended.

The Garlock Packing Company

Hamilton, Ontario

BRANCHES:

Montreal, Quebec	409 Shaughnessy Building
Toronto, Ontario	404 Continental Life Building
Winnipeg, Manitoba	Galt Building
Calgary, Alberta	211 Eighth Avenue West
St. John, N.B.	23 Water St.
Vancouver, B.C.	806 Pacific Coast Fire Bldg.

DART

UNIONS

CANNOT LEAK

With Dart Unions attention or replacement are wholly unnecessary, and there's never any damage from leaks.

Bronze to Bronze at the Joint
No eterioration

Dart Unions can be used over and over again — they're always efficient.

Heavy Iron Parts
Will not stretch nor pull apart under strain or heavy pressure

Manufactured by

Dart Union Co., Limited, Toronto

"MEAD-MORRISON"

CANADIAN MM ©

COAL and ASH HANDLING MACHINERY

Manufactured in Canada

DEPENDABLE SERVICE

Coal Handling Bridges
Weighing Lorries
Coal Crushers
McCaslin Conveyors
Clam Shell and Orange Peel Grab Buckets

Put Your Problem Up to Us!

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

LINCOLN ARC WELDING

Get That Boiler Repaired With Lincoln Electric Welding

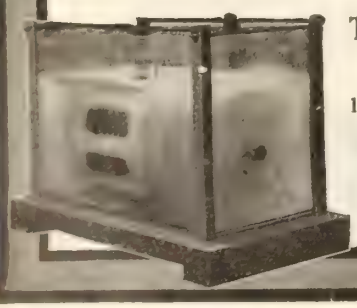
because it will make a permanent repair for you in as many hours as it takes days by any other method.

Therefore, by shortening the time of the "tie-ups" due to leaky defective boilers, this process is an economical one that every plant superintendent and owner should be informed about. It will not obligate you in any way if you will write for particulars about Lincoln Electric Welding.

Possibly it would not pay you to install a Welder of your own. In that case it might be advisable for you to utilize our welding plant located after June 15th, in new and enlarged quarters at 136 John St., (at present at No. 1 Jarvis St.) where we have, in addition to our regular outfits, portable equipment ready for emergency calls.

"Link Up With Lincoln"

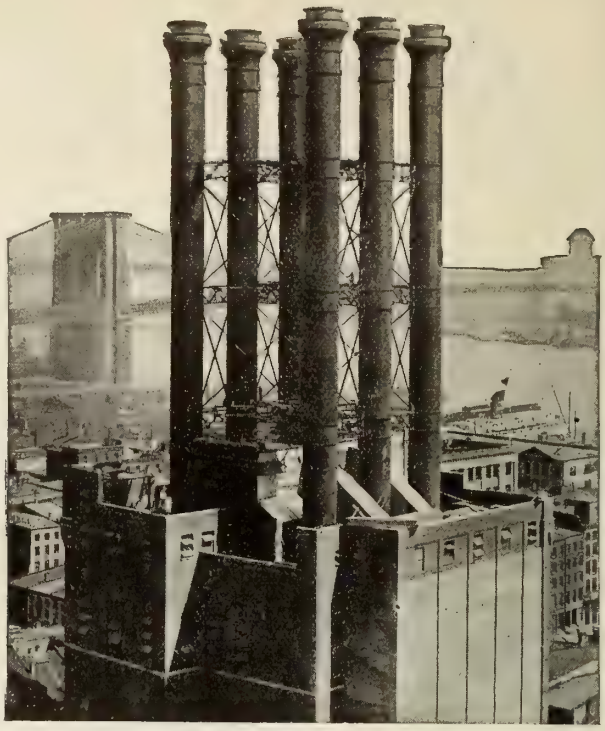
to-day by sending for complete information about Lincoln Electric Welding.



The Lincoln Electric Co. of Canada, Limited

1111 Temple Bldg., Toronto, Canada

Montreal Branch: Coristine Bldg.



THOMPSON STARRETT CO., CONSTRUCTORS

And in the new power plant of the New York Steam Co.

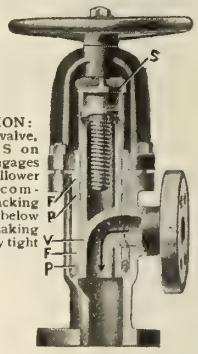
SEVENTY-ONE Yarway Seatless Blow-Off Valves are in Service in the new building of the New York Steam Company—a model of up-to-date power plant efficiency. Not all of these are original equipment; reorders helped to make up the present total.

YARWAY

Seatless Blow-Off Valves

NOTHING but proven value could bring orders and reorders from such concerns as these:

Atlantic Refining Company
American Woolen Company
American Smelting and Refining Company
Big Four R. R.
Delaware & Hudson R. R.
Gulf Refining Company
Libby, McNeill and Libby
Pennsylvania R. R.
Philadelphia Electric Co.
Standard Oil Company
Virginia Shipbuilding Co.
Westinghouse Air Brake Co.



OPERATION: In closing valve, shoulder S on plunger V engages the loose follower gland F, compressing packing P above and below the port, making an absolutely tight valve.

Ask for Bulletin No. B-410

YARNALL-WARING CO.

7604-20 Queen Street

Chestnut Hill Philadelphia

Agents in All Principal Cities

"No Seat to Leak"

How Well Do YOU Know Canada?

Gripping
Amusing
Informative

MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

One of the best edited publications in the world.

Contents of the Big June 1st Issue

"Parliamentary Dog Days." J. K. Munro. Illustrated by Lou Skuce. Canada's wittiest and shrewdest political writer gives us his regular monthly summary of the situation at Ottawa—replete with "inside information."

"Bertie and the Bolshevik." By A. Raymond Mullins. Illustrated by C. W. Jeffreys. A most humorous tale of an English soldier in Canada who gets "taken in" by a bunch of Bolsheviks.

"The Parts Men Play." By Arthur Beverley Baxter. Illustrated by H. Weston Taylor. Another gripping instalment of this great Anglo-American-Canadian serial.

"They're All Alike." By Mary E. Lowry. Illustrated by D. G. Summers. A delightful love story, with the scene laid in a big Canadian city.

"The British in Italy." By Brigadier-General Mitchell, formerly Chief of the Intelligence Staff of the Canadian Army. Illustrated by photographs. The first authorative recital of the part the Canadian troops played in the Italian campaigns.

"The March of the Overall." The Canadian Press, from Coast to Coast, treats in a fecitious manner with the craze for Blue Jeans.

"The Little Warrior." By Pelham Grenville Wodehouse. Illustrated by C. W. Jeffreys. A long, absorbing instalment of this masterpiece of humor—the finest serial story MACLEAN'S has ever run.

"A Safe Bet." By W. A. Fraser. Illustrated by R. M. Brinkerhoff. It's about a horse race in Montreal, and it's one of the best stories this world-famous sporting writer has ever written.

"Is Era of Wildest Prosperity Ahead of Canada Today?" Canada is in the strongest economic condition of any country in the world, says Agnes C. Laut, famous international authority, in a strikingly prophetic article which you'll keep for future reference.

Review of Reviews

"Will Colored Hordes Submerge the World?" By Lothrop Stoddard.

"Why Gasoline is High." By John K. Barnes.

"Eccentricities of a Despot." By A. C. Jewett.

"Holland is Too Wealthy." By Oscar T. Schweriner.

"To Probe Secrets of the Air." By Lloyd V. Turner.

"Russia is Turning to Germany." By Baron Eugene De Schelking.

"Odd Marriage Custom in Ireland." By Albert E. Knash.

"Embassy Mistakes." By A. Maurice Low.

"Two Million Extra Women." By William Ord Barker.

"Dangers of Spiritualism." By Doctor Mary Scharheb.

"How the Triple Entente Was Formed." By Count Iswolsky.

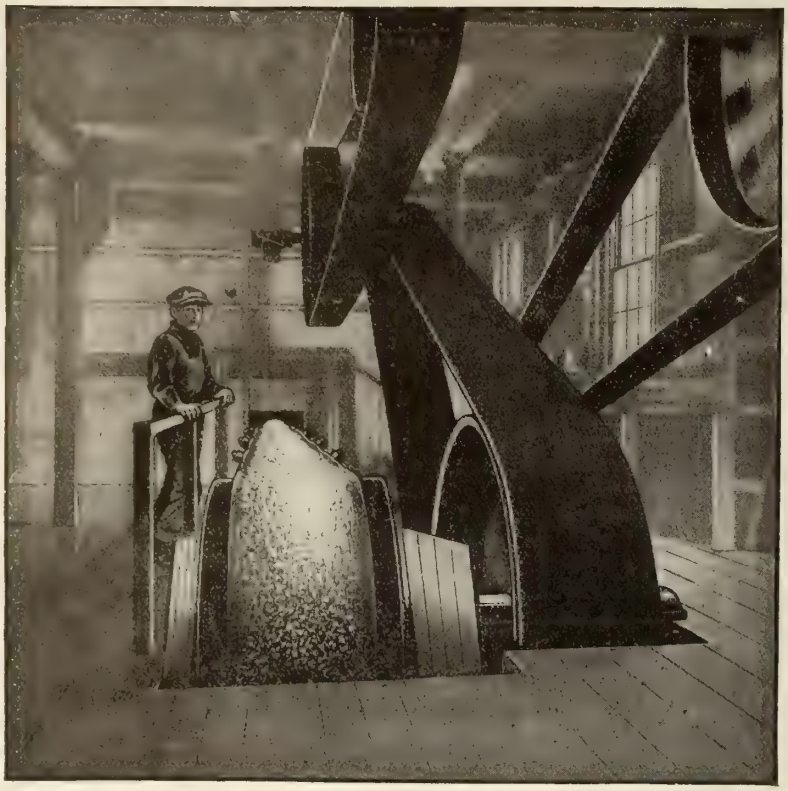
"Dread Disease Sweeping West." By A. E. McCullough

"Huge Fortunes in Popular Songs." By E. M. Wickes.

"Putting Socialism Into Practice." By Henry G. Alsberg.

The demand for MACLEAN'S MAGAZINE always exceeds the supply. Get your copy NOW!

At All Newsstands - - 20c



"P. M. S." BELTS

The unusual flexibility of P.M.S. Belts gives perfect conformity to pulleys, large or small, and is especially adapted to toper cone drives in Paper Mills —the most difficult belt test known. This unusual adaptability increases pulley contact and prevents loss of power. Where extra heavy loads are carried, P.M.S. Belts are particularly appreciated.

Conveyor Belts and Transmission Belts for All Sorts of Machinery and Conditions of Service

---

Gutta Percha & Rubber, Ltd.

Manufacturers of Mechanical Rubber Goods of all Descriptions

Head Offices and Factory: TORONTO

Branches in all Leading Cities of the Dominion

15 Sales Offices Backed by the 100% Standard of Quality

THE Canadian Fairbanks-Morse Company Limited reaches out to you through its sales houses and offers the service and satisfaction that is assured by its 100% standard of quality and service.

To be able to turn to an institution that dominates its field in the industrial world is to safeguard the character of the merchandise you buy. To deal with an organizationthat is doing business at your very door puts upon the man you know that "responsibility which is the conscience of business."

Every one of these 15 offices has been established to bring to you the full advantages and benefit that have made The Canadian Fairbanks-Morse Co. Limited a national institution. Here in these offices is offered everything mechanical that your business requires — they centralize your purchasing—group your orders—bulk your shipments and send but one invoice. And when you buy from The Canadian Fairbanks-Morse Co. Limited you are guaranteed the 100% standard of quality and service in product and organization.

Make our nearest office your buying centre—our catalogue is your buying guide —our 100% quality seal your guarantee.

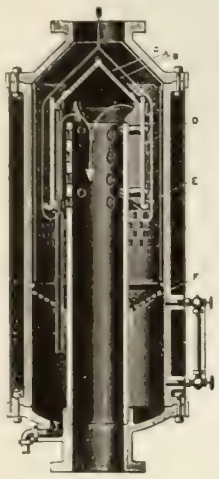
The Canadian Fairbanks-Morse Co., Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal
Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg
Regina Saskatoon Calgary
Vancouver Victoria

2

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

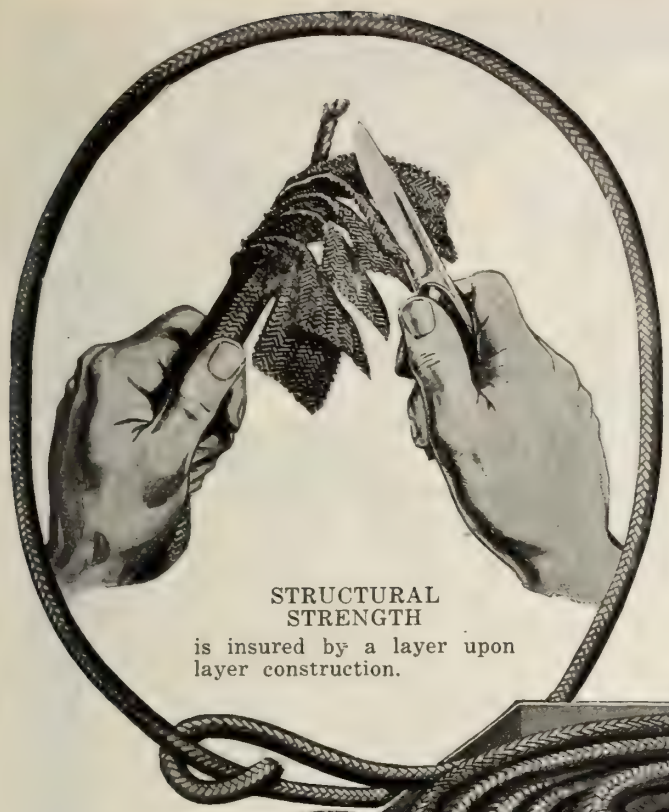
Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

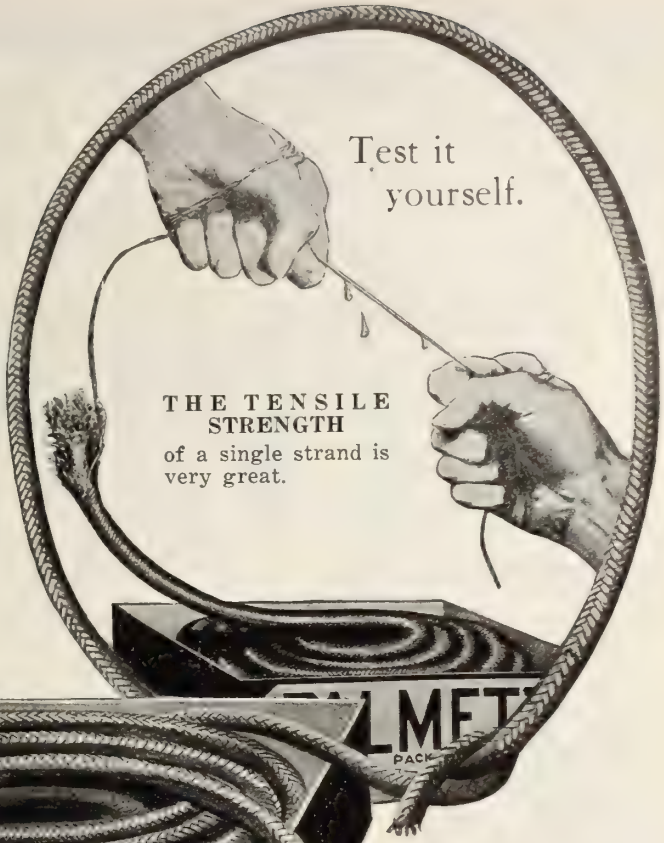
DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA



STRUCTURAL STRENGTH
is insured by a layer upon layer construction.



Test it yourself.

THE TENSILE STRENGTH
of a single strand is very great.

Three Reasons why "PALMETTO" PACKING

is superior for high pressure, superheated steam and compressed air.

It gives longer service than other packings and is therefore more economical.

Let us send you a working sample to test under your own conditions—no charge.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St., New York

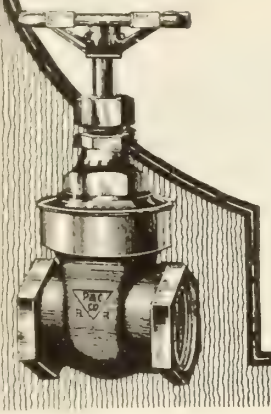
Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

Its graphite grease lubricant prevents friction.

Lubricant is forced into each single strand before braiding.

"Stop Thief!"
Save Your Valves!

When you throw away a valve because the seat is worn out, it's as if someone had stolen that valve from you.
Why don't you stop that extravagant waste? Why don't you scrap only the worn seat instead of the whole valve?
With a PRATT & CADY RENEWABLE GATE VALVE the seat rings save the valve—they save you almost the entire cost. You can insert a new set of seat rings for around 10% of the cost of a new valve. Then the valve is as good as new.
And you can put in the new rings without removing the valve from the line.



PRATT & CADY
Renewable Seat Gate Valves

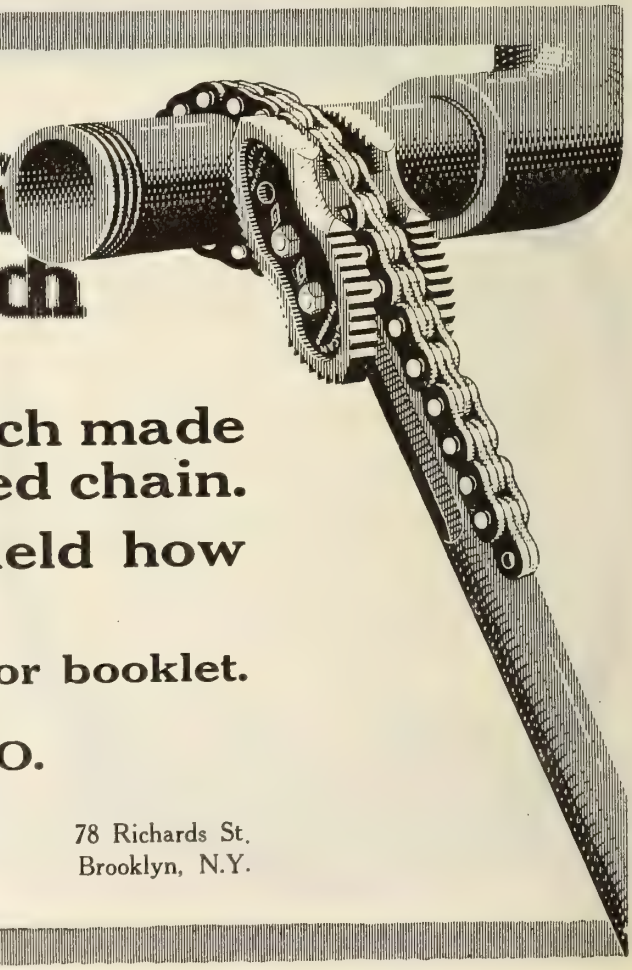
are saving money for hundreds of other firms—why not for you?
Pratt & Cady Valves have long life. They are designed to stand up under hard work.
Are double seated, so that the pressure can be applied at either end.
Bronze or iron in all standard sizes—for Steam, Air, Oil, Gas or Water.
Cutout valve reseating machines. Forget the trouble of scored seats.
Send for instructive valve book.

PRATT & CADY CO., INC.

Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Hot Water Service Heaters, Asbestos Packed Cocks and Power Pumps.

Boston Cleveland Hartford Philadelphia Rochester
Chicago Detroit New York Pittsburgh San Francisco
Representatives in all large cities.

Williams' Improved Vulcan Chain Pipe Wrench



The *only* chain pipe wrench made with proof-tested, certified chain.

Ask the men in the field how much this means.

For 1/8 to 18-inch pipe ask for booklet.

J. H. WILLIAMS & CO.
"The Wrench People"

78 So. Clinton St.
Chicago, Ill.

78 Vulcan St.
Buffalo, N.Y.

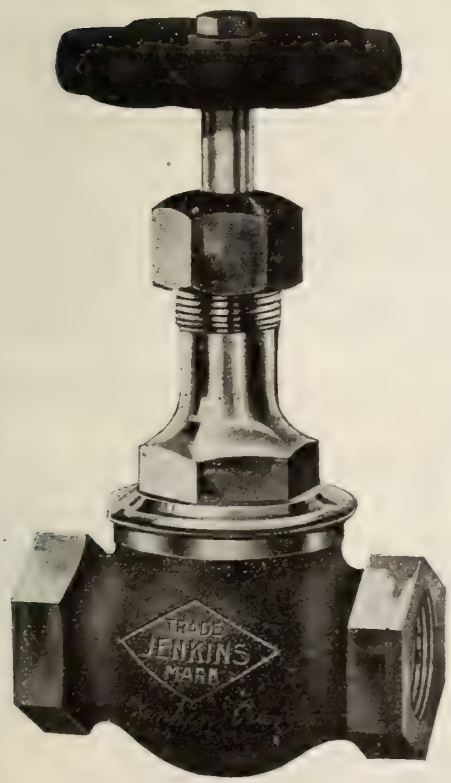
78 Richards St.
Brooklyn, N.Y.

TRADE JENKINS MARK

Jenkins Bros.

There's a Jenkins Valve for every purpose

The Diamond Trade Mark is cast on every genuine Jenkins Valve



Low Maintenance Costs

Economy is not a matter of buying that article which is lowest in price, but of buying that which will give the greatest **service** for your money.

Over half a century of experience goes into the manufacture of Jenkins Valves. Jenkins Valves give no trouble once they are installed. Their long reliable service reduces upkeep expense to a minimum.

Standardization makes every Jenkins Valve of equal quality. The performance of one is equalled by every other.

Be sure of your new equipment. See that the valves you receive have the Diamond Trade Mark cast on the bodies.

Catalogue No. 8 free upon request.

Jenkins Bros. LIMITED

Head Office and Works:
103 St. Remi Street
Montreal, Canada

Agencies in all the
Principal Countries
of the World

European Branch:
6 Great Queen St., Kingsway,
London W.C. 2, England

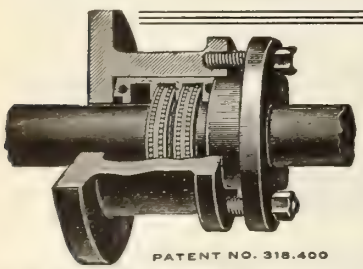
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM *and* GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



PATENT NO. 318,400

PAT. NO. 500,899 … PAT. NO. 829,118
" " 554,104 … " " 830,530
" " 602,428 … " " 856,103
" " 654,541 … " " 878,238
" " 654,542 … " " 894,537
" " 721,368 … " " 895,791
" " 774,490 … " " 893,066
" " 775,193 … " " 905,106
" " 775,194 … " " 934,829
" " 791,300 … " " 979,206
" " 806,689 … " " 1000,75

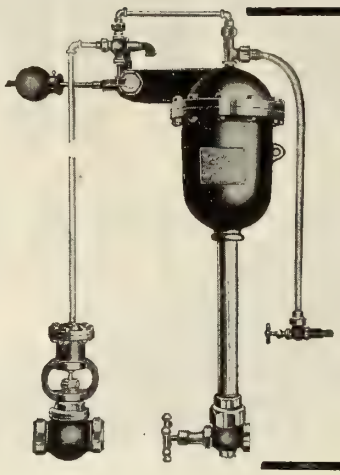
Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897



Make Sure of Constant Level and Stop Worrying

Eliminate the danger of boiler explosion due to low water or a wrecked turbine or engine due to high water by feeding your boilers automatically with

Vigilant Water-Feed Regulators

They hold the water level constant at middle gauge — the safest and most logical point — that insures better economy and protects the boiler against excessive expansion and contraction.

A paying investment for any plant. Write for Catalogue now

The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor.

CUT GEARS

In Grey Iron, Steel, Semi-Steel and Bronze.
On a Gleason Gear Planer Bevels cut up to 8 inches diameter.
Spurs cut up to 110 inches diameter.
Any pitch and width of face desired.
We employ three Gleason Gear Dividing Heads in our Plant, and cut wooden cogs in mortise gears with Gleason Attachments.
Largest range of Gear Patterns in Canada.
Our Pattern Shop, Foundry and Enginering Plant at your service.
Send in your inquiries and orders for immediate attention.

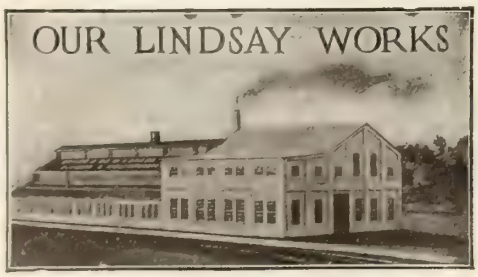
THE J. C. WILSON MFG. CO., LIMITED
BELLEVILLE, ONTARIO

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

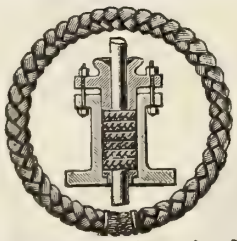
THE E. S. MANNY Co.

27 COTE St. MONTREAL, QUE

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB
Board of Trade Building, Montreal

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts. It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings ***Forgings***

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. ***Write for our latest catalogue.***

Patterns ***Machine Work***

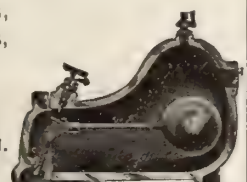
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

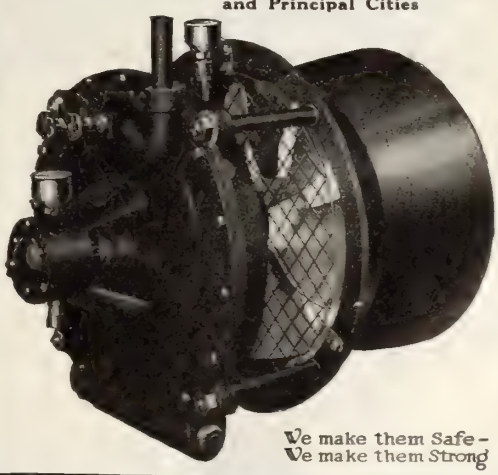
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

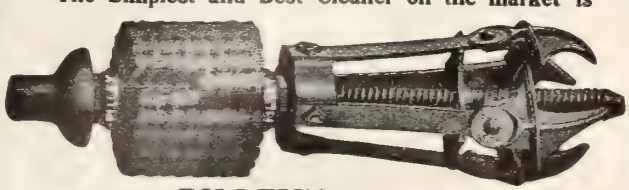
CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers **WORCESTER, MASS**
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.

Showing ease with which Plibrico is laid in place.

PLIBRICO IS PLASTIC

and particularly adapted for Jointless, one-piece front-door arches, bridge walls, side walls, combustion chamber walls and baffles.

BETTER THAN FIRE BRICK

Can you see the advantage and economy?

Write for book on furnace building

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

Trade Mark
Reg. U. S. Pat. Office.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

Say Good-bye to Funnels Use this "All-WAY" Oiler

Combination Filler and Funnel

This Filler eliminates the necessity of the use of a separate Funnel. With the Flexible Spout any part can be readily reached.

Saves much inconvenience and avoids dripping of oil.

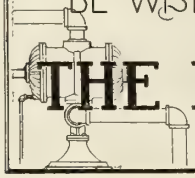
If your dealer cannot supply you, write us.

We also manufacture the well-known "All-Way" Oil Can. Saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY

196 King St. West **Toronto, Ont.**

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

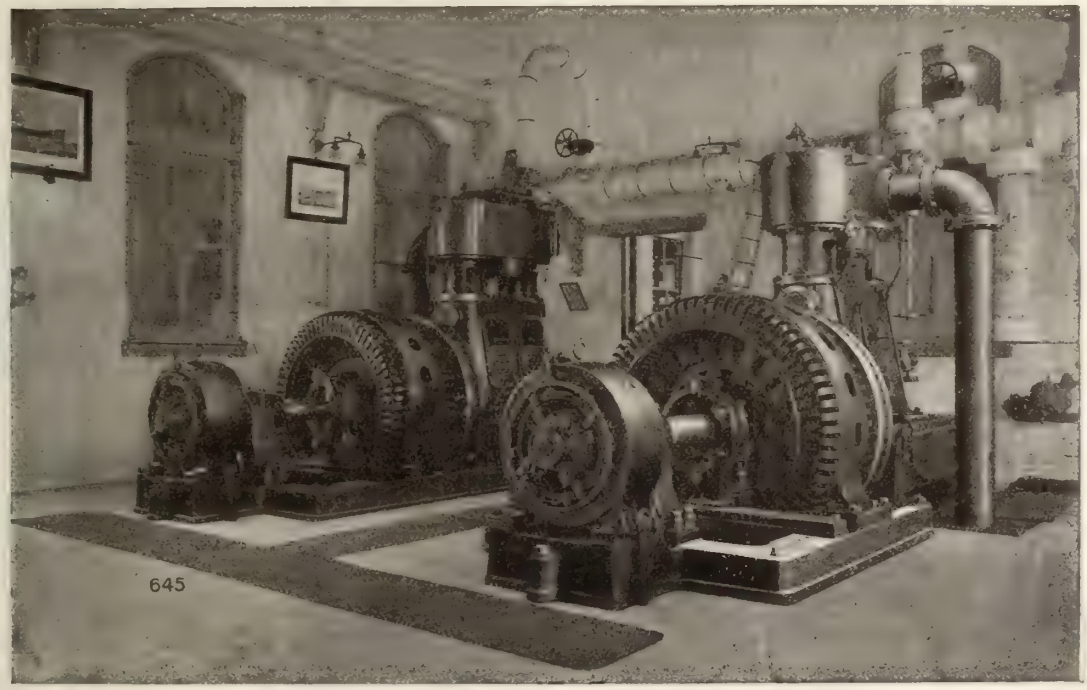
WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

WE handle only quality equipment. It is selected and approved by our engineers and backed by years of service.

We design and erect power plants for every service, no matter how large or small. If you have any knotty power plant problems, put them up to our engineers. Their services are at your disposal without obligation.

We Can Make Immediate Shipments and Installations
ON

Steam Engines	Condensing Plants	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

All enquiries cheerfully answered

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor. Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co. Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

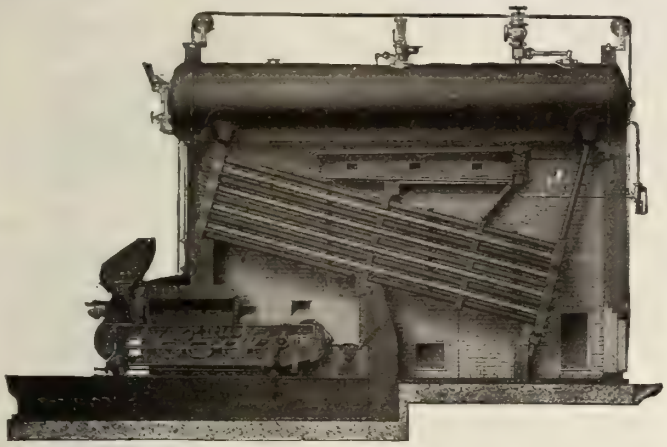
CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

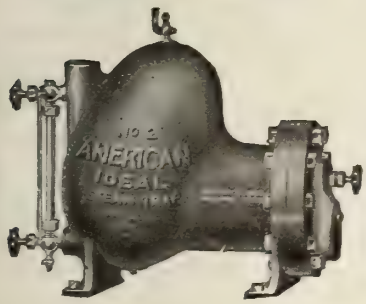
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

Complete Steam Trap Service



means:

Removal of all excess condensation without loss of steam, No maintenance expense.

This service is given by the AMERICAN IDEAL STEAM TRAP.

Saving Steam is saving Coal.

Saving Coal is saving Money.

Saving Coal is more vitally necessary now than ever before.

Write for our Trap Booklet.

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

Starrett Hack Saw Chart

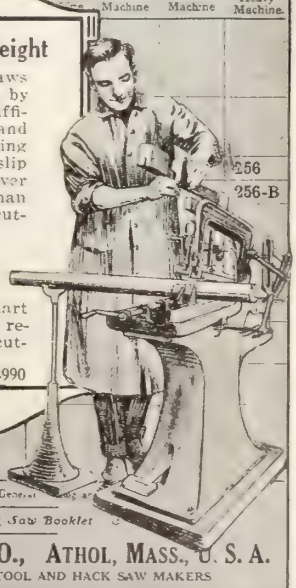
MATERIAL TO BE CUT	No. of Blade for Hand Frame	No. of Blade for Power Machine			
		Light	Medium Machine	Heavy Machine	Extra Heavy Machine
Light Angl					
Channels					
Tee Iron					
Ornamenta					
Heavy Angl					
Channels					
Tee Iron					
Light Struc					256
Heavy Stru					256-B
Steel and Iro					
Conduit an					
Brass Pipe					
Solid Stock					
Cold Rolled					
Machine St					
Tool Steel					
Cast Iron					
Brass					
Sheet Metal and Tubing					
Less than 18 gage,	253	258			
Over 18 gage	102	252			

Put On the Weight

More hack saws are ruined by using insufficient weight and pressure, letting the saw slip and slide over the work, than by actual cutting.

Get a copy of the Starrett Hack Saw Chart "CD" and reduce your cutting costs.

42-990



Numbers above are those given in the Starrett General Catalog and Machinists' Handbook

Get the Starrett Hack Saw Booklet

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton. Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co. Windsor Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto. Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons. Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk, Con.

The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXFORT, MUNORGIZE, LONDON."

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

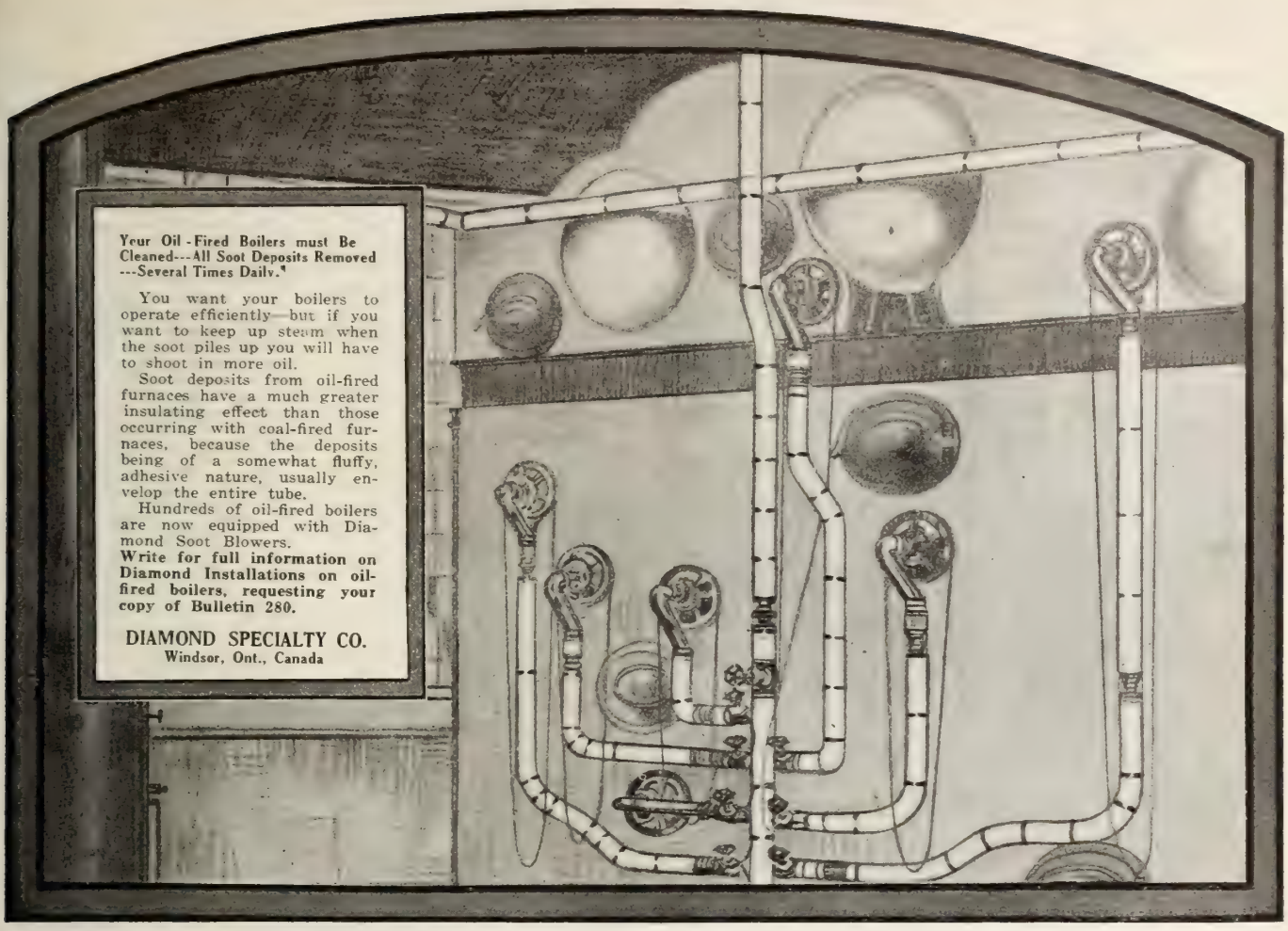
LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.



Your Oil-Fired Boilers must Be Cleaned---All Soot Deposits Removed ---Several Times Daily.

You want your boilers to operate efficiently—but if you want to keep up steam when the soot piles up you will have to shoot in more oil.

Soot deposits from oil-fired furnaces have a much greater insulating effect than those occurring with coal-fired furnaces, because the deposits being of a somewhat fluffy, adhesive nature, usually envelop the entire tube.

Hundreds of oil-fired boilers are now equipped with Diamond Soot Blowers.

Write for full information on Diamond Installations on oil-fired boilers, requesting your copy of Bulletin 280.

DIAMOND SPECIALTY CO.
Windsor, Ont., Canada

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application Also test thermometers, glass thermometers, etc.

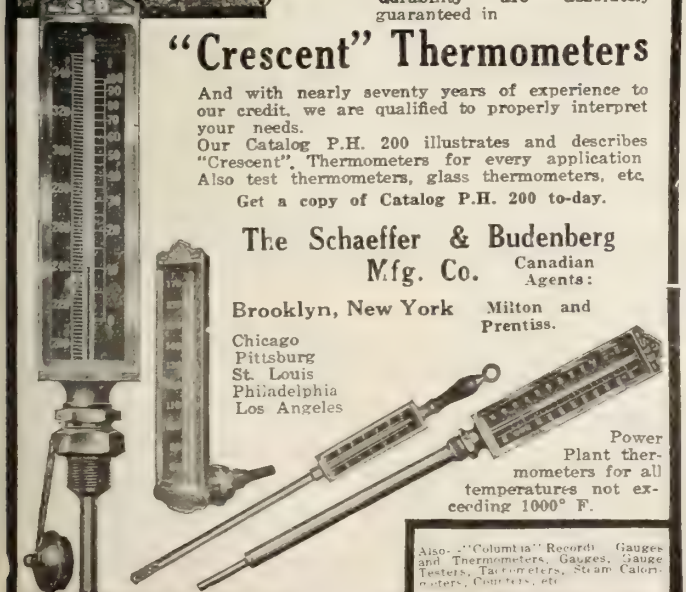
Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss.



Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

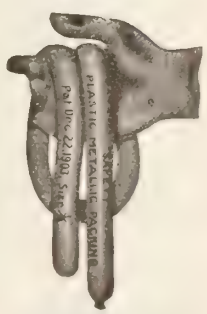
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Philip & Sons,, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

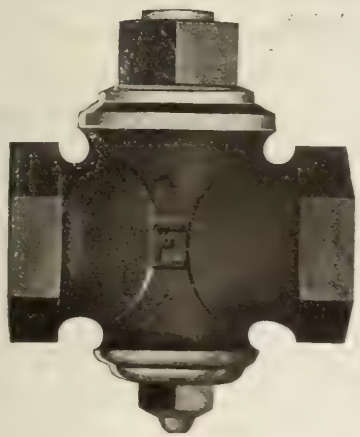
PUMP LEATHERS
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

"Empire" Guaranteed Stop Cocks Stand the Pressure

It is essential that stop cocks withstand the pressure exerted upon them in the system in which they are installed. Failure to appreciate the importance of these vital links in steam systems has resulted in both loss of time and property.



A-810

Obviate this by recommending and using time-tried and satisfactory, **Empire Steam Stop Cocks.** They are rigidly factory tested and fully guaranteed. Their use is your protection and assurance of permanency.

"If its an **Empire** product you know its right."

When buying specify our lines. They are carried in stock by the larger and more progressive jobbers in Canada.

Empire Manufacturing Company

Limited

London and Toronto, Canada

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
[illegible] Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL [illegible]
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 94 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

P&H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs. the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

For all High Pressure service, and where it is objectionable to reduce the thickness of the wall of the pipe by threading, we recommend P&H Lap Joint.

Made in Canada by

PAGE-HERSEY IRON, TUBE & LEAD CO LIMITED

Head Office: **100 CHURCH STREET, TORONTO, ONT.**

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, AIR

Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

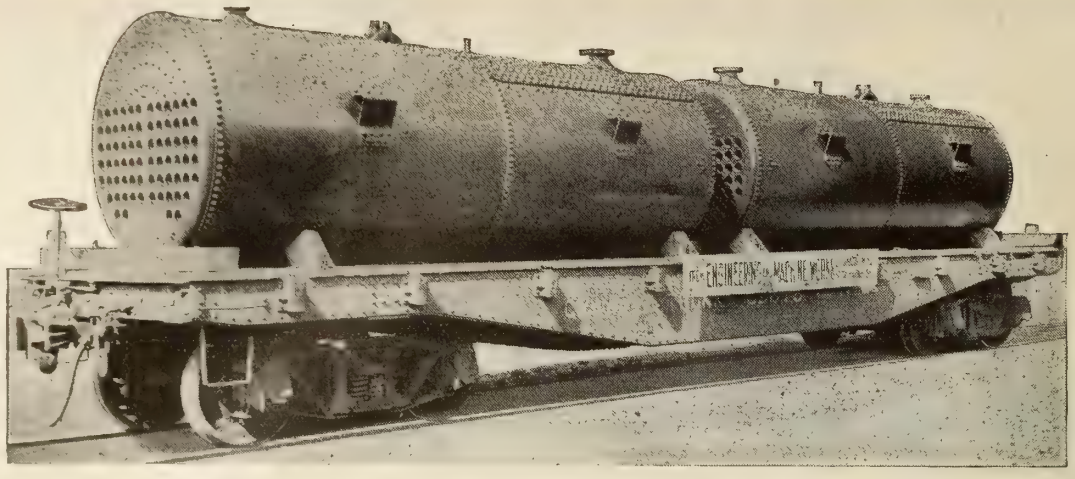
Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.



Good Service to Orders---Now!

It happens that our materials supply and our facilities stand at high water mark just now. If you will need Boilers (any type), tanks, plate work of any kind in the next few months, now is the time to tell us.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

INDEX TO ADVERTISERS

A

All-Way Oiler Co. 76
Anderson Co., V. D. 57
American District Steam Co... 54
American Steam Gauge & Valve Mfg. Co. 79
American Steam Pump 53
Armstrong Cork & Insulation Co. 12

B

Babbitt Steam Specialty Co.... 58
Babcock & Wilcox 79
Badger & Sons, E. B..... 58
Betson Plastic Fire Brick Co... 47
Boving Hydraulic Eng. Co..... 74
Bowser & Co., S. F. 14
Busch-Sulzer Bros.—Diesel Engine Co. 76

C

Can. Consolidated Rubber Co... 63
Can. Fairbanks-Morse Co. 69, 70
Can. Farnsworth Co., The..... 45
Can. Johns-Manville Co. 5
Can. Mead-Morrison, Ltd. 65
Can. Steam Boiler Equipment.. 61
Carling Turbine Blower Co.... 75
Chaplin-Fulton Mfg. Co.....74
Coppus Engr. & Equip. Co.... 15
Cole Ltd., Geo. W. 57

D

Darling Bros. 75
Dart Union Co. 65
D'Este Co., Julian 6
Department of Labor 75
Diamond Specialty Co. 83
Direct Separator Co. 70
Dominion Coal Co. 74
Dunham & Co., C. A..... 50
Durabla Mfg. Co. 70

E

Economy Fuse Co. of Can., Ltd. 58
Electric Welding Co..... 76
Empire Mfg. Co. 85
Engr. & Mach. Works of Can. 88
Escher, Wyss & Co. 61

F

Frick Co. 12

G

Garlock Packing Co. 64
Goodyear Tire & Rubber Co...2, 67
Goldie & McCulloch Co..... 16
Greene, Tweed & Co..... 71
Green's Economizer, Ltd. 52
Gutta Percha & Rubber Co.... 68
Garth Co., The 75

H

Hays Corporation, Jos. W..... 55
Holden Co., Ltd., The..... 3
Holmes Metallic Packing Co... 74
Homestead Valve Mfg. Co..... 46

I

Inglis Co., John...Inside back cover

J

Jamison Cold Storage Door Co. 11
Jeffrey Mfg. Co. 48
Jefferson Union Co. 60
Jenkins Bros. 73
Jointless Fire Brick Co. 76

K

Kellogg & Co., E. H. 47
Kerr Engine Co. 62

L

La Clede Christy Clay Products Co. 8, 9
Laurie & Lamb 74, 77
Leitch, The Arthur S. 59
Leonard & Sons, Ltd., E.....6, 53
Linde Can. Refrig. Co. 10
Lincoln Electric Co. 66
Long, J. T. 47
Lunkenheimer Co. 49

M

MacGovern & Co. 50
Magnolia Metal Co. 4
Manny Co., E. S. 74, 76
Mason Regulator & Eng. Co... 13
Ministry of Munitions 81
Morrison Brass Mfg. Co., Jas. Outside back cover
Mueller Mfg. Co., H. 56
Murphy Iron Works 7

N

Norwalk Iron Works Co..... 62
Northern Electric Co. ..... Inside front cover

P

Page-Hersey Iron and Lead Co., Ltd. 87
Penberthy Injector Co...Front cover
Philip & Sons, E. J. 6
Pilley Packing & Flue Brush Mfg. Co. 75
Pratt & Cady Co., Inc. 72

R

Robb Engineering Co. 54

S

Sexton Boiler Setting Co. 4
Sanford Riley Stoker Co..... 7
Scaife & Sons Co., Wm. B. ... 88
Schaeffer & Budenberg Mfg. Co. 83
Starrett Co., The L. S. 79
Steel Mill Packing Co..... 83

T

Technical Books 52
Trimont Instrument Co. 7

U

Uehling Instrument Co. 7

V

Victoria Foundry Co. 75
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd..... 70

W

Wall, W. J. 75
Waterous Engine Works Co.... 1
Watson & McDaniel Co. 75
Williams & Co., J. H. 72
Wilson Mfg. Co., J. C. 74
Worthing Pump & Machine Co. 51

Y

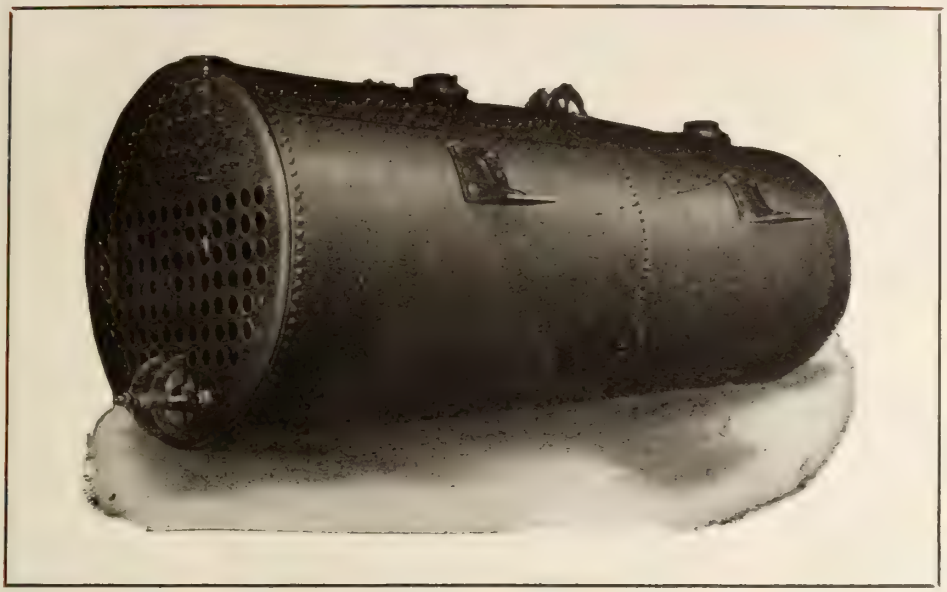
Yarnall-Waring Co. 66
York Mfg. Co. 11

WATER

WE-FU-GO AND SCAIFE

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



INGLIS BOILERS

TANKS AND ENGINES

Inglis Boilers, Tanks and Engines have been accepted as the Standard in Workmanship and service in Canada for over a half-a-century. Always reliable!

Write us for prices and specifications

The John Inglis Company
LIMITED

ENGINEERS AND BOILER MAKERS

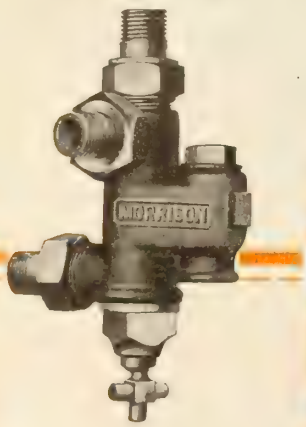
14 Strachan Avenue — **Toronto, Canada**

Representatives in Eastern Canada:
JAMES W. PYKE & CO., LIMITED
232 St. James St., Montreal

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

MORRISON

STEAM GOODS



Morrison Improved Injector

"Beaver" Globe Valve
Bronze

J. M. T. Reducing Valve

Good Specialties are Cheaper

Steam specialties bought from a viewpoint of price alone are rarely cheap. **True economy means the greatest service for your money.** In other words: the purchasing of J. M. T. Steam Goods.

Some of Our Lines

STOP VALVES,	INJECTORS,	VACUUM GAUGES.
CHECK VALVES,	EJECTORS,	AMMONIA GAUGES,
GATE VALVES,	INSPIRATORS,	GAUGE BOARD OUTFITS,
SAFETY VALVES,	JET PUMPS,	LUBRICATORS,
RELIEF VALVES,	STEAM GAUGES,	PIPE FITTINGS,
REDUCING VALVES,	PIPE,	STEAM WHISTLES,
STEAM TRAPS.	TOOLS, ETC.,	ENGINE INDICATORS.

A full description of these and other Morrison lines will be found in the Morrison catalogue. Write for a copy.

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

The James Morrison Brass Mfg. Co. LIMITED

93-97 ADELAIDE STREET WEST

Toronto, Ontario

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 12. Publication Office, Toronto—June 21, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

56 Years Service Record

The Diamond Trade Mark—

A GUARANTEE OF PROTECTION

As a tangible proof of Jenkins Valve superiority there goes with each Diamond Trade Marked Valve the following definite guarantee of service:

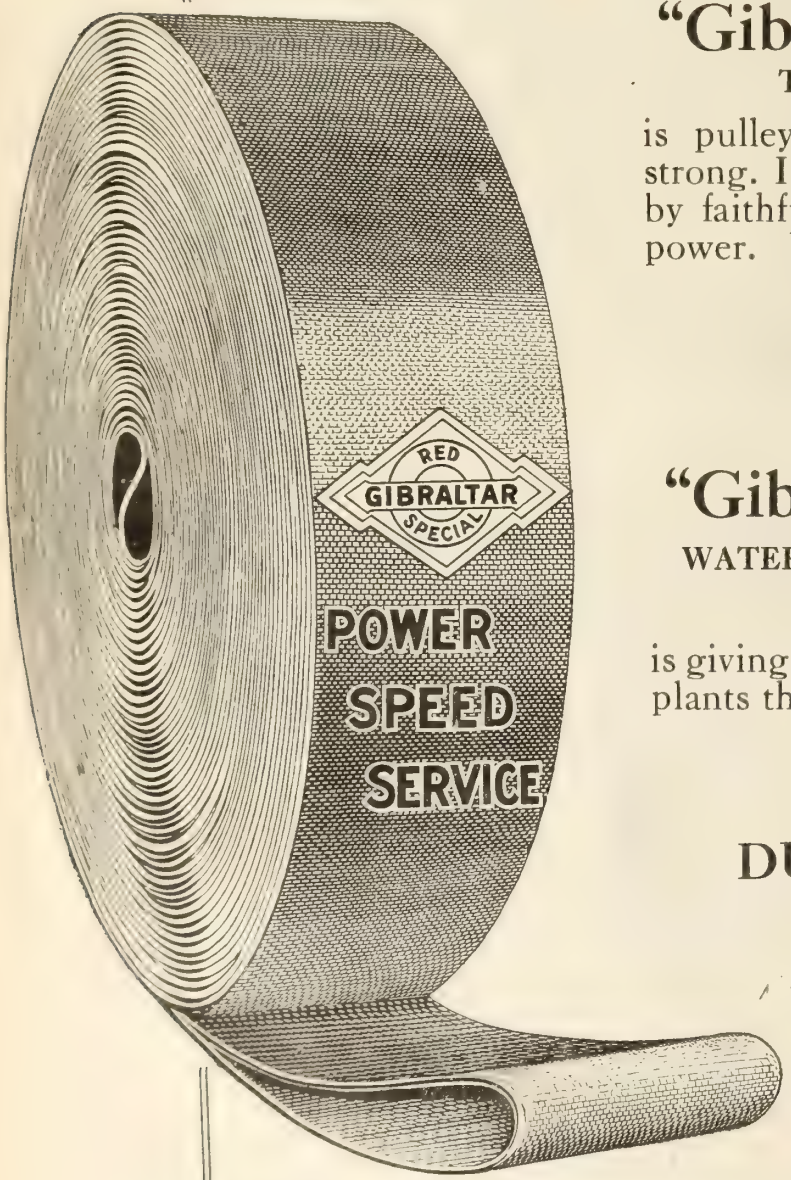
> "If you will put a Jenkins Valve on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight or does not hold steam, oils, water, acids, or other liquids longer than any other valve **you may return it and your money will be refunded.**"

Time and labor can be saved and shut-down charges for repairs and replacements eliminated by installing Jenkins Valves at the beginning. Look for the Diamond Trade Mark. It is an assurance of the best—of dependable and economical valve service under every condition of usage.

Stocks at all Dealers. Catalogue No. 8 free on request.

Jenkins Bros.
LIMITED
Head Office and Works: 103 St Remi St. Montreal, Can
EUROPEAN BRANCH 6 GREAT QUEEN ST KINGSWAY LONDON WC 2 ENG.
Agencies in all the Principal Countries of the World

SEAL OF QUALITY
DUNLOP
RUBBER PRODUCTS



DUNLOP
"Gibraltar Redspecial"
TRANSMISSION BELTING

is pulley-gripping, non-slipping, pliable, strong. It cuts down the cost of production by faithfully transmitting every vestige of power. Wears long, serves well.

DUNLOP
"Gibraltar Redspecial"
WATER HOSE AIR DRILL HOSE
STEAM HOSE

is giving highest satisfaction in hundreds of plants the country over.

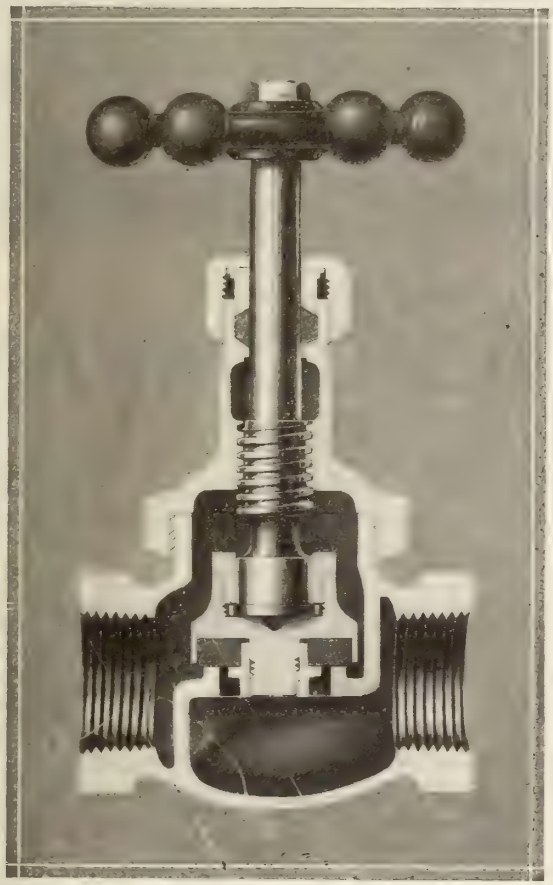
DUNLOP PACKING
for all purposes and
Every Condition of Service.

Dunlop Tire & Rubber Goods Co., Limited
Head Office & Factories : Toronto
Branches in the Leading Cities

POWER HOUSE, June 21, 1920. Vol. XIII., No. 12. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada $2.00, United States $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

TRADE PENBERTHY MARK.

BE SURE THIS NAME is on the Valve you buy



SECTIONAL VIEW OF PENBERTHY COMPODISK VALVE
Registered and Approved for 175-lbs. Steam Pressure

Then you get "The valve with the outside bonnet construction."

The first progressive improvement made in brass valve construction in generations.

Think of the advantages ! Valve always accessible.

No straining or stripping of threads when assembling or taking apart.

Impossible to spread or enlarge body of valve when screwing down bonnet to place.

No corrosion of threads, for they are on the outside, away from the action of steam and water.

Are You Responsible

For the Efficiency of Your Power Plant ?

THEN SPECIFY "PENBERTHY VALVES
THE BEST BY EVERY TEST

STOCKED BY LEADING JOBBERS AND MILL SUPPLY HOUSES IN CANADA

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

HOYT-- *for Efficient Babbitt Metals*

FOR 45 years we have devoted our endeavors exclusively to the perfection of white metal alloys. Experts have considered and tested carefully the chemical, physical and mechanical properties of each element entering into our mixtures.

Every effort has been made to place Hoyt's Babbitt Metals first on the market—every effort is made to keep them so.

HOYT'S FROST KING

For a first-class, all-round babbitt, which has been in use in many of the largest machinery plants in Canada for years—use Hoyt's Frost King.

HOYT'S DYNAMO GENUINE

As the name implies, this metal is compounded especially for dynamo and motor work. It is the only alloy that will give the best service on street car motors or any motor that runs under severe duty. It is an extremely high Copper alloy, and is as near an actual Bronze as a Babbitt can be made with success.

Largest makers of white metals in the world.

HOYT METAL COMPANY

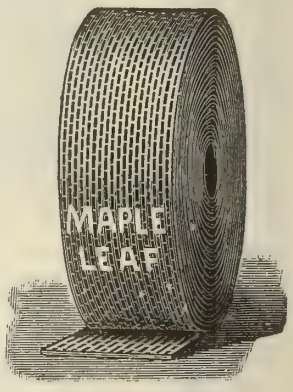
MONTREAL TORONTO WINNIPEG

Dominion Belting Company, Limited Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

Capacity Production

EVERY manufacturer wants capacity production; he wants every ounce of power and work from his machinery. Volume of production is largely a matter of steady, uninterrupted work, which means that the machinery must be maintained at maximum efficiency.

To give this continuous, efficient service, machinery must be properly lubricated. Correct lubrication is inseparable from the economical operation of machines and power equipment; it is a big factor in profitable manufacturing and *you cannot afford to use any but the best lubricants in expensive machinery.*

Imperial Lubricants are well known for their high, uniform quality. They are graded for every type of machine and every moving part. They have been tested and proved under actual service conditions to be of superior fitness for the work for which each is designed.

If you have lubrication problems or difficulties, write to our Imperial Lubrication Engineers. They will gladly study your problems and submit recommendations free of charge or obligation.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

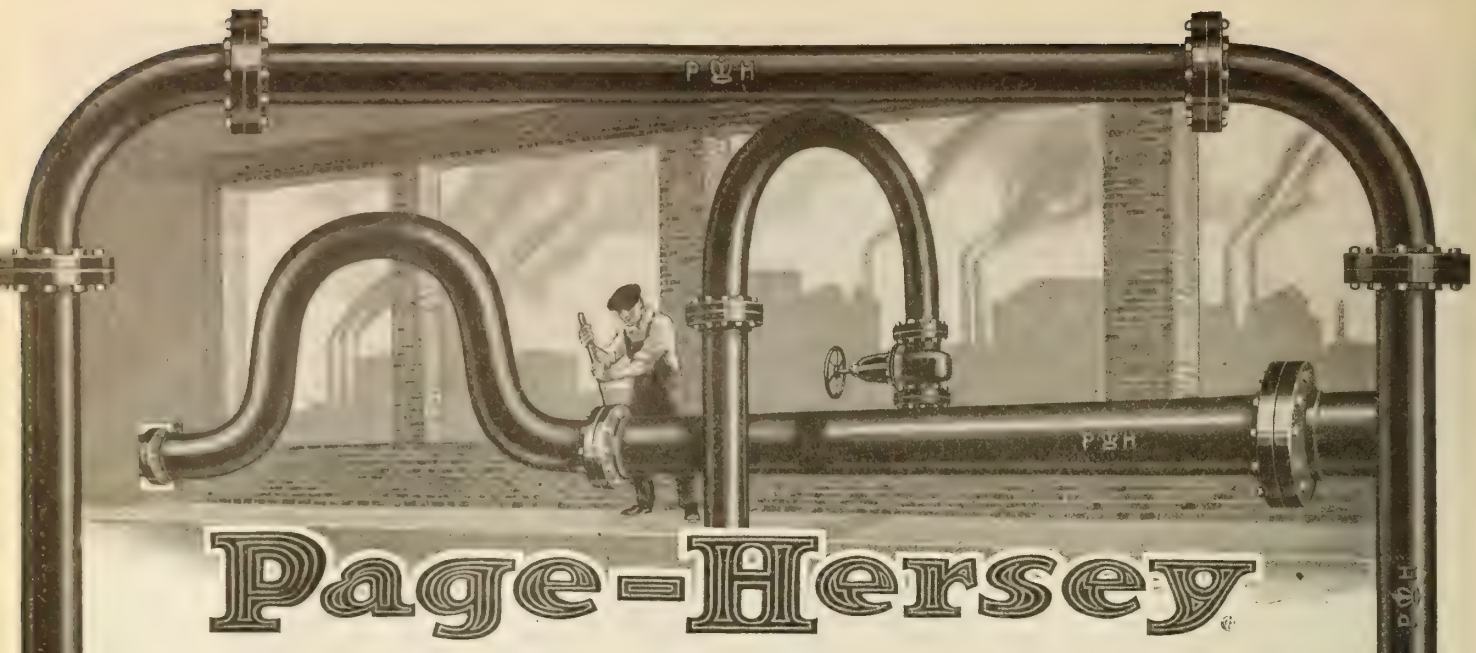
Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine O I
Imperial Ario Compressor Oil

Write to 56 Church Street, Toronto, or to any of our branches for an appointment or for information or advice on your lubrication problems.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES



Page-Hersey

Wrought Pipe Bends

ALL KINDS AND SIZES
UP TO 10 INCH PIPE

Flanged Pipe Joints

ALL TYPES

We maintain a Service Department comprised of Specialists on Pipe, who are ready at all times to consult with You

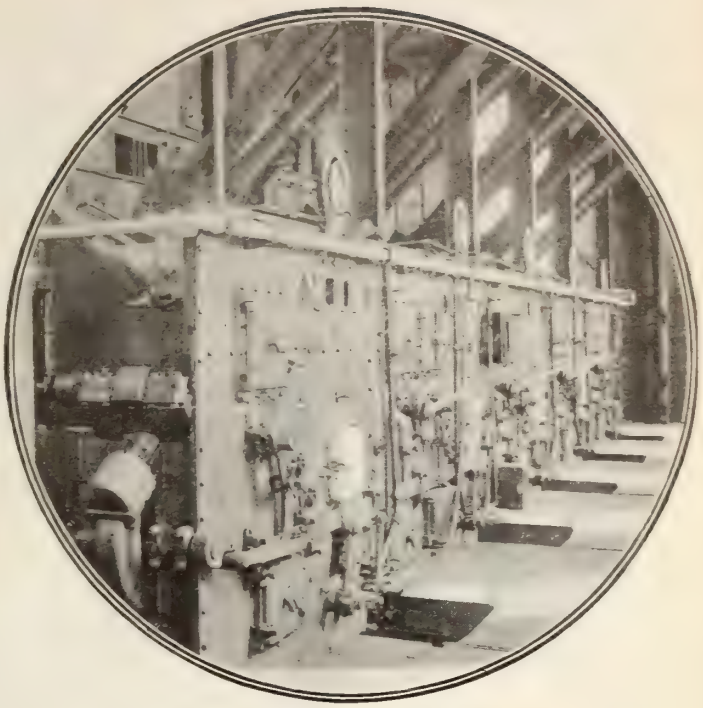
MADE IN CANADA BY

Page-Hersey Iron, Tube & Lead Co.

LIMITED

100 CHURCH ST. :: TORONTO, ONT.

Conserve Fuel and Labor

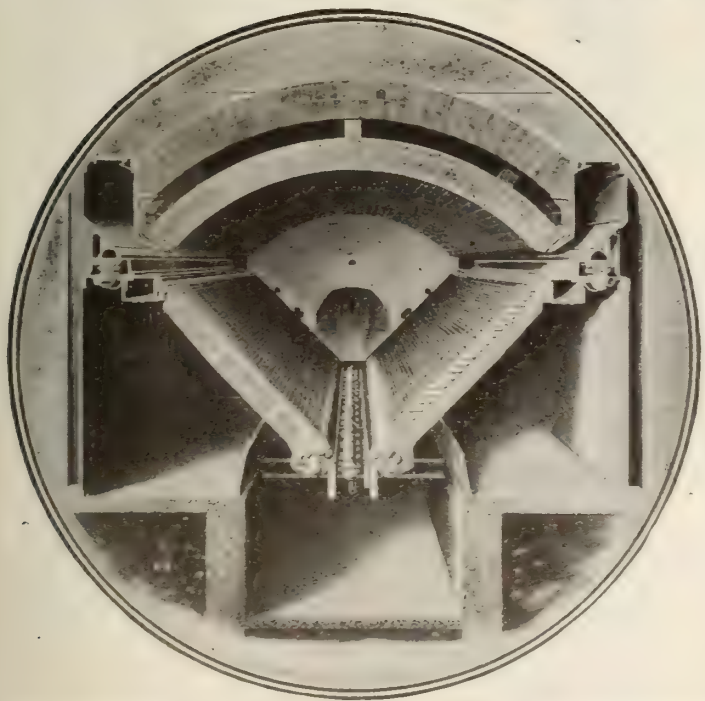


Five Murphy Furnaces as installed to fire 300 h.p. boilers

The Kalamazoo Vegetable Parchment Co. in 1916 decided to bring their power equipment up to par with the rest of their "modern mill" and installed ***Murphy Furnaces***. That they made no mistake is well recognized by the management, for in this time of great activity in the paper business, power is being furnished at the minimum of labor, fuel and expense.

Growing power demands have been promptly met because Murphy Automatic Furnaces double the normal boiler output "without one penny for draft."

MURPHY AUTOMATIC FURNACES



are highly automatic in their operation and require very little attention. The coal is fed—the fuel distributed—the fire cleaned—the ashes continuously and automatically removed.

Offset your mounting costs by installing a Murphy. It will enable you to cut the coal bill and solve the labor problem. Only a short time is required to make the savings pay for an installation.

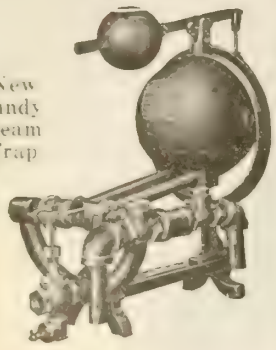
Send for Catalog HM-6. It will show you where you can save.

MURPHY IRON WORKS

Detroit, Michigan, U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

DON'T EXPERIMENT!



New Bundy Steam Trap

The splendid reputation of Mason Power Plant Devices is not the result of an accident, but the expected outcome of thirty years of persistent effort backed by large capital and superior manufacturing facilities.

They hold the first place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend upon these devices working in many critical locations and find them satisfactory.

Mason Equipment is designed by expert engineers of long and varied experience and having a full and complete knowledge of the requirements of a power plant, and they are built under the supervision of experts.

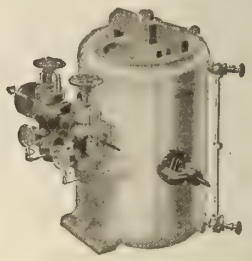
At The C.A.S.E. Convention

Our Toronto manager, Mr. S. Balmfirth, will be in charge of our exhibit.

Mr. Balmfirth is a practical engineer, having had charge of some important power plants before coming with our firm. Engineers will appreciate the fact that our Salesmen and Executives are practical engineers who sell from KNOWLEDGE of the application of our products to actual conditions, and not from catalogues.

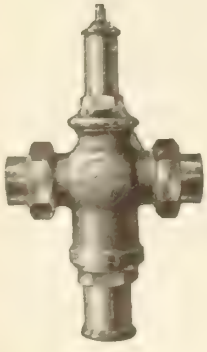
Mr. Balmfirth will be pleased to discuss any Power Plant problems with the many engineers visiting the Convention. Engineers with problems in pressure regulation, pump or engine control, Feed water heating, regulating or filtering, condensation drainage or return, are especially invited to visit our exhibit.

Reilly Feed Water Filter and Grease Extractor



SERVICE RELIABILITY

POSITIVE OPERATION



Mason Standard All-Bronze Reducing Valve

Mason No. 55 Pump Pressure Regulator

THE MASON REGULATOR & ENGINEERING COMPANY, LIMITED

MONTREAL
135-153 Dagenais Street

TORONTO
145 Wellington St. W.

COAL! THE FIRST STEP TO SAVE IT.

IN a series of tests made by eminent mechanical engineers, it was shown conclusively that 10% to 40% of the heat units of coal are lost, due to leaky boiler settings that allow an excess of air to enter the furnace or combustion chambers.

BETSON'S REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

Makes it easy for anyone to mould into place a solid, one-piece, monolithic boiler setting lining that is jointless, airtight and capable of withstanding the stress and strain because expansion and contraction have been neutralized.

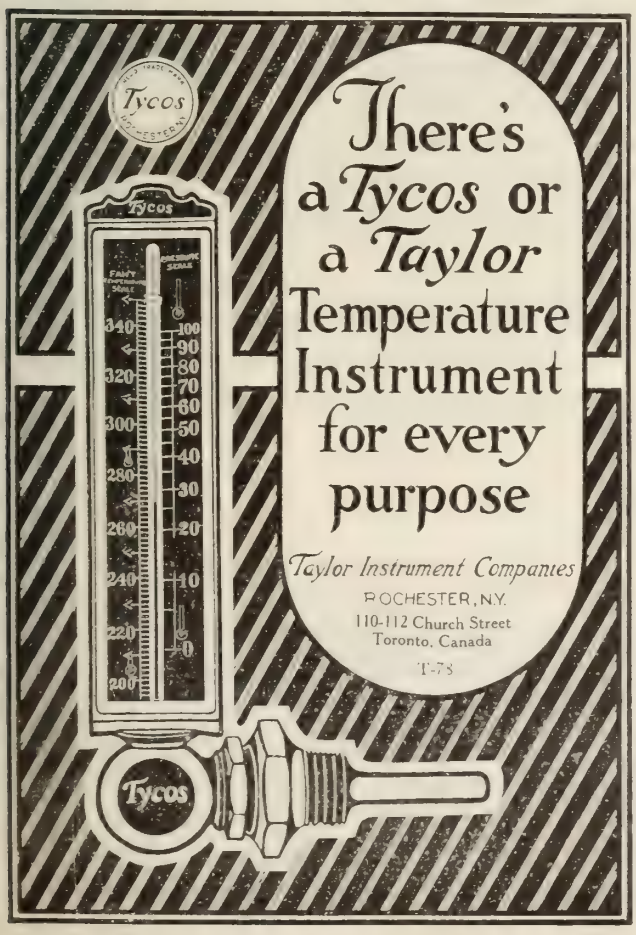
With air tight linings and gas tight baffles, you may not only save the 10% to 40% of wasted heat units, but also reduce your repair and upkeep costs.

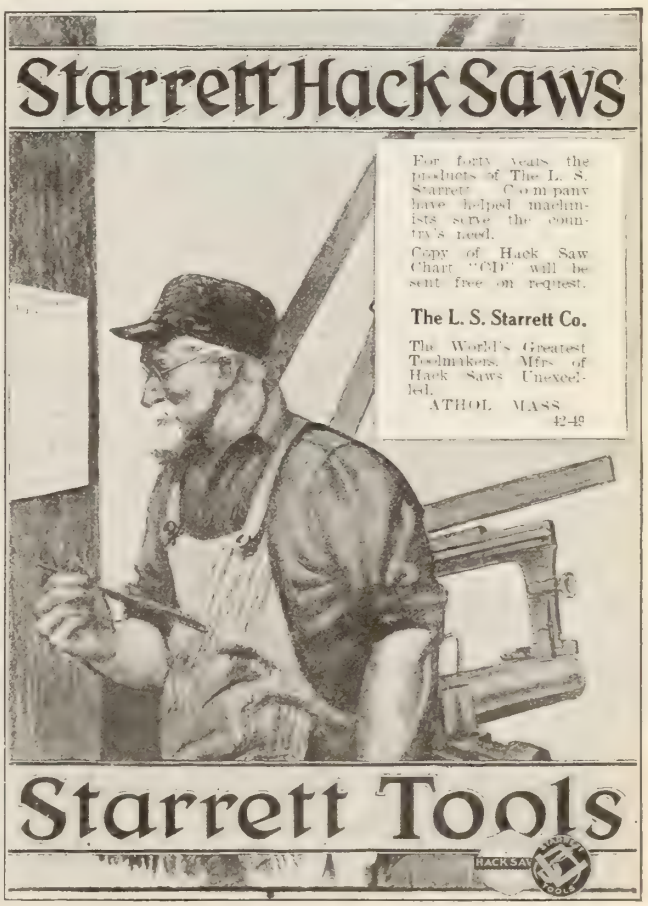
Betson's Plastic Fire Brick linings outlast other linings, not only because of high quality and experienced compounding but for the very logical reason that in the one-piece lining there are no bricks to work loose or joints to open up.

A pamphlet showing how to use Betson's Plastic Fire Brick is yours for the asking

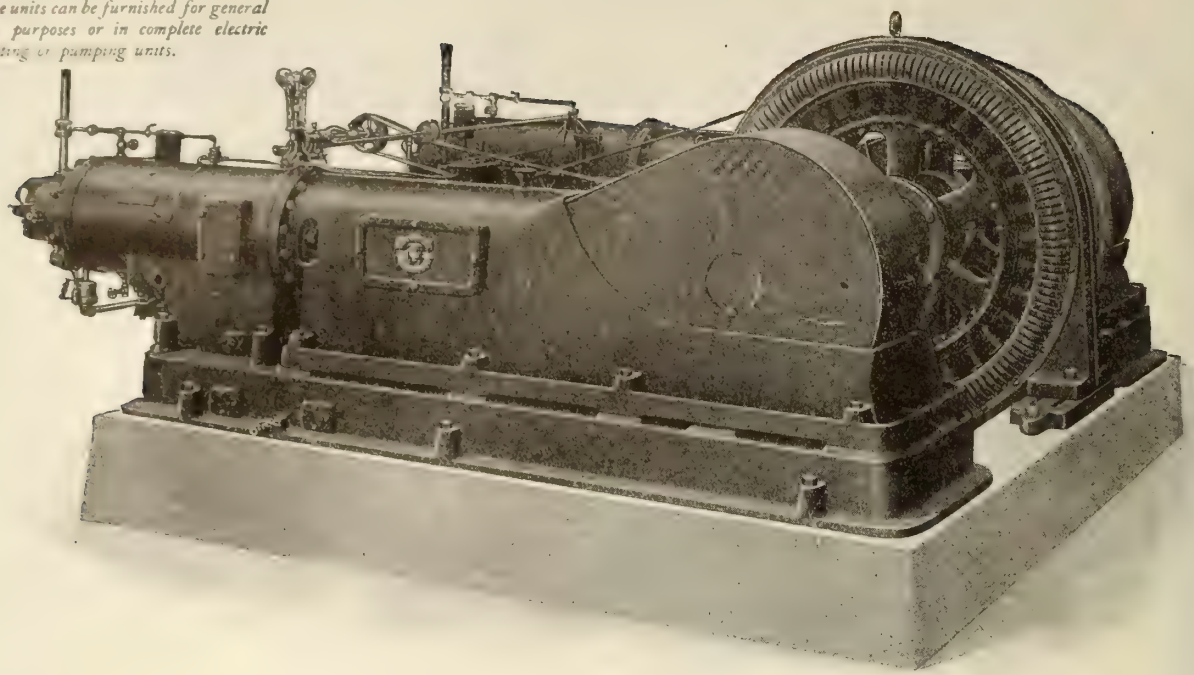
Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6, Rome, N. Y.

Canadian Distributors: INTERNATIONAL CHEMICAL CO., 44H Lombard St., Toronto, Ont., Canada
Shipment from warehouses in the principal cities




Starrett Hack Saws
For forty years the products of The L. S. Starrett Company have helped machinists serve the country's need.
Copy of Hack Saw Chart "CD" will be sent free on request.
The L. S. Starrett Co.
The World's Greatest Toolmakers. Mfrs. of Hack Saws Unexcelled.
ATHOL MASS.
42-49
Starrett Tools

Giant Oil Engines are built in capacities from 12 to 200 H.P., both single and duplex types, also for operation on gas. Engine units can be furnished for general power purposes or in complete electric generating or pumping units.



Power for the factory— Electric current for the isolated district

ISOLATED mill and factory owners are installing Giant Oil Engines larger than necessary for their plant requirements and utilizing the surplus power for operating an electric generator—thus permitting the very profitable sale of electric current for private or municipal lighting.

Under this plan a Giant Oil Engine pays for itself in a surprisingly short time—then throughout a long service life pays big dividends on the investment.

Giant Oil Engines assure low fuel costs. They burn the lower grades of low-cost fuel oil. Their automatic regulation under all loads prevents power waste and eliminates the human factor in obtaining highest operating efficiency.

Giant Oil Engines are dependable. They are ruggedly constructed—free from all valves, magnetos, carburetors and other trouble causing devices.

Performance records of Giant Oil Engines operating under service conditions similar to yours are available.

Expert engineering counsel without obligation. Ask for Bulletin.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN-33-H

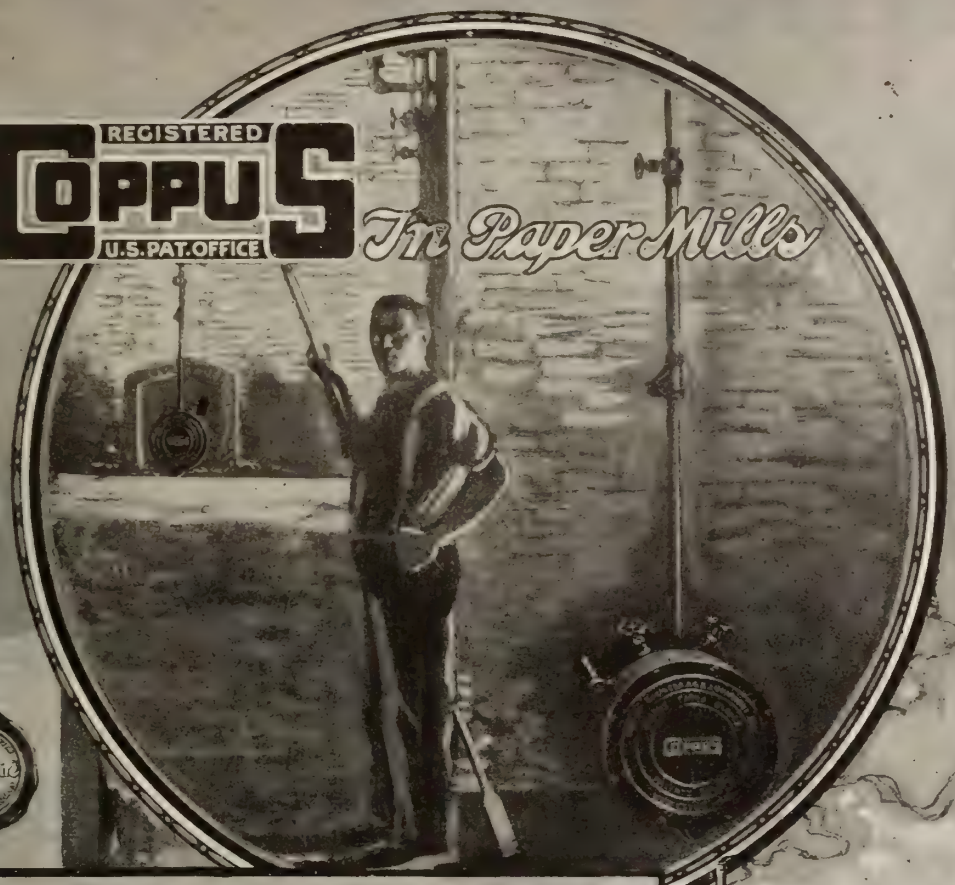
BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CANADIAN CP PNEUMATIC

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*

REGISTERED
COPPUS
U.S.PAT.OFFICE
In Paper Mills



Old Hampshire Bond

STEADY steam pressure is a vital factor in making good paper. A sudden drop at the gauge might mean serious loss in the mill. Keeping up steam is a matter of prime importance.

That is why modern paper mills are equipping their power plants with COPPUS Turbo Blowers to maintain constant steam pressure under varying conditions of load, fuel, and weather.

For instance, the COPPUS Blowers shown above operating in the plant of the Hampshire Paper Company, makers of good paper, at South Hadley Falls, Mass., have kept steady steam pressure with very satisfactory results. Peak loads are quickly met, steam pressure is always constant, and cheap fuel is economically burned.

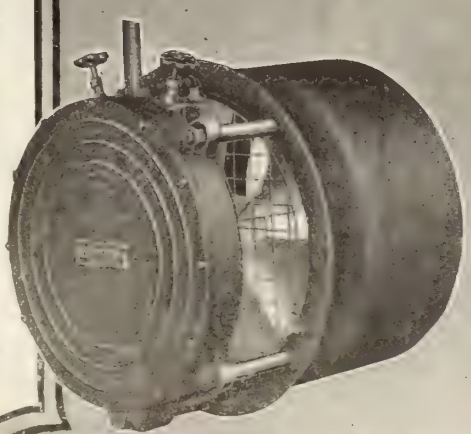
COPPUS Turbo Blowers are helping out engineers and speeding up boilers in power plants the country over. Their good work is not confined to the paper industry—it extends wherever power is used and coal is burned. If they are not already working for you it is likely that they could save time, money and labor in YOUR boiler room.

Write for Blower Catalog.

"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine
341 Park Ave., Worcester, Mass..

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta



COPPUS TURBO BLOWER

Mechanical Refrigeration

Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to **your** business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

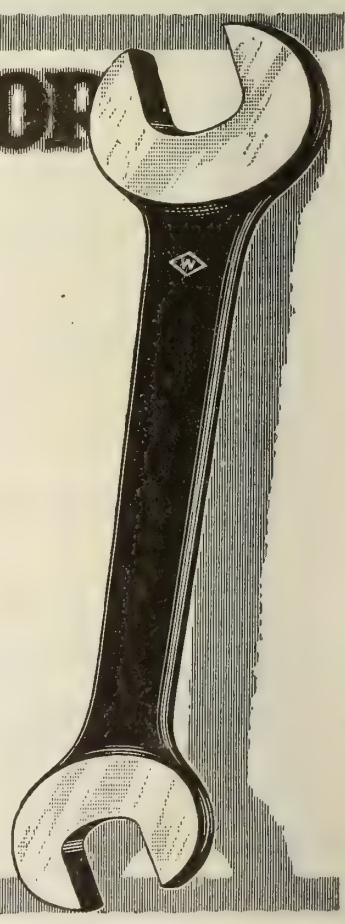
YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES



Better tools make better workmen—

And you can't buy a better wrench than a Williams'

J. H. WILLIAMS & CO.

"The Wrench People"

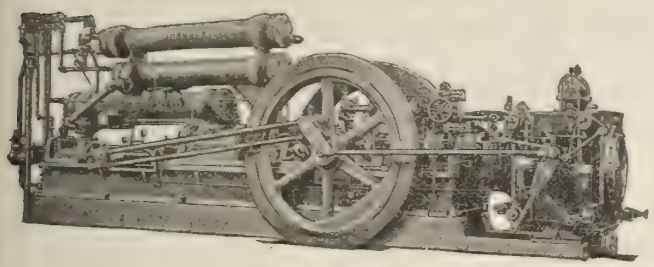
78 So. Clinton St. Chicago | 78 Vulcan St. Buffalo, N.Y. | 78 Richards St. Brooklyn N.Y.

NORWALK
AIR & GAS · COMPRESSORS

Select Your Compressor With Care

Few pieces of mechanism in any plant are called upon to show the degree of reliability which is essential to satisfactory results with an air or gas compressor. Under the circumstances you cannot be too careful in the selection of a compressor.

Norfolk Compressors are giving a distinctive and unfailing kind of satisfaction to users. This can be traced to two Norwalk policies—high quality construction and a thorough study of the precise operating conditions to be met in each installation.



A Norwalk Four-Stage Air Compressor Driven by Compound Corliss Steam Cylinders.

Write for Norwalk Bulletins

on compressors for air, oxygen, hydrogen, carbonic acid gas or acetylene gas. We'll send one or all promptly on request.

THE NORWALK IRON WORKS COMPANY

Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

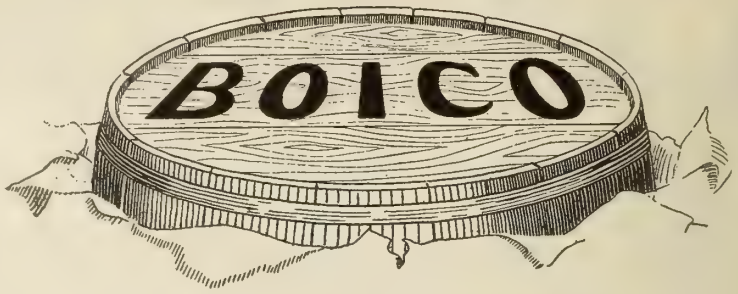
DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.



Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

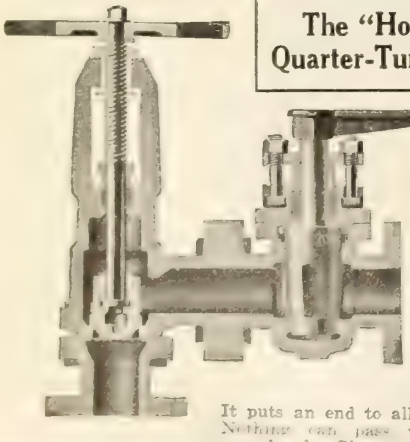
Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.

Reliable Combination

The "Hovalco" Renewable Blow-off Valve

Ends Blow-off Troubles

The "Homestead" Quarter-Turn Valve.



An absolutely reliable combination consisting of the "Hovalco" Blow-off Valve and the "Homestead" Quarter-Turn Valve.

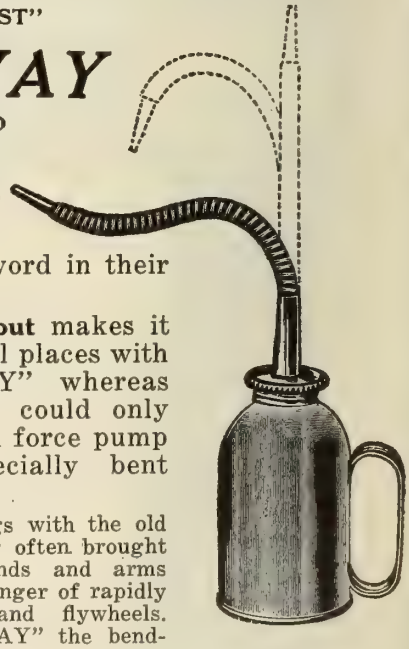
It puts an end to all blow-off troubles. Nothing can pass when both valves are closed. Gives a clear, straightway passage when open—no tendency to clog from scale. Write for full description.

Homestead Valve Mfg. Company

Pittsburgh, Pa. Works: Homestead, Pa.

"SAFETY FIRST"

ALL-WAY RAILROAD OILERS



are the latest word in their line.

The **flexible spout** makes it possible to oil all places with one "ALL-WAY" whereas previously they could only be reached with force pump cans with specially bent spouts.

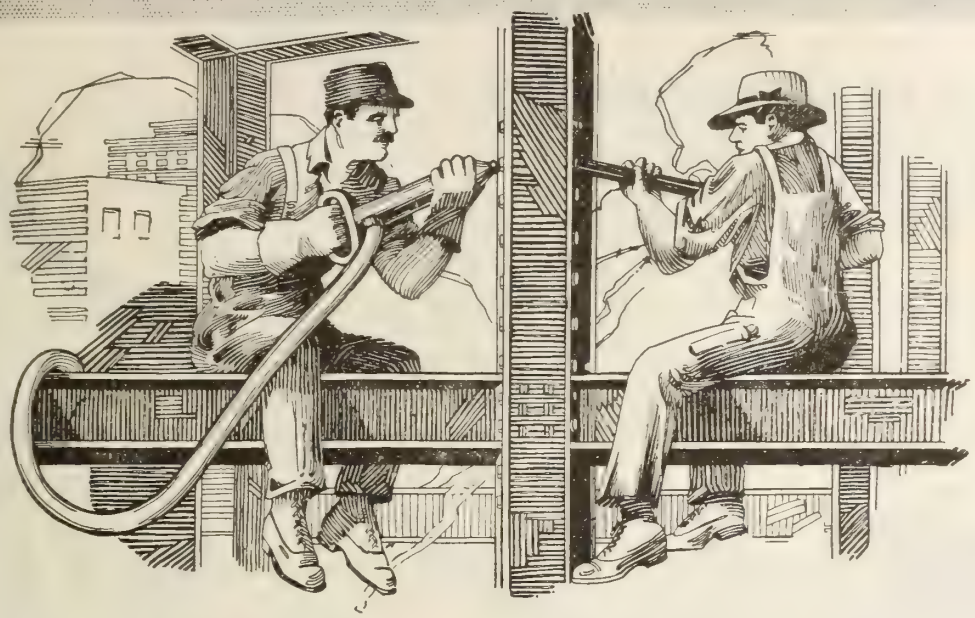
Lubricating bearings with the old straight spout oiler often brought the engineer's hands and arms very close to the danger of rapidly revolving gears and flywheels. With the "ALL-WAY" the bending of the spout removes this danger. Sizes No. 4, 1 pint—10 in. spout. No. 5, 1 quart—11 in. spout.

If your dealer cannot supply you write us.

We also manufacture the well-known "All-Way" Oil Can—saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY

196 KING STREET WEST - TORONTO, ONTARIO



The Policy Behind the Goodyear Cord Tire Built This *Better* Hose

MORE motorists would not be riding on Goodyear Tires than on any other brand, if Goodyear scientists had been satisfied with orthodox methods of tire building.

Neither would Goodyear Industrial Hose possess the qualities that enable it to give longer, more satisfactory service, if old-fashioned methods had been followed in its construction.

Modern industry's methods were studied exhaustively to ascertain the conditions industrial hose must meet in use. Then new formulae were created, new and more exacting standards set—resulting in a better hose, capable of standing up under the severest service.

The long service given by Goodyear Air Drill and Goodyear Pneumatic Tool Hose in mines, quarries, shipbuilding yards and structural work—where it is dragged over rocks and steel girders, beaten by ore and building materials—is evidence of the thoroughness of construction of all Goodyear Industrial Hose.

The cover on any air drill or pneumatic tool hose is prominently responsible for the life of the hose. The extra-heavy cover of tough, white rubber on Goodyear Air Drill and Goodyear Pneumatic Tool Hose resists wear and greatly prolongs the life of the hose.

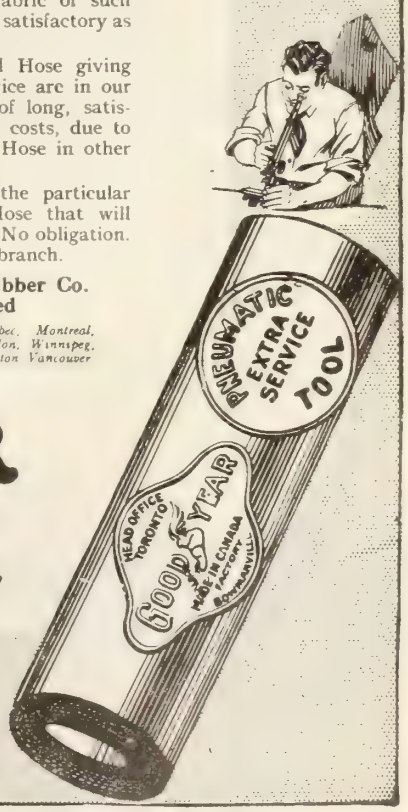
Inside this hard-wearing cover is a special, oil-resisting inner tube, and a fabric of such strength that five-ply is found as satisfactory as six or seven-ply of old-style hose.

Records of Goodyear Air Drill Hose giving from 18 months to 2 years' service are in our files. We have similar records of long, satisfactory service and lessened hose costs, due to the use of Goodyear Industrial Hose in other classes of work.

Let a Goodyear man specify the particular kind of Goodyear Industrial Hose that will lessen hose costs in your plant. No obligation. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

BRANCHES—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in other cities.



GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE

This Might Have Been Your Plant

The Story in a Nut-shell—

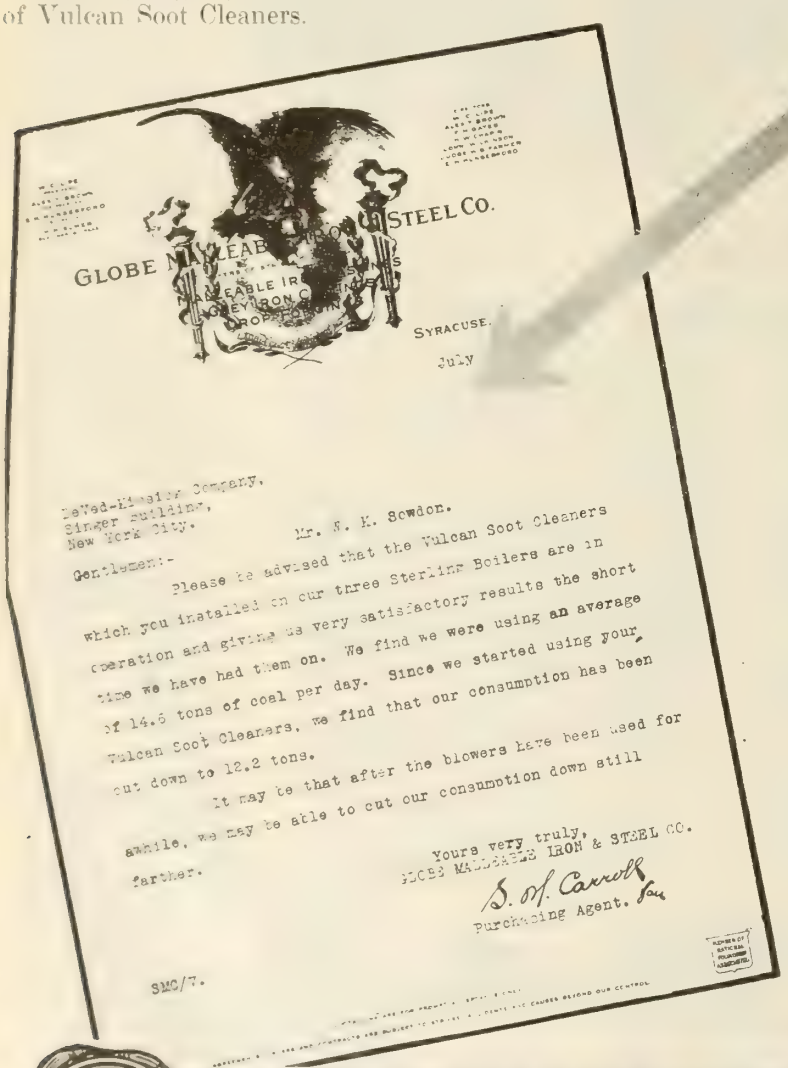
JUNE 11th: Received order to equip 2—250-hp. Class E22 Stirling Boilers and 1—125-hp. Class E11 Stirling with Vulcan Soot Cleaners. Steam pressure 110 lb., soft coal burned, hand fired.

JUNE 25th: Three Vulcan Soot Cleaners shipped from DuBois to Syracuse by express.

JUNE 30th: Vulcan Soot Cleaners arrived in Syracuse.

JULY 4-5-6: The three Vulcan Soot Cleaners COMPLETELY installed in three days.

JULY 29th: Received letter reproduced below from Mr. S. M. Carroll, Purchasing Agent, claiming fuel saving due to the installation and use of Vulcan Soot Cleaners.



GLOBE MALLEABLE IRON & STEEL CO.

SYRACUSE.

July

DeWed-Kingsley Company,
Singer Building,
New York City.

Mr. F. K. Sowdon.

Gentlemen:-

Please be advised that the Vulcan Soot Cleaners which you installed on our three Sterling Boilers are in operation and giving us very satisfactory results the short time we have had them on. We find we were using an average of 14.6 tons of coal per day. Since we started using your Vulcan Soot Cleaners, we find that our consumption has been cut down to 12.2 tons.

It may be that after the blowers have been used for awhile, we may be able to cut our consumption down still farther.

Yours very truly,
GLOBE MALLEABLE IRON & STEEL CO.
S. M. Carroll
Purchasing Agent.

SMC/7.

2.4 Tons of Coal per day —SAVED— by Vulcan Cleaners

Just suppose this had been YOUR plant, instead of that of the Globe Malleable Iron & Steel Company.

You know your daily fuel consumption—figure it out for yourself.

And this might well have been your plant. For time has demonstrated that the reliable VULCAN, operating on Stirling Boilers, is practically 100 per cent. THOROUGH—and it stands to reason that what it can do in one plant it ought to be able to do in another to a greater or less degree, depending upon conditions.

To be sure, we do not claim that the Vulcan Cleaner will absolutely produce as high a saving for you as it has for the Globe Malleable Iron & Steel Company. That would be an exaggerated claim—and it is the consistent VULCAN policy not to exaggerate. We emphasize this case merely to show the great possibilities of the efficient Vulcan Cleaner.

What we do claim, and we can back this up with evidence from practically every state in the union, under practically every condition of operation, is that the installation of Vulcan Cleaners on your boilers will produce a fuel saving more than enough to pay for the installation in the first year, and a worthwhile profit thereafter.

Ask for full Vulcan Data

You will be interested in the Vulcan method of removing soot from Stirling Boilers—ask for further information. Also, note that we make cleaners equally as efficient for all other types.

THE VULCAN SOOT CLEANER CO.

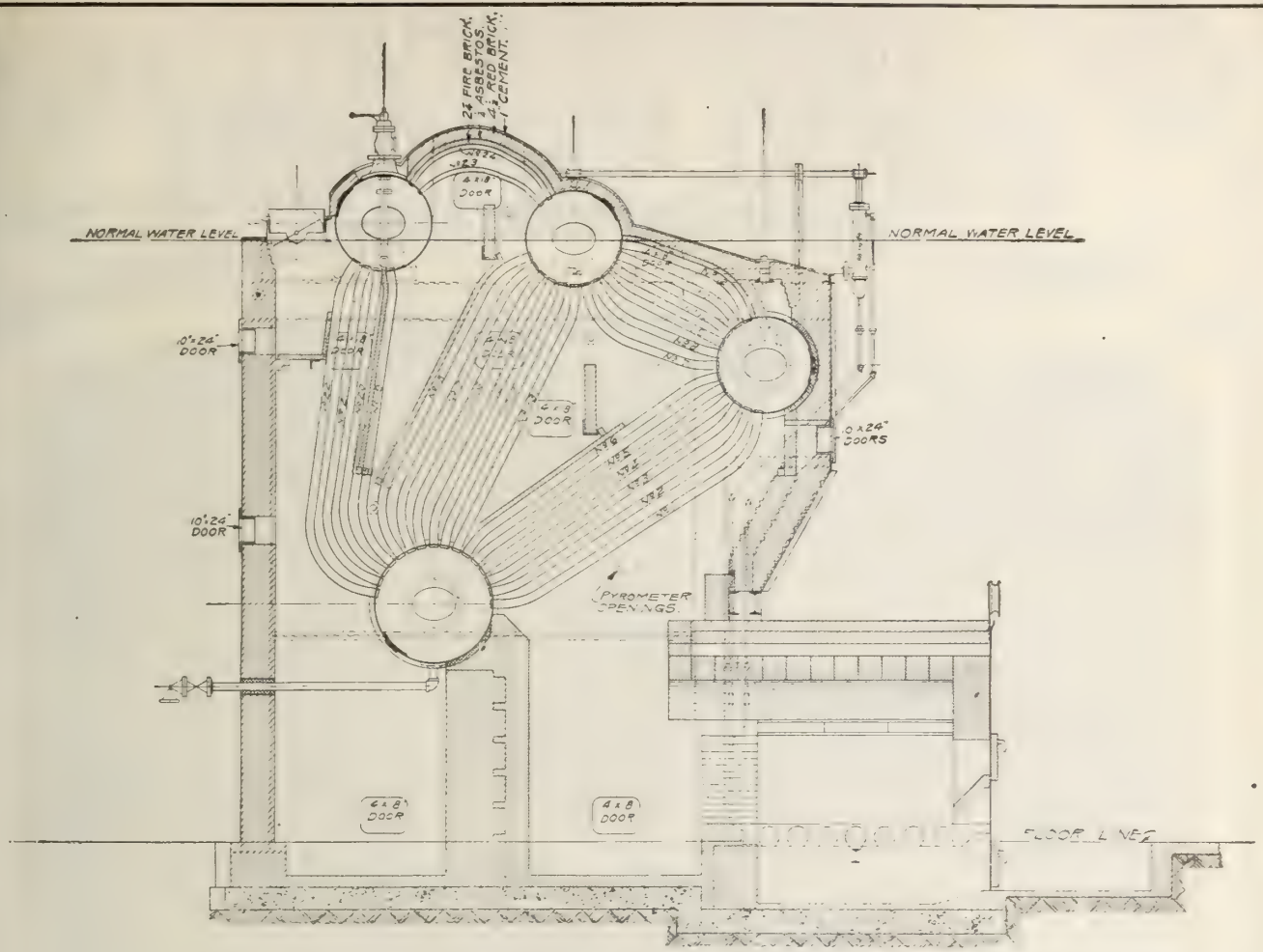
SOOT CLEANERS

FOR ALL TYPES OF BOILERS—SUPERHEATERS AND ECONOMIZERS

GREEN'S ECONOMIZER LTD.
KENT BLDG., TORONTO

P.O. Box 1439
DU BOIS, PA.

W. W. HICKS
WINNIPEG, MAN.



Above Installation made at General Motors Co. Plant, Oshawa, Ontario

Connelly (Patented U.S. & Canada) Water Tube Boilers

are of the 4 drum type, have 100% tubes area in the path of circulation and deliver steam superheated to from 5 to 10 degrees Fahrenheit.

Simple in design no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning both internally and externally.

Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation

E. LEONARD & SONS LIMITED

Head Office and Works: LONDON, Canada

Branches:

1790 St. James St., Montreal, Que. **62 Water St., St. John, N.B.**

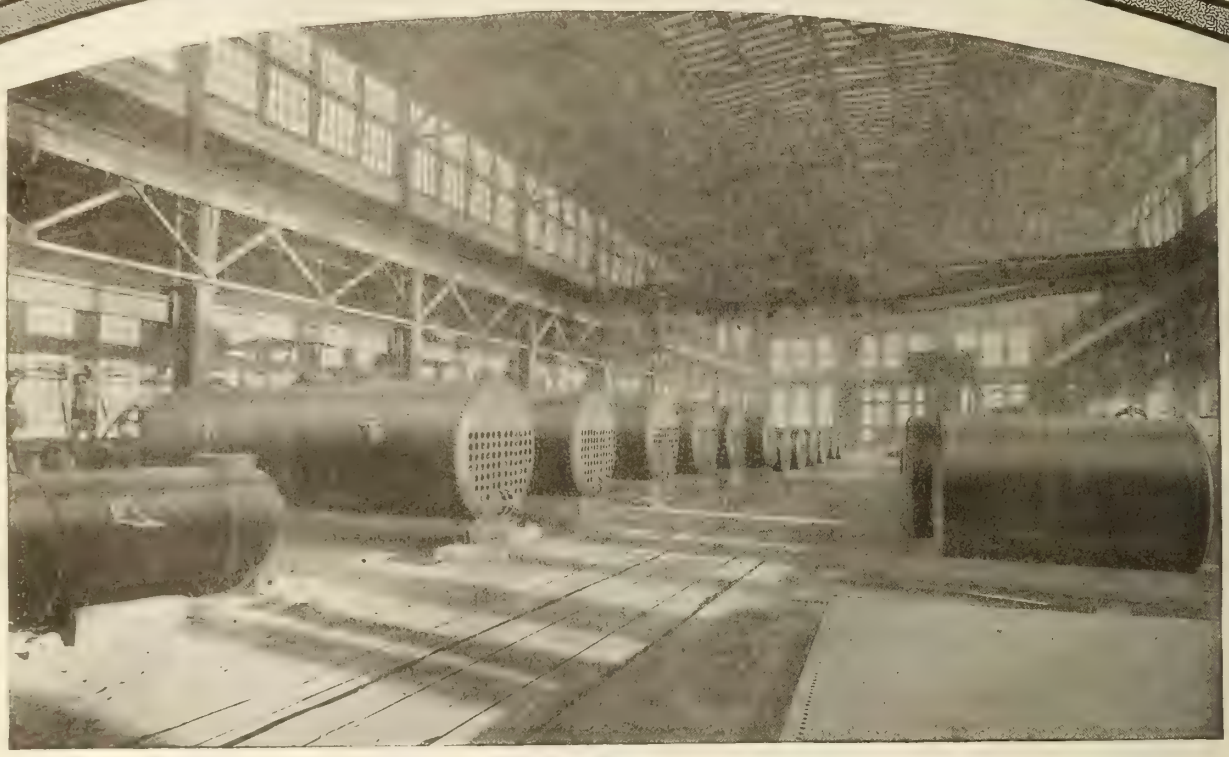
AGENTS:

E. Philips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning Street, Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave Street, St. John's, Nfld.

ESTABLISHED 1834

LEONARD

DEPENDABLE POWER EQUIPMENT



A small corner of our Boiler Shop, showing 12 Boilers under construction on one order

GOLDIE & McCULLOCH

Horizontal Return Tubular Boilers

WE ARE EQUIPPED FOR QUICK DELIVERY

An immense plant, with modern manufacturing facilities enables us to turn out G. & McC. Co. Boilers on short notice. Whether ordered for prompt delivery or not, the G. & McC. Co. quality in material and skill in workmanship is always maintained.

Tube holes are all drilled never punched. Flanging, riveting, caulking and staying is all done by the most modern methods, and the best material for the purpose is constantly used. G. & McC. Co. Boilers are designed to conform to various provincial regulations and are thoroughly dependable.

WE BUILD:—Steam Engines, Steam Turbines, Return Tubular & Water-Tube Boilers, Heaters, Tanks, Stacks, Pumps and Condensers. Catalogues sent on request.

The Goldie & McCulloch Co., Limited

Head Office & Works. GALT, Ontario, Canada

Toronto Office
Suite 1101-2 Bank of [illegible]

Quebec Agents
Ross & Greig
400 St. James St., Montreal.

Western Branch
248 McDermott Ave.
Winnipeg

British Columbia Agents
Robert Hamilton & Co.
Bank of Ottawa Bldg.,
Vancouver

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Woodstock the Scene of C.A.S.E. Convention

A Little Chat About the Town, Its Surroundings, and Industries, with a Brief Description of the Interesting Water Works System.

T. H. FENNER

WESTERN ONTARIO has again been successful in securing the convention of the Canadian Association of Stationary Engineers, and the precise location is the city of Woodstock. Here preparations are already under way to ensure that everything will go with a vim, and that the success of the convention at Brantford will be no whit greater than the one to be held by its smaller neighbor.

Woodstock, itself, is a city of industries, surrounded by some of the finest dairying and agricultural country in the whole Province of Ontario. The country round about is of the type known as rolling, and is pleasantly wooded. From a number of points just outside the city some wonderful views can be obtained, miles of green fields, woods and hills stretching away till they finally meet with the distant horizon. Seen from these vantage points, the city itself seems to have been set in the midst of a forest, the effect being produced by the number of shade trees in the streets.

The Early Settlers

Woodstock was somewhat of an aristocratic centre as far as its early settlers were concerned. These were mostly retired British naval and military officers, and their names are perpetuated to-day in the streets of the city. Vansittart Avenue, is for an example, named after Admiral Vansittart, one of the earliest settlers of the city. It is close on one hundred years ago since he came, so that Woodstock can lay some claims to having a history. Light Street, is named after an officer of the other arm of defense, in which he was a colonel. Another early settler was Admiral De Blaquier, whose grandson Lord De Blaquier, is at present living in England.

However interesting these old worthies may be from an historical point of view, there is something more up-to-date in the personality of Col. Joseph Boyle, whose home is also in Woodstock. Col. Boyle is perhaps better known as "Klondyke Boyle," and his services in the late war are such as to give every Canadian a thrill of pride. His achievements would fill a good sized volume, especially that part of them which took place in Russia.

Situated just on the outskirts of the city is the Woodstock College for boys, which is affiliated to McMaster University, Toronto. The college stands in the midst of wide grounds, and is a noted feature of the countryside.

The Industries

Although almost entirely surrounded by agriculture, Woodstock itself is as we have said, an industrial centre.

The Leading Firms

The main lines of manufacturing carried on are woodworking, textile and milling. The plants are mostly taking hydro-electric power to some extent, some running on this entirely. The woodworking factories include furniture making, piano making, and veneers. The textile factories make chiefly knitted goods. There are also one or two machinery firms. The names of the leading firms are as follows:—The Bain Waggon Co., making heavy wagons, such as are familiar to most of us who have seen them carrying loads of stone, gravel, etc. The Canada Furniture Manufacturers, who have a large plant, which is not run to full capacity at present, due to shortage of labor. The Thomas Organ Co., and the Kahn Piano Co., make as their names would indicate, musical instruments. Among the textile makers are the Harvey Knitting Co., Hosieries Ltd., Oxford Knitting, Sterling Textile Co., The Whitelaw Engine Company, and the Concrete Machinery Co., represent the heavy trades. The Peerless Cereal Co., Thos. Cullen & Sons, Westlake Confectionery Co., Hay & Co., Standard Tube Co., Bruthaup Leather Co., Crown Lumber Co., all represent important lines, while the James Stewart Manufacturing Co. look after the stove manufacturing industry. Power is cheap, though not as plentiful as could be wished. As in many Western Ontario towns, most of the people own their own homes, and are thus practically permanently settled. This feature of course insures a very steady labor market for the various firms in the city. Railway communications all over Canada are made by both Grand

SOUTH PARK AND PUMPING STATION.

Trunk and Canadian Pacific lines, while Ingersoll is also connected to Woodstock by an inter-urban electric line, 10 miles long. It is about two and a half hours distant from Toronto, and is in easy reach of Paris, Brantford, and London. The population is about 10,000.

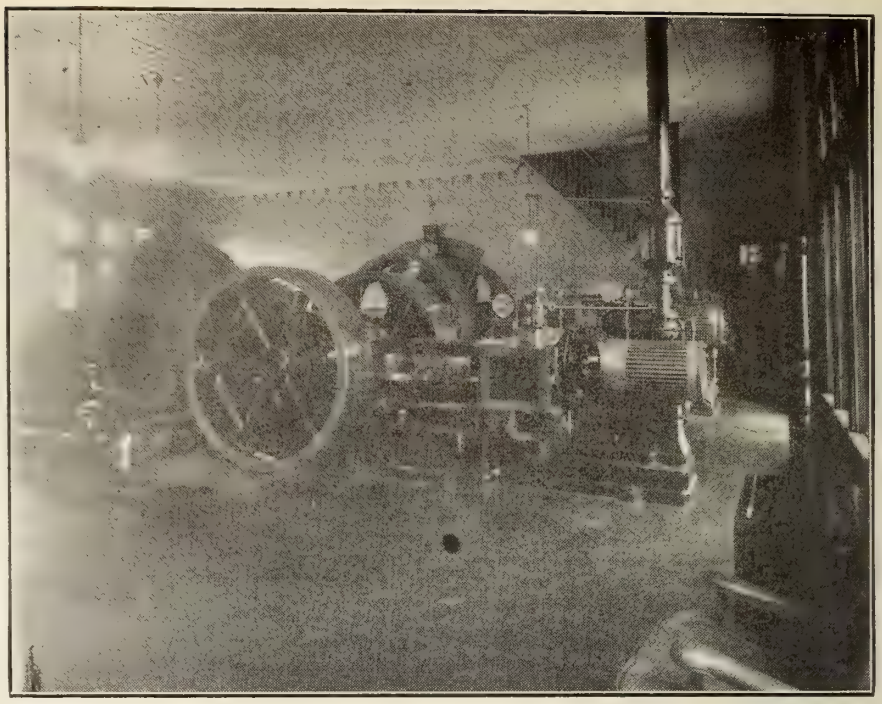
The South Side Park

There is a very pretty little park laid out on the south side of the town, surrounding the waterworks pump house, and the Ontario hydro electric station. There is a small lake on which boating is indulged in, and a pavilion is also provided, in which band concerts, etc., are given. The park is largely used during the warm weather as a picnic ground by the population, and for such a purpose is very well suited. Those attending the convention will no doubt spend a good portion of their time in this pleasant spot, especially if the weather is warm.

The Woodstock Waterworks

We have mentioned the pump-house standing in the park, and a description of the waterworks system will no doubt be of interest to readers in general, as well as delegates to the convention. The system is unusual in some ways, as the water supply is wholly derived from springs, which deliver the most delicious, cold and translucent fluid that man could desire. It is perhaps not all it might be for boiler feed purposes, but for drinking water it is ideal.

The works date back to 1880, when they were first built by private owners. In these days the works were used only for fire protection purposes, and the people secured their drinking water from wells. This condition obtained until the year 1885, and at that date there were approximately 6½ miles of mains, and about 60 hydrants. At this date the town took over the existing plant, and the present system was constructed, being completed in 1892. The site chosen for the pump house was on Cedar Creek, and here enough land was bought to make the present park, about eight acres in extent. The engineer in charge of the station also has a house on the property, the house being of course owned by the city, and retained for the use of the engineer.



TANDEM COMPOUND ENGINES.

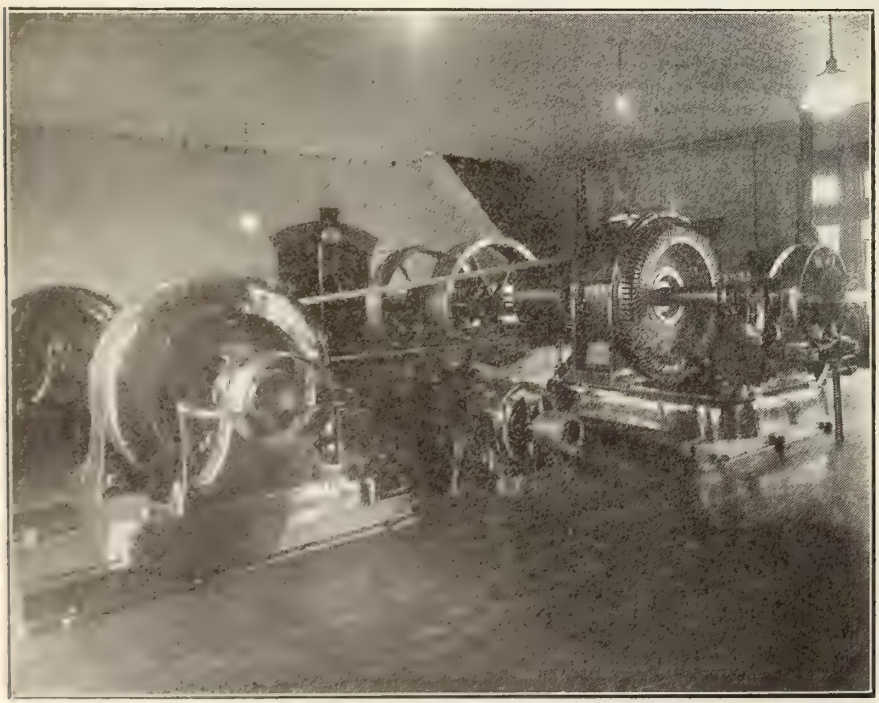
The Pumping Station

The pumping station is a one storey brick building, with concrete floors, slate roof, and masonry foundation. It is divided up into pump room, boiler room, store room and coal bunker. Originally it was equipped with horizontal return tube boilers and steam pumps, but this was discarded, and replaced by more modern units.

The present equipment consists of a compound duplex high duty reciprocating pump, built by the John Inglis Co. in 1908, and having a capacmity of 4,000,000 gallons per day. This pump is now used only as a stand-by unit. The daily work of the station is carried on by two 8-inch centrifugal pumps of the Mather & Platt design, built by the Canadian Allis Chalmers, and driven by direct connected induction motors. These were installed in 1911.

Steam is supplied by two 220-H. P. Babcock & Wilcox boilers, one of which is kept under banked fires with 50 lbs. steam pressure always handy, in case of emergency.

The electrical equipment consists of a Canadian General Electric Co. synchronous motor of 470-H. P., 25 cycles, 2300 volts, running at 500 R. P. M. This supplies power to the 2-200 K. W. revolving field, C. G. E. generators, and also acts as a power factor corrector. The power is taken from the hydro lines at 13,000 volts into the station, and it then transformed to 2,300 for power and distribution purposes. Power is also supplied from the Hydro through the station switchboard for factory purposes, the limiting amount being 1250 K.W. There are two switchboards, one being the incoming board from the Hydro, and the other of six panels, being used for distribution purposes.



SYNCHRONOUS MOTOR AND GENERATORS.

Steam Power

There are besides two steam engines, both of the compound tandem jet condensing type, but built by different mak-

VIEW OF SWITCHBOARDS.

ers. One is by Leonard & Son, London, the Peerless; while the other is a Mansfield engine. The Leonard engine is used in the winter to relieve the peak conditions, and is a great saving to the town by this means, bringing the maximum peak load down considerably. There is a condenser built by the Stillwell Pierce & Smith Vaile people.

The station is kept in such condition that it is a pleasure to look at. The Hydro Electric Commission have a substation in the rear of the pumphouse which possesses features of interest to those interested in the electrical field, especially of the high tension variety.

The Receiving Well

Just behind the pump house is a well in which the conduit that conveys the water from the spring is delivered, and the pump suction draws from. The conduit which brings the water from the springs is 17,600 feet long and is made for the most part of vitrified pipe, excepting at certain portions where cast iron pipe has been installed. These places are where depressions occur in the line, and in order to avoid air pockets, breathers have been installed, which are brought up to a little above ground level.

The Springs

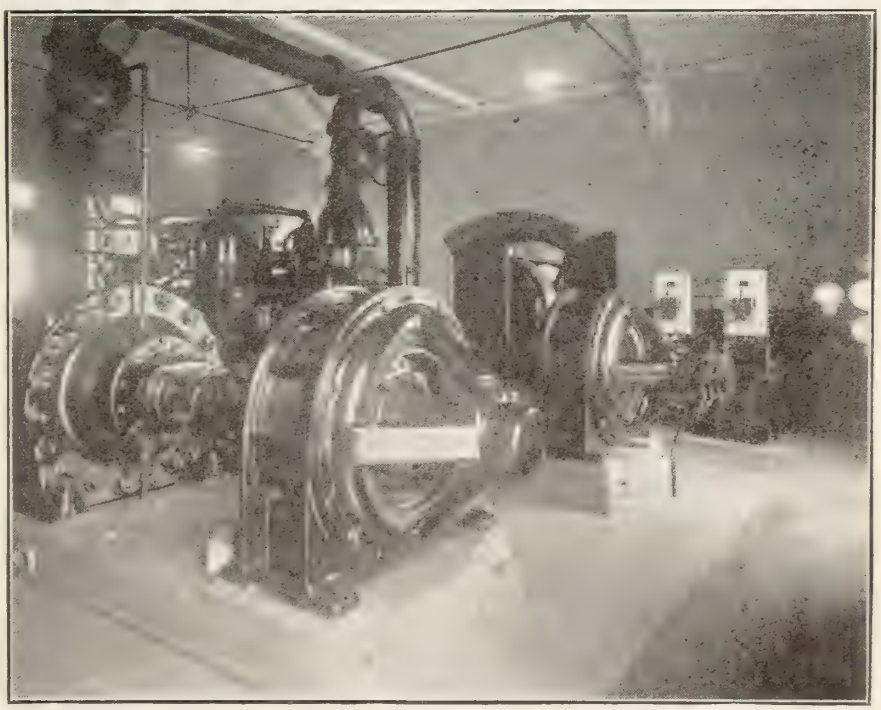
The springs that supply Woodstock with its clear, beautiful water, are situated some three miles out of town. They are three in number, known as the Hart springs, the Cormac Thornton group, and the Webster-Thornton group. The total flow is about 4,000,000 galls. per day. The source of these springs is unknown, but it is surmised that they come from a considerable distance. This opinion is based on the fact that neither flow nor temperature vary to any appreciable extent at any time of the year. The main groups are the two last named, and the ground surrounding these to the extent of about 150 acres has been acquired by the city. A farm house is on the land, and the tenant is supposed to keep an eye on the ground and prevent trespassing. These grounds are kept strictly private, everybody but the necessary officials and workmen being rigidly excluded. This is of course to guard against the development of insanitary conditions. It is somewhat unfortunate that this must be so, as the situation is one of extreme beauty, well wooded, and the floor covered with all kinds of wild flowers, which the rich moist soil encourages, the whole area is traversed by the small streams which flow like veins to the main basin. In order to guard against the irruption of surface water, a protecting ditch has been carried practically all around the property, which effectually drains the surrounding land. All these small water channels have been thoroughly cleaned, and many of them are paved. The settling basin itself is of concrete, and at its lower end a screen is provided, to intercept any matter floating on the surface. The water which goes down the channel below the screen comes up from underneath and through a set of horizontal screens, after which it runs down to the house which covers the end of the main conduit and the valves for closing off the supply. In the settling basin there is also a flushing arrangement, and by dropping a gate into a weir at the upper end, the basin can be closed off, and the water be passed. The settling basin can then be emptied, and cleaned out, and this operation is performed at regular intervals.

In walking around the grounds observing these springs, the writer came across a mechanical apparatus rarely met with. This was a hydraulic ram, which supplies the farm house and barn with water, year in and year out, and as far as could be ascertained, with little or no attention. This is one of the earliest forms of pumping apparatus, and employs the kinetic energy of flowing water to raise itself to a higher level.

The Reservoir

Leaving the springs regretfully, for the spot was certainly one in which it was pleasant to linger, we proceeded to the reservoir. This is situated high

Continued on page 291



VIEW OF CENTRIFUGAL PUMPS.

A Discussion of the Uniflow Steam Engine

A Paper Read Before the Manchester (England) Association of Engineers, by Mr. Henry Pilling, M. I. Mech. E., Goes Fully Into the Principles of This Engine.—Part II.

THE next interesting matter to consider is the cylinder. Experience appears to have resulted in a uniform practice of placing the inlet valves in the cylinder heads. This is advantageous to economy on account of the reduced clearance volumes and clearance surfaces, but the practice makes withdrawal and inspection of the piston and of the cylinder interior more difficult. Designers may with advantage consider this point. There are some very interesting constructions in existence which show great ingenuity. For example, observe the sketch—Fig. 9—of a jacketed double cylinder cover. The design is a continental one. Fig. 10 represents a cylinder of a "Uniflow" engine designed by the author. It has a built-up cylinder, a bolt reinforcement across the otherwise weak exhaust belt and an access door—Fig. 11—whereby in large sizes a man obtains access to the cylinder, and in small sizes makes his inspection by means of a periscope. The design may be usefully studied from another point of view. "Uniflow" cylinders, when in work, are hot at the ends and cool in the centre. If the cylinder is originally bored parallel, then in work the cylinder would be come a double cone and the piston and rings would suffer. In practice, therefore, the cylinder has to be bored with a double taper, so adjusted that when working temperature conditions obtain the cylinder is parallel. The amount of correction required has to be computed. In a large cylinder, say 60 in., the correction will be about ⅛ in. in diameter at each end.

Pistons

Closely connected with this matter of diametral change is the piston, which is also subject, though in different kind and degree, to diametral alteration. It is easy to see that the piston will be hot at the ends and cooler about the centre. Hence the piston also requires turning double taper, in order that it may be as nearly as possible a true parallel cylinder when at work. It should also be easy to observe the rule—though some makers have let themselves in for quite avoidable trouble by a failure to note the point—that under any or all circumstances, even the worst, i.e., a hot piston in a cold cylinder, the piston must have clearance.

Next, owing to the long piston-rod and cylinder peculiar to the "Uniflow" engine a back piston-rod support in large engines is useless. Deflection of the rod would be too great. The piston must therefore be carried on the cylinder bottom. This important *main slide* requires care in design and manufacture.

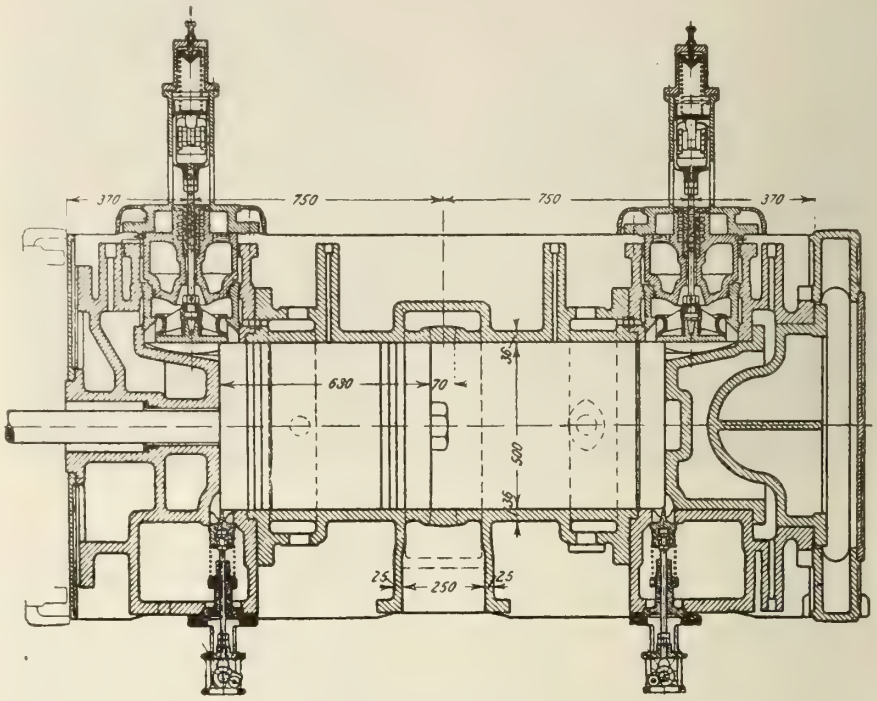


FIG. 9

Item 1.—Piston must be straight and not barrelled when working. Cylinder must be straight and not barrelled when working. Otherwise correct contact is impossible.

Item 2.—Piston diameter must be less than cylinder diameter to prevent seizing. The lower third of the piston must bed truly on the cylinder, otherwise line contact only takes place, followed by wear and tear and risk of overheating.

The two difficulties are met in small engines thus—the first one by suitable boring and turning during manufacture; the second one by turning the piston or the shoe thereon in two operations, *i.e.*, turning the shoe part to the exact expected hot cylinder diameter, and all the rest of the piston to the desired clearance diameter. For large pistons, however, I do not regard this as entirely adequate. For example, in the 60 in. cylinder 6 ft. stroke which I have cited, the piston is about 5 ft. 6 in. long. Owing to changes of working load, changes in steam pressure and superheat temperature, it is certain that the bottom of the cylinder will never consistently be a dead true straight line, nor will the piston be straight. This would mean point or line or shifting contact with resultant wear and risk of heating.

My mental processes in designing this piston started with the inquiry, "*How* can I make certain that the weight of this heavy piston—about 5 tons with its rod—shall be distributed on the cylinder bottom in such manner that the pressure

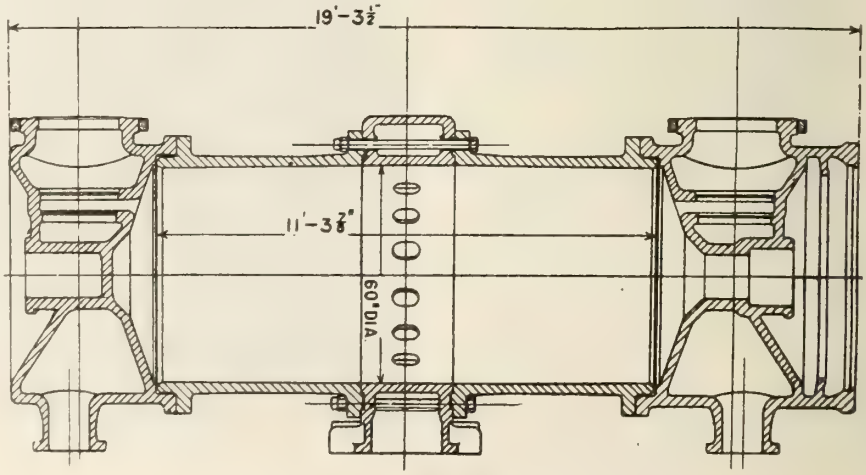
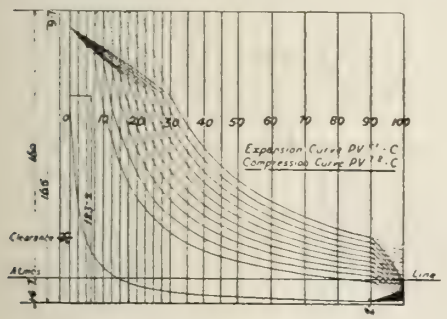


FIG. 10

per square inch is *absolutely uniform* and constant, no matter how the cylinder or piston may vary in diameter, and no matter how the piston may tilt or settle fore or aft."

The next mental step was to realise that some method of articulation might meet the difficulty. The next to conceive the piston as having five flexible fingers or five flexible feet capable of sliding comfortably up hill or down hill without any one losing contact. The next to sketch and re-sketch alternatives until in actual fact six flexible shoes as shown on the drawing—Fig. 11—were duly incorporated. The piston heads are separate, and each separately held against a collar which takes all the load, while the connection is secured by a nut which takes *no steal load*. This makes for safety, and it may fairly be claimed that the piston cannot work loose. Longitudinal expansion and contraction of the piston-rod in the part between the two piston discs cannot cause any straining. This is due to the chair or mainslide on which the piston is carried being not bolted to either of the piston discs. It is quite free to expand



Initial Pressure on Piston 165 lbs absolute

Steam per I.H.P. hour from Diagram lbs	Cut-off % of Stroke	Mean press. lbs per sq. in.	Press. at cut-off lbs. absolute	Press. at beginning of Exhaust lbs. absolute
10 77	7¼	33·5	148	12 44
11 34	10	40 9	145	16 65
11·96	12½	46 6	141	19 65
12 45	15	51 9	137	22·5
12 89	17½	56·5	133	25 2
13 35	20	60·8	130	27 96
13·84	22½	64 9	128	30 84
14 25	25	68 9	126	33 65
14 71	27½	72 8	125	36 67
15 13	30	76 6	124	39 67

FIG. 12

and contract on its own account. The clearance allowed at one end of the chair cannot cause knocking or wear, inasmuch as the horizontal springs at this end have sufficient strength to prevent motion. There is no usual barrel or cylinder connecting the two piston discs. Hence a man can get through the inspection door of the cylinder, drop *into* the piston, examine the cylinder, examine the shoe details and note whether or not the piston is remaining central in the cylinder. The condition of the piston rings can be noted by barring the engine round and bringing the rings in turn under the inspection opening. By depressing the rings observation can be made of the amount of wear, and so on. Access is practicable to each side

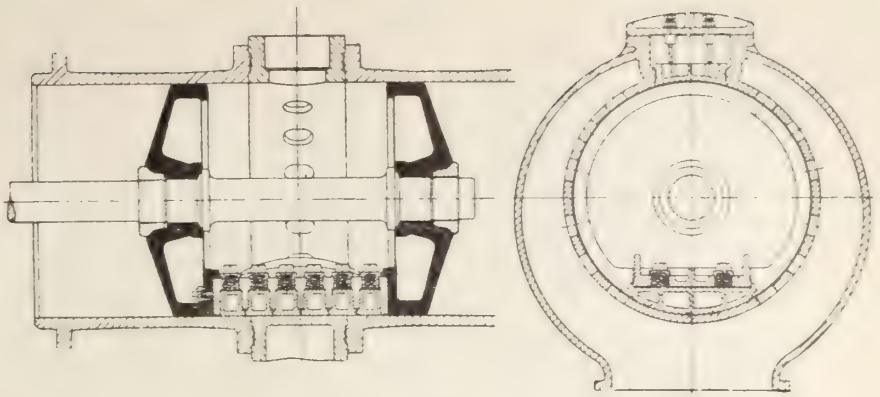


FIG. 11

of the piston right up to the cylinder heads.

Clearance and Compression

Attention requires to be given to the fact that a usual clearance in uniflow cylinders is about 3 per cent. for condensing conditions and 18 per cent. for non-condensing conditions. These assume about 1½ lb. and 15 lb.—absolute—back pressure respectively. If a 3 per cent. clearance condensing engine is at work under 1½ lb. condensor back pressure, the compression will rise at the end of the stroke to about 130 lb. For falling vacuum up to non-condensing working the compression would be as follows:—

Three Per Cent. Clearance

1½	lb.	Back	Pres.	= 130	lb.	Com. Pres.
3	"	"	"	= 260	"	" "
9	"	"	"	= 780	"	" "
15	"	"	"	=1300	"	" "

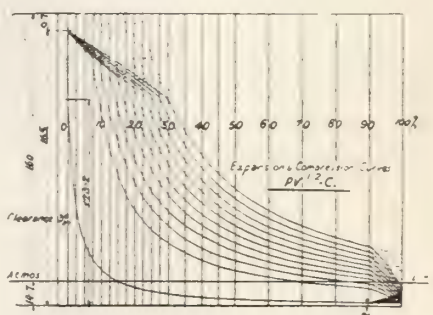
Clearly a falling vacuum is dangerous unless safety devices are provided. There are many attempted solutions from the ringing of bells to warn the attendant up to purely automatic self-acting relief devices. I prefer and advise the latter. Nothing else is safe. This also is fertile ground for inventors to cultivate.

Of course every condensing engine is—at starting—a non-condensing engine. The usual plan to ease the compression at starting where automatic devices are not fitted, is to open a by-pass valve, which admits the compressed steam to the interior of the cylinder cover. In this way the requisite augmentation of the clearance is obtained. The valve is closed after the vacuum is obtained. Reliance on maintenance of vacuum should not be carried too far. Ample relief valves are essential, but, as mentioned above, some form of automatic supplementary exhaust makes greatly for safety.

Indicator Diagrams and Steam Consumption

Inasmuch as "Uniflow" engines are substantially free from initial condensation losses, and as there are no complications due to the presence of receivers, as with compound engines, the following calculated diagrams—Figs. 12 and 13—will be useful.

The diagrams show clearly the nature of the expansion and compression curves, which will vary according to the circumstances of each particular case, *i.e.*, efficiency of cover jacket, efficiency of barrel jacket, if any, and so on. The diagrams must therefore be used with care. The good steam economy shown thereon can be readily obtained with care and skill. It can be lost for the want of it. It is known that different makes of engines have different efficiencies and economies, and that with the same maker even sister engines do not usually give similar results, and that as a rule the larger the engine the better the economy. No definite figure can be given here, therefore, to anxious inquirers. It is true here, as elsewhere, that usually the best engine is the result of unremitting care and attention to details, to observances of sound



Initial Pressure on Piston 165 lbs absolute

Steam per I.H.P. hour from Diagram lbs	Cut-off % of Stroke	Mean press. lbs per sq. in.	Press. at cut-off lbs. absolute	Press. at beginning of Exhaust lbs. absolute
9 47	7½	30 4	148	10 [illegible]
9 80	10	37 7	145	13 65
10 16	12½	43 7	141	16 42
10 53	15	48 7	137	19 09
10 96	17½	53 2	133	21 66
11·17	20	57 5	130	24 61
11 51	22½	61 7	128	27 39
11 78	25	65 [illegible]	126	29 84
12 09	27½	69 9	125	32 8
12 36	30	73 9	124	35 76

FIG. 13

theoretical principles, and to excellent workmanship.

As a matter of interest, two non-condensing indicator cards are given in Figs. 14 and 15. The first one is a "no

load" diagram. A third card, taken at a lower boiler pressure, and later cut off, is given in Fig. 16. The cards will repay careful study, special attention being given to the reduction in the mean average pressure by reason of the shape of the compression curve. The increased capital cost of the non-condensing "Uniflow" engine due to this fact is, however, more than balanced by the economical operating results obtained by the application of the "Uniflow" principle.

A comparison of the steam consumption of a "Uniflow" condensing engine with that of other engines will show that it is as low as in three-cylinder triple-expansion engines, and lower than in two-cylinder compound engines. More-

Fig. 14

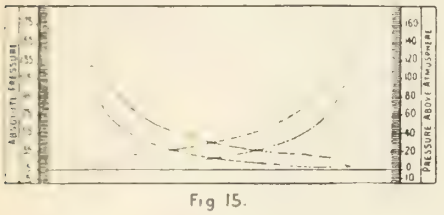


Fig 15.

FIGS. 14, 15, 16

over, this improved economy is attained not only in very large engines, but extends much in the same way as with gas engines, down to the very smallest sizes. Furthermore, the steam consumption per indicated horse-power per hour is more even over all loads between quarter and full load than with ordinary engines in which the steam consumption rapidly becomes unfavourable if the load on the engine passes either upwards or downwards from a very limited economical load region.

The Westinghouse Company have issued a catalogue dealing with their line of Watt-hour Meters. This is known as the Miniature Catalogue 3-A-1, and shows a great number of varieties of these instruments. A page at the beginning of the catalogue deals with ordering instructions, while on the inside back cover there is a list of Westinghouse agencies.

How Many Sizes of Shafting Should We Have?

IN ANSWER to the above query, the American Society of Mechanical Engineers recommend that fourteen sizes of transmission shafting be used. The committee of this society devoted to War Industries Readjustment, state that an immense amount of steel is continuously tied up in manufacturers' and dealers' stocks of shafting and that a corresponding amount of cast iron is also held in stock in the form of hangers, bearings, couplings, collars, bushings, pulleys, etc. At the suggestion of the chairman of the committee on War Industries Readjustment, a committee was formed to investigate the subject of the standardization of shafting sizes. The personnel of the committee is as follows: Cloyd M. Chapman, chairman; George N. Van Derhoef, Hunter Morrison, Louis W. Williams, and Russell E. Nelles.

This committee was confronted with two distinct but closely related problems, namely, standardization of the diameters of shafting used for transmission of power, such as lineshafts, countershafts, etc., and the standardization of the diameters of shafting used by machinery manufacturers in making up their product. The first of these problems seemed to be the simpler of the two. While a large number of sizes of transmission shafting are now listed and stocked, it was believed that comparatively few of these are in extensive general use. Accordingly, a letter was sent to thirty-six of the largest manufacturers and dealers in transmission shafting asking for statistics on the consumption of each size of shafting handled by them. About twenty of the largest concerns in the industry furnished complete statements of their sales over periods of time chosen by themselves. These data were reduced by the committee to a uniform basis of percentages. The amount of each size sold was expressed as a percentage of the total sales, both on a weight basis and on a lineal-foot basis. From these data, plotted in the form of a diagram, it was evident which of the sizes were popular and generally used and which were more rarely called for. A tentative list of twelve sizes was prepared from this diagram and sent to forty-six other dealers in transmission shafting and shafting supplies, from whom twenty replies were received.

In the letters to these firms, the committee expressed the opinion that the custom of using shafting 1/16 inch under the unit sizes is so firmly and so nearly universally established in this country, that it would be unwise to attempt to adopt sizes in even inches and fractions as standard. It was pointed out, also, that certain sizes stand out pre-eminently as "popular sizes" and that others are sold in relatively small quantities. It therefore seemed feasible to reduce the number of sizes now listed by the trade from fifty or sixty down to twelve or fifteen.

The response to these letters was practically unanimous in opinion. The transmission shafting users and dealers approved the plan of standardization, and the sizes suggested were generally approved except that the diameters 1 11/16 inches and 2 3/16 inches were in many cases requested to be included. After due consideration the committee decided to include these two sizes in the original list, making the fourteen sizes now adopted as standard.

Shafting Sizes Used in Machine Design

The second problem was a more intricate one. The number of sizes now produced by the rolling mills for use in machinery is very large. Almost every sixty-fourth of every inch up to three inches is drawn. If a reasonable number of these sizes could be eliminated or classed as "specials" and a comparatively few sizes selected as standard or stock sizes, a great saving would be effected. In order to get the opinion of leading consumers of shafting for machinery purposes, the committee decided to lay the plan before 225 large consumers of this material. It was explained that it was not intended that the adoption of certain sizes as standard should make it impossible to secure any other size required on special order.

In the case of machinery shafting the users were equally unanimous in their approval of the plan to standardize sizes, but recommendations as to size intervals varied greatly. However, these recommendations, in so far as they were definite and specific enough, were tabulated and a diagram constructed showing the relative popularity of the various size increments for each inch of diameter.

With these data accumulated and sifted down to usable form, the committee felt that it was in a position to present its information and preliminary deductions to representatives of other interested organizations. Accordingly, invitations were issued to twelve societies and associations requesting them to consider the proposed lists of standard sizes and to appoint representatives to confer with the committee before its report was finally formulated. The seven

organizations listed below responded, and the standard sizes which follow have the unanimous approval of these representatives and, as far as can be learned, of their associations: American Hardware Manufacturers' Association; American Railway Engineering Association; American Supply & Machinery Manufacturers' Association; National Association of Manufacturers of U. S. A., National Association of Purchasing Agents; National Machine Tool Builders Association; and Southern Supply & Machinery Dealers' Association.

Report on Shafting Sizes

On January 14 the committee submitted to the council a report in which it recommended the approval and adoption of the following lists of sizes as standard for the society:

Transmission Shafting—15/16, 1 3/16, 1 7/16, 1 11/16, 1 15/16, 2 3/16, 2 7/16, 2 15/16, 3 7/16, 3 15/16, 4 7/16, 4 15/16, 5 7/16, and 5 15/16 inches.

Machinery Shafting—Size intervals extending to 2½ inches, by sixteenth inches; from 2½ to 4 inches inclusive, by eight inches; and from 4 to 5 inches by quarter inches. The council approved the report and accepted the recommendations.

Troubles Caused by Moisture in Compressed Air

It is a Well-Known Fact That Moisture in Compressed Air is Something to be Avoided—The Discussion Explains How This Trouble May be Overcome

By F. A. McLean

MOISTURE in compressed air should always be avoided as much as possible, especially where it is to be used to operate reciprocating or rotating mechanisms on which it has a pernicious effect when carried into the working parts, tending to wash away the lubricant, thereby increasing the wear and shortening the life of the moving parts through leaving highly finished and closely fitted surfaces bare, and in sliding or rolling contact with each other. While this is true of practically all air-operated machines, it is particularly so in the case of those operating at high speeds, such as hammer drills, pneumatic tools, motor-driven air-hoists, sand rammers and the like, in which the surfaces exposed to wear are of necessity limited in size, and since air underpressure is hard to hold, the parts are machined to very close limits, and wear is particularly objectionable on the ground of lowered economy through increased air consumption and loss of power.

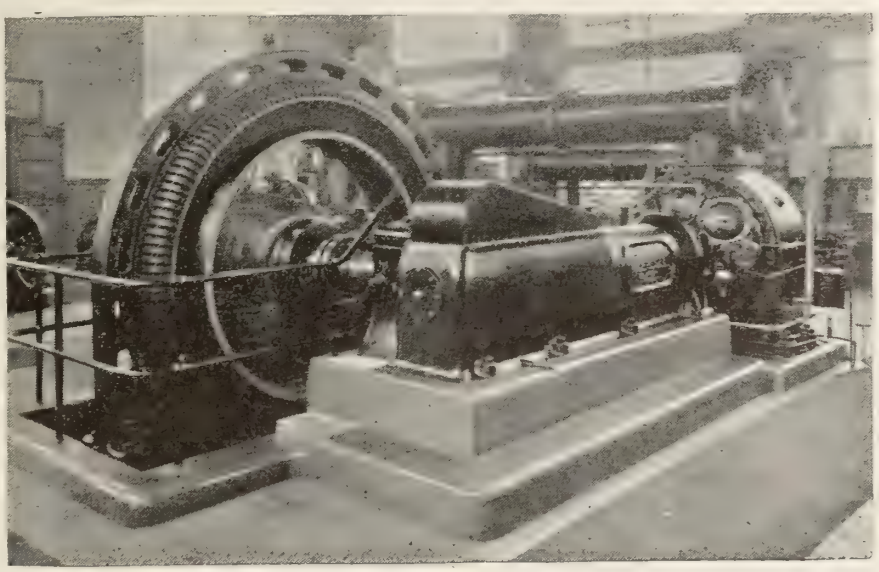


FIG. 2—MOTOR DRIVEN, DIRECT CONNECTED COMPRESSOR AND HORIZONTAL AFTERCOOLER. THE AFTERCOOLER IS DIRECTLY IN FRONT OF THE COMPRESSOR, AND NEAR THE WINDOW.

While moisture in wet air is bad enough in interior piping, its effects are likely to be far worse out of doors in open cut mining, quarrying, contracting, shipbuilding, switch and signal work, etc., where it is likely to collect at low points in the system, causing water hammer with consequent racking effect on the joints and loss of power through reduction of the air passages, as well as increasing the danger of freezing and bursting of the pipes during cold weather. The low temperatures caused by the rapid expansion of the air from the exhaust of rock drills, pneumatic hammers and other air-operated devices will often freeze the moisture, clogging the exhaust openings and preventing their efficient operation.

On railroad switch and signal work, freezing is a very serious matter, as, should these devices fail to function at the proper time through the freezing of the working parts, it is likely to cause considerable loss of life and property.

Time is generally an important factor in contracting and mining operations and losses in this respect are usually of more importance than in other directions. It is, therefore, essential that the proper precautions be taken to ensure freedom from interruptions which are too often caused by freezing of the pipe lines, drills or tools. In a case of this kind which came to the writer's attention late last fall, operations at a large Eastern mine were held up and the miners forced to sit around and "swap" stories for two hours while waiting for the pipes to be thawed out. This did not happen on a cold day, but on one that was damp and muggy.

While it is possible to compress air, it is practically impossible to compress water and sometimes breakage of the working parts of a tool is caused by too much water in the air lines. Pneumatic tools and other air-operated equipment are designed to operate on air and are not adapted for "hydraulic drive."

Where tools or drills are operated on air which contains an excessive amount of water and are then allowed to remain idle for a while without proper attention they soon get rusty and it is usually not long before losses from air leakage and maintenance costs grow larger.

The Importance of Cool Compressed Air

Air discharged from the cylinder of a compressor is hot in comparison with the atmosphere, and on entering the supply pipe lines heats them to some extent. this heating effect travelling further along the pipe lines with the continued operation of the compressor causes them to expand gradually, with the result that when the compressor is shut down for the night, in the cooler atmosphere, they are subjected to an equivalent, but more violent contraction. Although this effect may not be readily noticeable, it is likely to result in strained and loosened joints, with consequent loss of efficiency through leakage.

Aftercoolers—The Remedy

It is a well-known fact that atmospheric or free air always carries moisture (the amount varying with meteorological conditions in different localities),

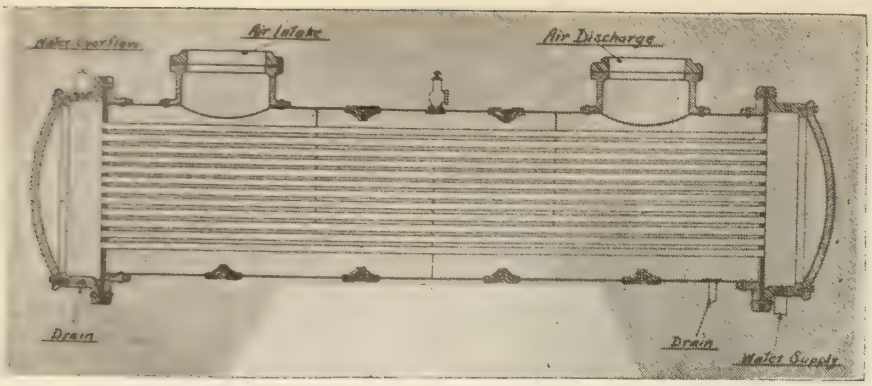


FIG. 1—DIAGRAMMATIC VIEW OF A HORIZONTAL AFTERCOOLER.

and that it also has the capacity to absorb more up to the time that its saturation point is reached.

The moisture carrying capacity of air increases rapidly with rises in its temperature and decreases, but not quite so rapidly with increases in pressure. As the pressure will always be at the highest point just as the air is leaving the compressor, if we can reduce its temperature to the lowest point, the air will be in a position to give up so much of its moisture that there will be little or none left to cause trouble when lower pressures and mayhap higher temperatures are reached further along the line. It is thus evident that the remedy for these conditions lies in reducing the temperature of the air after it leaves the compressor and before it enters the pipes, to as low a point as possible, which will not only prevent all of these troubles, but will ensure better all around distribution efficiency as a whole. Some cooling takes place in the intercooler of a compound or state compressor, and with the larger and better designed intercoolers used on modern compressors, more of the moisture is removed by this means than was possible with the older types. The air receiver also cools the air to some extent and serves as a receptacle for the collection of moisture from the air which passes through it, and for this reason is fitted with cocks by which the moisture can be drawn off at intervals.

In the simplest form of compressed air power plant, the receiver is the only means of removing moisture from the air that is employed. Too much reliance should not be placed on the receiver for this purpose, however, as when located close to the compressor as it should be and the consumption of air is heavy, the temperature of the receiver shell will usually be such that little or no condensation can occur. In some cases, the temperature of the receiver becomes so high that oil carried from the compressor cylinder becomes ignited, causing serious fires or explosions. It is, therefore, better to depend on some means of cooling and drying the air after it has left the compressor and before it enters the receiver and supply lines, and this is where the aftercooler "fits in."

What the Aftercooler Will Do

Aftercoolers cool and dry the air more thoroughly than is possible with the best type of receiver, and so reduce to a minimum the troubles which follow the use of wet air, and in addition remove some of the oil which might be carried into the receiver and perhaps to the pipe lines, to the detriment of the air supply hose. While of considerable importance in mining, quarrying and contracting, especially in tunnels and shafts where oil in the exhaust of rock drills or coal cutters tends to vitiate the air, clean air is even more of a necessity in the case of foundries or in wood-working and textile plants where the air is used for cleaning machinery, or spraying paints, varnishes and other finishes, and the aftercooler is of great value under such conditions.

One of the principal functions of an air receiver is to compensate for the pulsating effect of each stroke of the compressor piston and prevent rapid fluctuations in the air pressure. For this reason the receiver should have sufficient capacity to prevent any material rise in the receiver pressure by the volume of air forced into it at each stroke of the compressor piston. If the air is allowed to pass directly into the supply pipes, there will not be sufficient space for its immediate accommodation and the pressure will momentarily run up far in excess of the average pressure in use, accompanied by a periodic acceleration of flow. This results in an increase in the frictional resistance of the pipes and at the end of each stroke the compressor piston is required to force the air out of the cylinder against a pressure temporarily greatly in excess of normal, increasing the power consumption and putting an unnecessary strain on the compressor. In a single cylinder compressor the discharge pulsations are more violent than in stage compressors, as the total discharge must take place from a cylinder of larger diameter in a smaller portion of the stroke than is the case with the high pressure cylinder of a multistage compressor where the discharge valves open earlier in the stroke and the diameter of the air pipe is about one-half that of the cylinder. In this respect the installation of an aftercooler, since it increases the available receiver capacity, will be of considerable benefit, especially in intermittent work, such as running rock drills, pneumatic tools, hoists, etc., and will assist the governor

AIR AFTERCOOLERS

80 TO 100 POUNDS AIR PRESSURE

Number	Size of Aftercooler: Diameter Shell Inches	Size of Aftercooler: Height or Length Feet and Inches	Actual Square Feet of Cooling Surface	Pipe Connections: Air: Inlet, Inches	Pipe Connections: Air: Outlet, Inches	Pipe Connections: Water Inlet and Outlet	Maximum Capacity of Aftercoolers in Cu. Ft. of Free Air per Minute with Cooling Water at: 60° F. Single Stage Compression	60° F. Two Stage Compression	70° F. Single Stage Compression	70° F. Two Stage Compression	80° F. Single Stage Compression	80° F. Two Stage Compression	90° F. Single Stage Compression	90° F. Two Stage Compression	Shipping Weight lbs.: Domestic	Shipping Weight lbs.: Export
1	14	16'-0"	55	5	4	1	253	360	230	330	207	297	186	268	1800	2160
3	26½	10'-6"	152	8	6	1½	705	1170	640	1054	575	957	518	860	3090	3600
5	22½	14'-6"	305	10	8	2½	1410	2360	1280	2135	1150	1920	1035	1725	4200	5000
7	30	17'-8"	757	14	19	3	3500	5840	3180	5299	2880	4750	2590	4270	8500	10200
9	39	19'-0"	1497	18	14	5	6900	11500	6280	10479	5650	9400	5100	8450	16100	19300
10	45½	19'-0"	2012	18	14	6	9300	15500	8450	14084	7600	12650	6850	11350	19700	23700

FIG. 3—TABLE SHOWING CAPACITIES OF INGERSOLL-RAND HORIZONTAL AFTERCOOLER.

or regulator of the compressor in maintaining a steadier pressure.

Aftercoolers usually consist of a cylindrical steel or cast iron shell with cast heads supported on cast iron foot pieces surrounding a nest of iron or brass tubes, the ends of which are either expanded or fitted with copper ferrules and caulked into steel tube plates at each end of the casing, provision being made for expansion and contraction. Water enters the lower set of tubes, traverses each row and leaves at the top of the shell, while the air enters and leaves at the top, surrounding the tubes in transit and travelling in a direction opposite to the water. Baffle plates are arranged so as to cause the air to cross and recross the tubes several times. An open funnel is generally placed in the water discharge to show the amount of water flowing and facilitate its adjustment. The moisture collected from the air is prevented from escaping with the latter by a plate in front of the air discharge opening.

There is some difference of opinion as to the respective merits of iron and brass tubes for this class of service. Brass is a better conductor of heat than iron, but on the other hand, galvanized iron tubes are usually rougher and present more surface to the air, so that there is probably little or no difference between them in cooling effect. Vertical aftercoolers are sometimes preferred on account of the smaller floor space which they occupy, but aside from this, there is no reason for using one style in preference to the other. While aftercoolers of different makes vary in minor details, the essential principles of all are the same and their construction will be more readily understood by referring to Fig. 1.

Aftercoolers are usually equipped with pressure gauge, safety valve, flanged pipe connections, water fittings and drain cocks. When properly designed and supplied with the requisite amount of water they will readily reduce the temperature of the air passing through them to within 15 or 20 degrees of the entering cooling water. The temperature and quantity of the latter required depends on the cooling effect desired. The following figures which are based on good cooling results with air at 80 to 100 pounds gauge pressure when compressed by a two-stage machine, will be found accurate for use with aftercoolers of the type described:

Temperature of Cooling Water	Gallons per hour per 100 cu. ft. of actual free air per min.
50 Degrees Fahr.	120
60 Degrees Fahr.	150
70 Degrees Fahr.	180
80 Degrees Fahr.	210
90 Degrees Fahr.	240

Aftercoolers are made in a number of different sizes, the capacity of which varies with the temperature of the cooling water, and whether the air to be cooled is obtained by single or multistage compression. This point will be seen more clearly by examining the table in Figure 3, giving the sizes and capacities of Ingersoll-Rand aftercoolers.

An aftercooler may be suspended from the ceiling or mounted on or under the floor, as may be most convenient from the standpoint of economy of floor space or ease in making the necessary connections. It should be placed between the receiver and the compressor and as close to the latter as possible. Pipe of amply large size should be used in making the necessary connections and care should be taken to provide piping by which the moisture may be drained off at intervals. It is good practice to make connections from the compressor to the aftercooler and from the aftercooler to the receiver, one or two sizes larger than that leaving the receiver, using reducers to make the actual connections if necessary. Elbows should be avoided, any bends that are necessary being made by giving the pipes a wide sweep.

In some localities water is scarce, and where this condition exists it is often possible to use the cooling water from the aftercooler for hot boiler feeding, increasing the efficiency of the plant and adding to its economical operation to some extent through the recovery of waste heat.

While an aftercooler will not eliminate all of the moisture from compressed air, the best results in this respect, especially in the case of large installations, being obtained by the use of an aftercooler in conjunction with a number of small secondary receivers or moisture traps (of which there are a number now on the market, one of the best known as the Stratton) placed at intervals along the supply lines, it will be found that in the majority of cases the aftercooler alone will dry the air to such an extent that the troubles due to wet air and the consequent inconvenience and low efficiency which follows, are entirely done away with.

In addition to this, the installation of an aftercooler often results in increased economy in power consumption with no outlay other than the cost of the aftercooler, the necessary connections and a moderate supply of cool running water. It is thus evident that the inclusion of an aftercooler when securing estimates on new compressed air plant, or the addition of one to a plant already in existence, is a subject well worth the attention of anyone desirous of obtaining the highest efficiency from their compressed air equipment.

MUNICIPAL AUTHORITIES INSPECT DIESEL ENGINES

The Council of Yorkton, Saskatchewan, have decided to send the Mayor, Mr. Gibson, Deputy Mayor, Mr. Moritz, and the electrical engineer, Mr. McNicol as a deputation to visit the plants of the Nordberg Manufacturing Co., at Milwaukee and the Busch-Sulzer Co., at St. Louis, to inspect the Diesel engines manufactured by these firms and also other points where these engines are in operation, before definitely deciding which engine shall be purchased for the municipal power plant.

This decision was the result of a lengthy and exhaustive discussion upon all phases of the question, the Council being unable to decide which engine was the most suitable for their requirements from the information it had been able to secure on the subject. Both engines have strong points in their favor but there are matters of detail, which can only be decided by a personal inspection and in conference with the executive heads of the firms in question. The Council was also agreed that the cost of a deputation was but a minor item on a deal of this magnitude and that this expense could be saved many times over by personal negotiation with the manufacturers.

From information previously secured the total cost of the 500 2-cycle Nordberg engine together with generator, was placed at $90,000 and the total estimated cost of the Busch-Sulzer unit together with generator, at $88,000. As the Busch-Sulzer unit is rated at 520 h.p. the final cost per horse power worked out in favor of the Nordberg machine, it being $165.14 as against $177.26 for the Busch-Sulzer machine after making altitude allowances.

Both engines are designed with a water-cooled piston, which eliminates danger of seizing, but the Nordberg piston is designed for use with a cross head, making for ease in connection and inspection of connecting rods and bearings, no dismantling being necessary to make adjustments of these. The system of lubrication also appears to be to the advantage of the Nordberg but to make a definite decision in a matter of such grave importance to the town all were agreed that both engines should be seen in actual operation, not only in the plants where they are manufactured, but also in plants where they have been in service for some years where much valuable experience can be got from users in regard to troubles experienced and efficiency of operation.

There are also such points as guarantees, terms of payment, elimination of exchange, assistance in erection and supervision, time of delivery, etc., which can be discussed to much better advantage on the ground, all of which will be gone into fully by the deputation. When all the facts of the matter have been secured by the deputation they will be laid before the Council as a whole and definite action will be taken.

The deputation will leave for the south on Friday evening.

The Norwalk Iron Works Company of South Norwalk, Conn., manufacturers of air and gas compressors, have now a Canadian sales agency with offices in Toronto. This is in the hands of the A. S. Leitch Company, Kent Building, Toronto.

Some Examples of Economiser Tube Failures

Extracts of a Report Dealing with Explosions of Economizers. These Are Comparatively Rare, But the Causes Leading to Them as Shown by the Report Are of Interest.

C. E. STROMEYER

THE question of safety of cast-iron economisers has unfortunately once more forced itself on our attention by a destructive explosion at Brighouse, the damage to surrounding property being very great. These cases are very rare, as will be seen from Table II., which summarises all the economiser explosions, 17 in number, reported upon by the Board of Trade since 1882. Only nine of these explosions, inincluding the present one, No. 2,470, were destructive, but unfortunately none of the enquiries into these mishaps have revealed their true causes. As will be seen shortly, very material facts about the Brighouse explosion were not mentioned in the Commissioners' report, even the thickness of the metal being omitted, and there are indications that equally important information about previous explosions was either not found by the surveyor or, if found, was kept out of the reports.

The curious point about economisers is that from a practical engineering point of view, economiser pipes should not fail and yet they fail frequently. In fact these failures are so frequent that they are by common consent looked upon as being wear and tear, and are only discovered, if at all, at the annual inspections, when information may come to hand that during the year a sheet of pipes has been blanked off, or a pipe renewed. The metal of economisers is sound, the thicknesses more than ample, the factor of safety being between 20 and 30, there is plenty of room for expansion and contraction, and the simple cylindrical shape of pipes compares favorably with the relatively much thinner and more complicated steam engine cylinders. Yet although these are subjected to innumerable reversals of strain, they hardly ever fail, whereas unreported failures of economiser pipes, occur almost daily.

The information contained in Table II. has been carefully summarised as to the numbers of pipe failures which were reported to have occurred previous to the several real explosions in such a way as to represent the annual failures amongst 10 economisers, aggregating, say, 1,000 pipes. A negligible number of failures occurred in the first two years, due no doubt to carelessness during erection; but from the second year, and, therefore, long before serious corrosion could have occurred, up to the twentieth year, there was a steady annual rate of failures of 2.2 pipes per 1,000 pipes. According to these figures therefore there is a probability that after the second year the renewals per economiser will be about one pipe every five years. These averages, based on the above-mentioned 17 official reports, are in excess of the renewals amongst our members. Our more favorable experience is no doubt due to the fact that a very careful record is kept of the pipe gaugings by our inspectors, and when certain limits of wasting are reached we advise renewals to prevent inconveniences. Thus in the Brighouse explosion it appears that our inspector's reports about the extent of the wastings were in the closest agreement with the measurements made on the broken pipes, viz., 3-16 in. Unfortunately, however, at least for those who attach extreme importance to average results, it was not the most wasted pipes, which had all been located in the A block, but some pipes in the B block which gave way, evidently by drawing out of their sockets. This block was a comparatively new one, and being in the second group these pipes were but slightly wasted.

The makers of the economisers are very positive that, at present, at least, failures of cast-iron pipes are far less frequent than the above estimate from the official reports, but they admit that there are a fair number of renewals every year. Violent explosions occur on an average only once in four years. The ratio is possibly one or perhaps two thousand pipe renewals to one serious explosions.

The explanation of this discrepancy is that under ordinary working conditions, economisers are full of water, which is cold at the bottom ends of the pipes and hot at the top. If a pipe fails at the bottom end, as is usual, cold water runs out, and as appears from reports Nos. 485, 1,590, 1,856, 1,970, the first intimation about anythisg being wrong is that the water-level in the boiler is noticed to be sinking, or water is seen to be running out of the flue. However, if, as in the Brighouse explosion, and in cases Nos. 220, 242, 1,790, a pipe fails in an economiser through which hot flue gases had been passing for some time, while the feed supply was shut off, it is evident that the whole mass of the water in the economiser will have been raised to the temperature of the water in the boiler, and as hot water under pressure can be looked upon as containing about 30 times its volume of steam, it is evident that if under these circumstances it is the turn of one pipe of an economiser to burst, a very large volume of high-pressure steam is suddenly liberated and a destructive explosion is the result.

If the feed supply be suddenly shut off while the flue gases continue to pass through the economiser, it takes about half an hour before the water temperature is sufficiently high to generate steam, which then either escapes into the boiler or, if the feed valve has been closed, it escapes through the safety valve. Now if we assume that there have been 1,000 harmless failures during a period of four years, equal to 60,000 half hours of working time, then if we knew the number of economisers at work, certainly several thousands, and if we knew how often a fireman negligently shuts off the feed and yet allows the hot gases to pass through the flues, we could estimate the chances of the two things happening together, and a destructive explosion occurring. Conversely as we know that this coincidence takes place about once in 60,000 half-hours, we might estimate the frequency of negligence on the part of the firemen in terms of the number of economisers at work. Adopting some reasonable number it will be found that, on an average, one or other of the firemen somewhere in the United Kingdom is alway behaving negligently. This conclusion is somewhat startling, but on reflection it is not an improbable one. Many a fireman does not know that he ought to close the damper when he temporarily shuts off the feed, because he has never been told, and amongst those who have been told to shut their dampers, there are many who, having on one occasion accidentally omitted to carry out their instructions and found that no harm resulted therefrom, will have been less careful in the future than they were in the past.

Nevertheless, Report No. 2,470, on the Brighouse economiser explosion, just issued, lays it down that the explosion was caused by a damper being accidentally left open. The wording is:

"The cause of the explosion was the omission to close the dampers of the economiser flue of the high-pressure section of the economiser when that section was intended to be put out of use, and the feed valve inlet and outlets had been closed for that purpose. The result was that the high-pressure section of the economiser became a closed vessel in which steam generated to a pressure which it could not withstand, and in consequence exploded."

The above remark implies that the economiser was not a closed vessel until somebody closed the feed valves, and the natural tendency is to blame the person who shut the feed valves. But that is quite a wrong view of the case. The economiser was a closed vessel, otherwise the enquiry could not have been held, for the Boiler Explosions Act, 1882, defines a boiler as being a

SUMMARY OF BOARD OF TRADE REPORTS ON ECONOMISER EXPLOSIONS.

Report No.	Dates of I. Build. II. Explosion	Age. Years.	Number of Pipes	Renewal of Pipes	Economiser Pressure. Lbs.	Thinnest Metal of Pipes. Inches	Maximum Stress. Tons.	Nature of Explosion.	REMARKS. (Bracketed information by M.S.U.A. Inspectors.)
106	? 2/1/1885	9	6×24 =144	No renewals.	120	5/16 average.	—	Destructive	All economiser valves were closed and safety valve exhaust probably frozen. A case of overpressure.
154	-/-/1877 13/11/1885	8	8×16 =128	3 in '78	235	1/8 (1/4)	1·68	Destructive	Report silent on question of feed working (only one pump available) and of dampers being open.
186	-/-/1867 25/6/1886	19 and 10	8×24 =192	No renewals.	180	1/16 (1/8)	2·54 (0·66)	Semi-destructive. Two rows and two pipes.	Explosion at 7-10 a.m. Dampers open all night. (Two pipes drawn out of sockets.)
220	-/8/1882 7/5/1887	5	6×16 =96	2 in '86 1 in '87	131	1/8	0·94	Destructive. Sharp report.	(Feed and delivery valves closed since morning.) Dampers not closed till some hours before explosion.
242	-/6/1875 22/8/1887	12	8×52 =416	3 in '84 5 in '85 2 in '86 3 in '87	142?	Not reported. (under 1/8).		Destructive. Hissing noise before explosion. Some pipes discoloured by heat.	Explosion 15 minutes after starting engine. Economiser doors had been open all night and feed supply stopped. Graphitic corrosion.*
485	-/-/1860 2/4/1891	31	6×8 =48	9 about '85	154	1/16	2·16	No report heard. Water level in boiler sinking.	A case of wear and tear.
566	1873, 1881 23/3/1892	19 and 11	6×32 =192	12 in '89	212	1/8	1·51	Destructive. Pipes hurled upwards.	Overheating suggestion was rejected but was probably correct.
647	-/-/1885 27/5/1892	7	8×28 =224	1 in '87	120?	1/4	?	Destructive	(Economiser valves closed). Safety valve blanked off. (Flue dampers bad fit).
1590	-/-/1877 30/8/1905	28	6×20 =120	No renewals.	120	Not reported.	—	No report heard. Water ran out of flue.	A case of wear and tear.
1687	-/-/1902 15/5/1907	5	6×24 =144	12 loose in '02, 14 in '06	112	1/32 to 3/32		Destructive. Report says Gas explosion.	Explosion occurred while cleaning fires, and while water level was high. Feed probably shut off. Hydraulic test 11/12/06 to 240 burst a pipe 1/8in. thick; stress, 1·78 tons.
1790	1903, 1905 7/9/1908	5 3	8×16 =128	No renewals.	257 then 299	5/8	2·13	Destructive. Pipes drawn out of sockets.	The feed was shut off while hot gases passed through economiser. (The photograph, Plate II., shows a pipe broken in socket).
1856	-/-/1901 6/5/1909	8	8×20 =160	3 in '08	190	3/8 but cracked.	—	Light explosion. One old crack revealed.	The hydraulic test of one month previous did not show up old crack, or else it started it.
1970	-/-/1904 27/6/1910	6	8×12 =96	2 in '09	165	Not reported.	—	No report heard. Water ran out of flue.	A case of wear and tear.
2080	10/1890 11/1901 2/8/1911	21 10	8×24 =192	No renewals.	120	1/16	1·69	One dull, one sharp report. Only the old economiser destroyed.	Curious case if correctly reported. 1910 hydraulic test to 190lbs.; stress, 2·68 tons. No failures.
2251	-/-/1911 30/1/1913	1	12×36 =432	No renewals.	166	1/2	0·315	Three top boxes burst longitudinally. Also 15 transverse fractures. Two pipe fractures in sockets.	The cause was doubtless weakness of boxes, or excessive forcing in pressure.
2257	— 18/6/1913	6	6×12 =72	No renewals.	155	1/8	1·11	Only one tube shattered.	Curious case. Shattered tube suggests that there was steam in the economiser. Report silent on this point.
2470	-/7/1909 6/11/1918	9	10×24 =240	1 in '17 3 in '18	198	— (5/16)	— (0·96)	Destructive	Reported cause: accidental omission to close damper. Real cause: a number of circumferential cracks in sockets.

*Note for Table II., Case 242. ANALYSIS OF ORIGINAL PIPE AND GRAPHITIC CORROSION.

	Cast-iron pipe M.S.U.A. per cent.	Graphitic Corrosion M.S.U.A. per cent.	Graphitic Corrosion B.T. per cent.
Silicon	2·08	—	—
Sand	—	22·22	3·20
Graphite	3·16	4·09	3·20
Comb. Carbon	0·23	—	—
Sulphur	0·13	—	—
Phosphorus	1·48	—	—
Manganese	1·26	—	—
Iron	90·72	52·71	—
Oxygen	—	20·08	—
Black Oxide	—	72·79	84·60

The Board of Trade Graphitic Corrosion was probably obtained from another cast-iron vessel. According to our (M.S.U.A.) analysis 48in. per cent. iron has been dissolved out.

TABLE 2.

closed vessel. Thus although the Commissioners might plead that they were merely quoting the words of the Act, they do so in such a way as to make it appear that some person had changed the economiser from being an open vessel into becoming a closed one.

It is not intended to indulge in speculations as to why the Commissioners adopted this course; why, in the abovementioned sentence, they did not state that this so-called vessel was provided with a safety valve of ample size, which was doing its duty by blowing off steam, nor why the Commissioners disregarded the evidence of the Board of Trade Surveyors, and all other engineers, and entirely omitted from their report any mention of the real cause of the explosion. However, in view of the importance of this case, it has been thought desirable to go into some detail on several of the points which do not appear in the report, though they were given in evidence, or which are dealt with in an unsatisfactory manner. No details are given in the report of the reduced thickness of the pipes, though 3-16 in. was mentioned in the evidence. Assuming a tenacity of 2.35 tons per square inch (see experiments p. 23), the bursting pressure would be 490 lbs. per square inch, but if, as may be, the tenacity was twice as great, the bursting pressure would be about 1,000 lbs. The pressure to which the safety valve was loaded, was 188 lbs., and it is ridiculous to imagine that the valve, which was quite free in action, should allow an accumulation of over 400 per cent. of pressure. In fact, there would not be enough heat in the flue gases to produce any accumulation.

Economisers collect about 15 per cent. of the heat supplied to their boilers. In this case the boilers had 88 sq. ft. of grate area, and at 188 lbs. would, according to the Board of Trade rules, require a safety valve area of 16 sq. ins. Therefore 15 per cent. or 2-4 sq. ins. would have sufficed for the economiser.

The safety valve was 1 15-16 in. diam., or 3 sq. ins. area and, therefore, amply large enough to relieve the economiser of any excess of pressure. For a pressure of 490 lbs. a safety valve of 1 1-8 in. diam. would have sufficed, and for double that pressure a safety valve of 7-8 in. diam. would have been sufficient. There is, therefore, absolutely no justification for the Commissioners' suggestion that an excessive pressure was generated in the economiser.

During this very prolonged enquiry, at which I was present, occasional questions were asked about the effect of passing hot gases through an economiser while out of use. It is, therefore, desirable to deal with this point. The temperature of flue gases is about 600 degs. Fah., or about equal to that of superheated steam. Now superheated steam can safely be passed through cast-iron pipes and into cast-iron cylinders of engines which are subjected to innumerable reversals of stress, without any failure occurring. Then again during the early days of electric power stations, when the peak load demand was often far in excess of the boiler power, it was quite a common practice to shut off the feed during the peak load period while allowing the flue gases to continue to pass through the economisers, thus converting them temporarily into steam producers, and thereby raising the boiler power by about 30 per cent. The chief engineer of one of the largest power stations of those days has recently confirmed what he told me years ago, that he knew at the time that he was producing steam in his economisers. He had no failures during these periods (evidently it was not the chance turn of any of his pipes to rail during the hour of maximum peak load) and now that they are 10 or 12 years older than then, they are still working satisfactorily. Then again, it is well known that the makers of economisers at one time thought that water-tube boilers could be made of cast iron, and they actually worked an economiser as a steam generator. They had troubles and gave up the idea, but they had no failures. That they at least have no fear of failure in case the feed should be shut off, and dampers left open, is evident from the fact that in their working instructions to firemen there is not a word to suggest that dampers should be shut whenever the feed is shut off or that the economiser would explode if this were not done. In fact if the leaving open of a damper were known to lead to an explosion, anybody who advises the use of a vessel which would explode every time that a careless fireman forgets to shut a damper is a criminal.

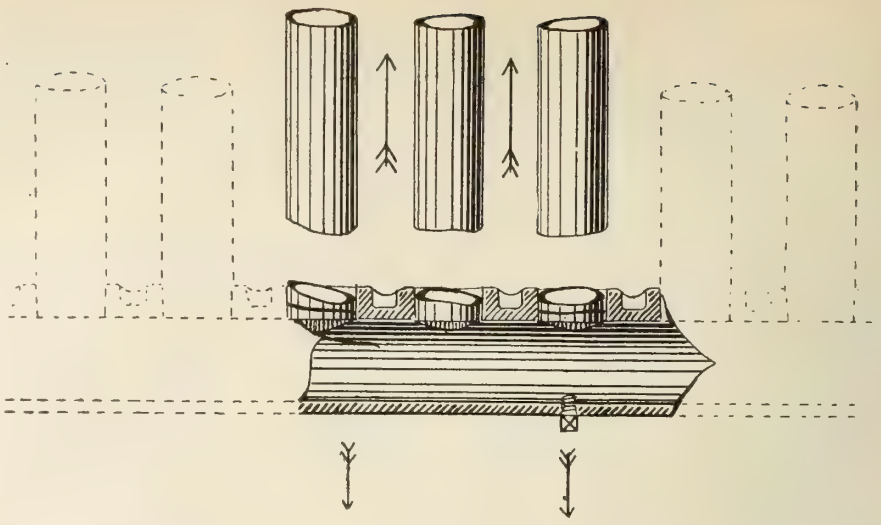
Had the report contained this conclusion, and its corollary—that all existing economisers must be scrapped—engineers and steam users would have dismissed the report with a smile; but the seriousness of the present report (No. 2470), and the reason why it has been specially mentioned here, lies in the fact that it omits to mention certain old fractures. Two "competent and independent engineers, practically conversant with the manufacture and working of boilers," were selected by the Board of Trade from among their own staff to make the preliminary enquiry, and had carried out their task with the most painstaking care. These and other engineers refused in their evidence to admit that the open damper could have caused the failure of any of the pipes, and attributed the explosion to the just-mentioned old fractures. By withholding this information the report deprives the engineering profession of the means of studying the problem of economiser safety, and were thus hampering them in their constant efforts to make structures safer and safer. This course may have seemed to them a natural one, for the cart had been put before the horse in this enquiry, and instead of first ascertaining the nature of the explosion and its cause, and who was responsible for this, the first three or four days were devoted almost exclusively to subjects of personal responsibility which had already been disposed of in so many hours at the coroner's inquest. Sworn evidence was taken as to when and how the victim was killed—whether the works manager, his engineer, or the leading stoker, or the company, was responsible for his death, or for appointing the man who may have caused his death. This wearying evidence, which lasted for several days, was absolutely valueless, except for the purpose of confirming or reversing the verdict given at the inquest. But the commissioners have no power in this respect; their power is limited by the Act to adding to the evidence—which, as in this case, is filed away in the Board of Trade archives—"any observations on the evidence or on any matter arising out of the investigation." The report, but apparently not the evidence, nor, it would seem, the remarks which the commissioners may feel inclined to make on the evidence, must be published by the Board of Trade.

The intention of the Act was that the publication of reports on the causes of explosions should enlighten engineers and steam users, and thus pave the way for reducing the risk of explosions, and the present report, therefore, ought to have contained not merely the observations of the commissioners on the evidence, but, above all things, a statement as to the cause of the explosion. It should not have fastened on one of several coincidences and misinterpreted the words "closed vessel." Unfortunately, in legal circles great confusion seems to prevail with regard to the meaning of the words "cause" and "coincidence." This is, of course, excusable, for it has been a human failing through all ages to attach importance to coincidences, even to the positions of stars at the birth of children. Engineers, however, may be pardoned for not wishing to be guided by coincidences. They will refuse, and rightly refuse, to admit that because once every fours years the opening of a damper coincides with one of the thousand of economiser pipe failures, therefore economiser explosions are caused by leaving dampers open.

Having discovered the cause of the explosion, but which engineers would merely call a coincidence, it was, of course, quite natural that the commissioners should attach no value to expert evidence on subjects which they considered of no importance, and should refuse to listen to evidence about experiments made specially for the enquiry, and should, as already stated, banish from their report all mention of some very important evidence about old circumferential fractures in the pipes, to which their predecessors in this enquiry attributed the explosion, the broken pipes being actually shown to the commissioners.

Reports Nos. 186, 566, and 1,790, and particularly the illustration in this last report, suggest very strongly that in these economisers, too, some of the pipes were fractured circumferentially, but in the absence in these reports, of any indications as to whether they include all the essential facts, it is impossible to say whether these fractures existed and were discovered, and if so whether mention of them was kept out of these reports or not.

A part of one of the bottom boxes of the present economiser is illustrated in Fig. 1, which represents a section through the broken piece, now in our museum. The dotted lines indicate the continuations of the box, which could not



be found, and the arrows are intended to show how the box and the pipes moved relatively to each other when they parted company and caused the explosion. This box had been removed from the site of the explosion, and it is, therefore, impossible to say definitely whether it belonged to the old worn-out A block or to the comparatively new second block B. Judging, however, by the upper fracture of the left-hand pipe (Fig. 1), which includes the waist of the wasted portion of this pipe, where it is ⅝ in thick, this box belonged to the B group. It also appears that the flue arch which fell in, was situated under the B block. This failure will have been caused by a bottom box of that group becoming detached and striking the top of the flue. An examination of Fig. 1 shows that two of the remaining three pipes had two circumferential cracks in the sockets. Of these the lower ones were quite old, and the upper ones seemed to be older than the explosion.

In consequence of this discovery special attention was paid to the ends of the pipes of economiser parts which have had to be rejected when new, after the first hydraulic test. Even at this early stage of their lives occasional pipes were found to be cracked circumferentially in their sockets. These facts, the knowledge that there are zones of severe shearing stresses near to the nipped portions of the pipes, and the knowledge that cast iron has no great shearing strength, may be a guide to researchers into this interesting subject.

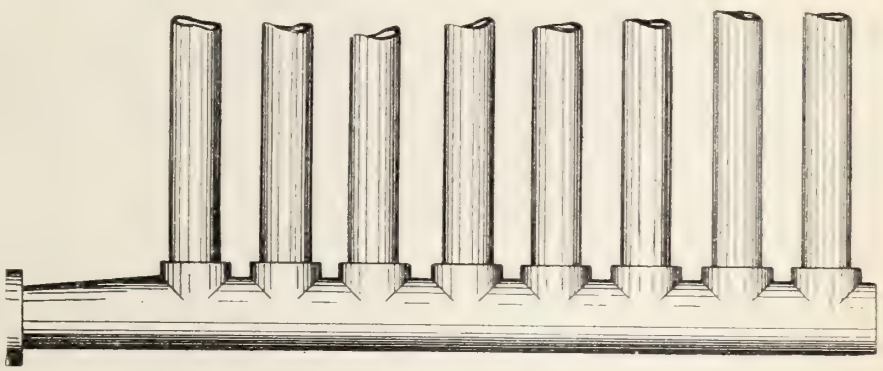
In order to test this point a model economiser was made of glass pipes, which, according to Table IIa, should break under a side pressure of 14 pounds per square inch. The central tubes were replaced by an air reservoir whose end was closed with a celluloid disc. This disc burst with a loud report, as of a pistol shot, when the pressure had reached about 300 pounds, but no pipes were broken. On repeating the experiment, with broken pipe ends piled up over the celluloid, some of the vertical pipes were broken. It is intended to repeat this experiment at the M.S.U.A. annual meeting, for it shows that side-pressure alone, without flying fragments, will not fracture pipes. This simple experiment definitely settles the vexed question about the flue-gas explosions. These cannot burst economiser pipes. It also explains that it is a mere matter of chance whether a pipe explosion will confine itself to one pipe or sheet as in cases Nos. 186, 1,856, and 2,257, or whether it will be a destructive one, as in cases Nos. 154, 220, 566, 647, 1,790, 2,080. In the one set of cases the flying fragments of the first pipe, or sheet, which burst, evidently did not strike the adjoining pipes, and the liberated pressure alone could not break them; in the other set the surrounding pipes were evidently struck by fragments.

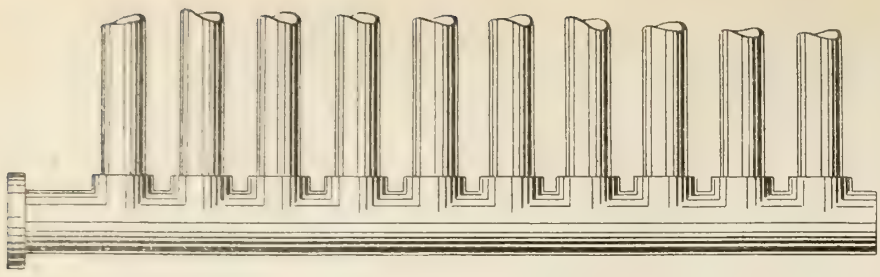
Destructive economiser explosions like the present one are extremely rare and difficult to understand, and it is, therefore, very regrettable that the enquiry was not carried out in harmony with the spirit of the Boiler Explosions Act, which says that the commissioners shall report on the cause of the explosion. As already explained, the commissioners' view of the cause of this explosion is obviously a wrong one, but whether it be right or wrong it ought to be correct in its details. Thus, they assert that the explosion was caused by the leaving open of a damper and closing the valves, but they make the wrong assertion that the economiser was now a closed vessel, omitting to mention that it was provided with a safety-valve of ample size. If this very important fact had been mentioned their assertion that the economizer exploded owing to over-pressure (of which there was absolutely no evidence) could hardly have been made, and then they would have had to explain how their alleged cause acted. Did it result in overheating and if so, does overheating weaken iron? (Experiments show that up to a fairly high temperature the tenacity does not diminish.) Does this overheating slacken the tubes in their sockets? (There was no indication of this amongst the fragments.) The fact is that the commissioners, of whom one or more has to be "a competent and practical engineer specially conversant with the manufacture and working of steam boilers," do not actually make their investigations in such a manner as "to enable them to make the report hereinafter mentioned, which report shall be a full one on the cause of the explosion." The investigation is, in effect, carried out by the solicitor of the Board of Trade, who brings forward sworn evidence, though the swearing is not required by the Act, and without any warning to the witnesses, these may now be cross-examined both by their own side and by the commissioner, and then very often their own sworn evidence is used against them. This is un-English and not as it should be.

It is unfair to witnesses who wish to give the commissioners every assistance, and as the whole atmosphere is now a legal one, even a Lord Advocate once appearing for an insurance company, the technical causes of exeplosions are hardly inquired into.

Now, in this almost unique case, if one or more engineers having a free hand in the matter could have enquired into those economiser points which have always been a mystery, they would certainly have investigated the strength and quality of the cast iron, its behaviour when heated, on the holding power of the sockets, and above all, on the causes of the circumferential fractures, more particularly why they seem to have been confined to one bottom box. If such engineering commissioners had thrown any light on any of these points, their report would have been highly valued by engineers, but the reports produced under the present system are not of this class, and few engineers pay any attention to them, so much so that when the influential British Engineering Designs and Construction Committee, which recently issued Standard Conditions for the Design and Construction of Marine Boilers, were deliberating on this subject, the Board of Trade reports were apparently not consulted even though their chief engineer attended the meetings.

Yet these reports could be made valuable if the system which our Explosions Act was intended to perpetuate, were carried out. Before, and even after, 1882 this association made it its duty to investigate boiler explosions. But we did not send our surveyors in rotation to do this work, as is the Board of Trade practice. We confined these enquiries to one assistant who soon grew to be an expert enquirer into explosions, as is proved by the very valuable reports furnished by him and formerly published by us. I have on several occasions suggested that instead of appointing every one of their surveyors in rotation to investigate explosions, the Board of Trade should retain an "independent engineer, practically conversant with the manufacture and working of boilers," as required by the Act, and instruct him to make thorough enquiries whenever an explosion occurs, both into the design of the boiler, the strength of its material, and the conditions of working. The Board of Trade surveyors would be relieved of suddenly-imposed tasks which interfere with their routine duties, whereas many an independent engineer thoroughly qualified both theoretically and practically to discover the causes of explosions would enter with enthusiams into the investigation of interesting engineering problems. The heavy legal expenses of the present formal enquiries, which would then rarely be necessary, would be set off against such an independent engineer's fees and expenses, including experiments. Judging by conversations which I have had with Board of Trade





surveyors, and also with chiefs of boiler insurance companies, the retaining of an independent engineer for explosion enquiries would be most welcome and sure to add to our knowledge of the safe working conditions of boilers.

There is one point with regard to the safety of economisers which deserves a closer study. This is the question of deterioration of the cast iron. It will be remembered that in my Memorandum for 1916-17, dealing with enquiries into boiler shell explosions, I found that wrought iron which has been wasted down to about ⅛ in. or 1-16 in., has lost its nature and should not be credited with any tenacity. Does cast iron behave in the same way? Two tests were carried out on this subject some years ago.

First Test

The sheet of eight pipes gave way at the bottom end of one of the pipes (see Fig. 2), at a pressure of 620 pounds per square inch, a triangular piece, 6¼ in. × 2¾ in., being blown clean out. The thickness of this piece varied from ¼ in. to 9-32 in. The internal diameter of the pipe was 4 in., and the mean diameter 4¼ in. The tenacity of the cast iron was therefore

$$\frac{4\frac{1}{4}\text{ in.} \times 620\text{ lbs.}}{2\text{-}4\text{ in.} \times 2{,}240\text{ lbs.}} = 2.35\text{ tons per sq. in.}$$

Second Test

The sheet of ten pipes gave way at the bottom end of one of the pipes (see Fig. 3), at a pressure of 350 pounds per square inch, a piece about 9 in.×2 in. being blown out. The thickness of this piece varied from 1-16 in. to ⅛ in. The internal diameter was 4 in., and the mean diameter 4 1-16 in. The tenacity of the material was therefore

$$\frac{4\text{ 1-16 in.} \times 350\text{ lbs}}{2\text{-}16\text{ in.} \times 2{,}240\text{ lbs.}} = 5.08\text{ tons per sq. in.}$$

See also Table II., Report No. 1,687. Bursting stress 1.78 tons.

The lowness of these tenacities is probably due to the deterioration of the material in its exposed position and is, of course, taken into account by us when reporting on the fitness of our members'

HAVANA CENTRAL STATION TO DOUBLE POWER-PLANT CAPACITY

On account of a rapid growth of load and the possibility of a still further growth in the next few years, the Havana (Cuba) Electric Railway Light and Power Company has just ordered two 25,000 kw. Westinghouse steam turbine-generators to double the plant rating. At present there are, in this plant, three 12,500 kw. generators supplying a combined railway and power load. In the original installation, space had been provided for only one additional unit, but now that the load has become so great it was thought necessary to increase the capacity still more. Consequently the two 25,000 kw. units were ordered, one to be installed in the space available, and the other to replace one of the 12,500 kw. units. By this means it is unnecessary to extend the power plant buildings. However, the 12,500 kw. unit is in perfect operating condition and will probably be utilized elsewhere.

The first unit will be installed and will be in operation in 1921 and the second one will be on the line in 1922. The units are to be designed to operate at 185 lbs. pressure, 150 deg. superheat and 28 in. vacuum. In addition, arrangements have been made to operate this equipment at higher pressure and superheats if desired at a later time.

To go with these turbine-generators, Westinghouse Le Blanc 56,000 sq. ft. surface condensers and Le Blanc air and circulating water pumps have also been ordered. Each condenser will have two circulating pumps and divided water boxes so that one-half of the condenser may be cleaned while the other half is in operation.

This station, which is the largest in Cuba, is modern in every respect and has an operating economy which is comparable with some of the best plants in the United States.

The average fuel consumption is less than 2 lbs. of coal per kw. hr. notwithstanding that the plant has a low load factor. This economy is due to the excellent operation and maintenance afforded by the management and operating engineers of the plant.

COAL CONSERVATION FILM AVAILABLE FOR EXHIBITION

Engineering clubs and societies, manufacturers' associations, commercial organizations, technical schools, and the educational departments of large corporations will be interested in the announcement that the Diamond Specialty Co., Windsor, Ontario, now has available for free distribution three copies of its motion picture, "Coal is King." This picture was prepared from a scenario by Robert June, and the pictures were taken under his direction by the Ford Motor Company.

The film was originally prepared as part of the Coal Conservation Campaign used during the war, but has just been completely revised and brought up to date, all war material being eliminated and much new material added. The film deals with good and bad methods of coal mining and transportation, good and bad methods of firing, combustion losses and their minimization, power plant instruments such as draft gauges, CO_2 recorders and their uses, losses caused by leaky boiler settings, good and bad management of the boiler room, and the necessity for keeping the boiler surfaces clean is properly brought out. Pictures of scale and soot removal, losses caused by firing the boiler too high or too low above or below rating, losses caused by cutting in stand-by boilers too early or too late, losses caused by uncovered steam pipes, leaky pipes, steam traps, etc., are shown.

The film is in four reels, requiring approximately 50 minutes to be shown. Bookings are now being made for the summer and fall, and those interested should make their reservations without delay in order that schedules may be completed.

MINIATURE CATALOGUE DESCRIBES WATTHOUR METERS

The Westinghouse Electric Manufacturing Company, has issued miniature catalogue 3-A-1, measuring 4 in., by 7 in., which describes and illustrates its lines of watthour meters. In this booklet the following instruments are described as to the operation, distinctive features, construction and application: Type OA watthour meters for alternating current service, type OA prepayment watthour meters, type RO watthour demand meters, (single phase and polyphase); type RA recording-demand watthour meters (polyphase), type RH thermal demand meters, type CW-6 watthour meters, and portable standard watthour meters.

The information contained in this catalogue is the same as that on pages 625-638 inclusive of the Westinghouse annual supply catalogue and descriptive leaflet No. 3484.

A Swedish engineer, remarks "Engineer," ran several incandescent lamps at temperatures of 200 degrees Cent., while others cooled by water were worked at about 2 degrees Cent. After some hour's running in the case of the lamps at a temperature of 200 degrees the luminous intensity had dropped considerably, and they were unusable after forty hours' running, whereas with the lamps run at 2 degrees the diminution of intensity was inappreciable after that period. This deterioration is apparently explained by the fact that at high temperatures the glass of the bulb becomes porous and air enters the bulb, and it also explains why, where large numbers of lamps are arranged close together in advertisement signs, etc., they rapidly deteriorate.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE have covered the ground fairly well in the two previous lessons as far as fractions and decimals are concerned. By this we mean that we have given sufficient indication of the methods of using these functions to enable the student to perfect himself after a little practice. We propose now to indicate the methods of raising numbers to their different powers, and of extracting the roots of the various powers of numbers. These operations are known as involution and evolution. While it is as well to know how to perform these operations arithmetically, we would like to emphasize here that it is far more easy to use tables, either those giving the powers and roots of numbers, or logarithmic tables. It is not only easier, but there is less liability to error, while time is saved which would be used in making long calculations. There are cases where the only way to get the result is to use either tables or logarithms. However, we will indicate the method of getting the square and cube root by the ordinary arithmetical way, and leave it to the reader to find out the use of the tables, or logarithms if he feels like it. We may take up the use of logarithms at a later stage of these articles, but at present we wish to get over the preliminary ground as quickly as possible, and reach the actual engineering problems.

Involution

Involution is the act of multiplying a number by itself a given number of times, the number itself being the root, and the times it is multiplied by itself being the power of the number. The power to which the number is to be raised is indicated by a small number placed above and to the right of it, as for instance 3^2 which signifies that 3 is to me multiplied by itself once, or in other words, to be raised to the second power, or as usually expresesd, to be squared. If it is 3^3, it means 3 is to be multiplied by itself twice as $3 \times 3 \times 3$ or to be raised to the third power. The same applies to all the powers, as 3^4, 3^5, 3^6, and so on. The small number is known as the index or exponent of the power.

In multiplying together two powers of the same number as $3^2 \times 3^3$, the exponents or indices are added together, thus $3^2 \times 3^3 = 3^5$. Two powers of the same number are divided by subtracting the exponents thus: $3^4 \div 3^2 = 3^2$. If we have $3^2 \div 3^4$, we get as the result of the subtraction, $2 - 4 = -2$, then the exponent will be 3^{-2} or three to the minus 2 power. Now the minus 2 power can be expressed by making the number the denominator of a fraction with one for its numerator, and raising the denominator to the power indicated. Thus 3^{-2} would be written as $1/3^2$. Take $2^5 \div 2^9 = 2^{-6} = 1/2^6$: The exponent of the power may be a fraction and then means that the number is to be raised to the power shewn in the numerator, and the root as expressed by the denominator extracted. For instance, take $2^{2/3}$ means that the cube root of 2 squared is to be taken, or we might write it as $\sqrt[3]{2^2}$. If written thus, $2^{1/2}$ we know it means to take the square root of 2, because the first power, as expressed in the numerator of the index, is the number itself. 2 to the first power is 2. The zero power of a number always equals 1. Thus $2^0 = 1$, $3^0 = 1$, $3^1 = 3$, $3\frac{3}{3} = 3$. There is no limit to which a power can be raised, but in practice it is only the first two or three powers which are in general use.

For the work we are concerned with the square, cube, and fourth powers and roots will be ample.

Evolution

The extraction of the root of a power of a number is known as evolution. In the ordinary way, it involves a lot of work, and is better achieved by the use of tables. However, in order that it may be of use in refreshing the memory of some, and instructing others, we will give herewith the method of extracting square root and cube root by the arithmetical process. Square root is comparatively simple, but cube root is more involved. The fourth root can be obtained by extracting the square root, and then extracting the square root of the result. In other words, it is the square root of the square root. The sixth root is the square root of the cube root. The ninth root is the cube root of the cube root. If a number is to be raised to a power, and a different root extracted, the whole thing can sometimes be done by dividing the index of the root into the index of the power. Thus $2^{6/3} = 2^2 = 4$. $2^{3/3} = 2^1 = 8$ and so on. The small figures in this case representing fractions.

The method of extracting square root will now be explained in detail. The first thing to be done is to space off from the unit figure every two figures. If we have a number 784, which we want to extract the square root of we will start at the figure 4 and space off to the left. We will have 784

Now take the first figure 7 and divide it by the greatest number whose square is less than 7. The square of 3 is 9, so that is too much. The square of 2 is 4, so we can take that. This will be the first figure of the quotient and the sum is set down as follows:

```
784(2
4
-
3
```

The next operation is to bring down the two figures remaining, and place them after the 3, making the sum.

```
784(2
4
—
384
```

We then multiply the first figure of the quotient by 2, and bring the product down to form the next trial divisor. We now have

```
      784(2
      4
      —
4     384
```

4 is now the first figure of a new divisor for the number 384. We try 4 into 38. It will go 9 times. We place 9 after the 4 and try it, thus $49 \times 9 = 441$. We see it is too much. We then try 8, which makes $48 \times 8 = 384$. We see this is an exact dividend. We therefore place 8 in the quotient and alongside the 4 and we now have:

```
      784(28
      4
      —
48    384
      384
      —
      ...
```

And the square root of 784 is 28. Let us take another number, say 4225. Proceed as at first, spacing off each second figure from right to left. Then we have 42.25.

What is the greatest number whose square is less than 42. We can decide this mentally. It is 6, so we have

```
42.25(6
36
—
.6
```

and bringing down the next two figures

```
4225(6
36
——
.625
```

We then multiply the first figure of the quotient by 2, as before and get 12 as the first part of the trial divisor, which gives us:

```
      4225(65
      36
      —
125   .625
       625
       —
      ...
```

65 being the required square root.

In both the preceding cases, the root has come out even, but this is not always so We may have a fractional result, and it is usual to make this a decimal, as it is very simple to carry out. Let us find the square root of 8. The nearest root figure we can think of is 2, the next 3 being too large, and the square of 2 is 4, thus giving us the following:

```
8(2
4
-
 4
```

There are no more figures to be brought down, and we have a remainder of 4. We proceed as follows: Put a decimal point after the 2 in the quotient, and add two ciphers to the remainder in the dividend. Thus we will have :

```
8(2.
4
---
4   400
```

We have then 4 as the first figure of our trial divisor. What will be the second 4 into 40 will go 10 times, but that is not practicable. Try 9 which would make the divisor 49, and the next figure of the quotient 9. $49 \times 9 = 441$ which we see is too much. Let us try 8 which gives $48 \times 8 = 384$ which will go. We now have:

```
8(2.8
4
-
48  400
    384
    ---
    .16
```

We must now bring down two more ciphers, and multiply the quotient by two for a trial divisor, thus:

```
8(2.8
4
-
48  400
    384
    ---
56  .1600
```

The next figure will be 2, by trial, and we can proceed. Each new trial divisor is found by doubling the root all ready determined, and the dividend is continually renewed by adding two ciphers. The root is carried to as many places of decimals as is thought necessary, though of course, it might never work out exactly. Let us see how far it goes:

```
8(2.828427
4
-
 48  400
     384
     ---
 562 .1600
     1124
     ----
 5648 47600
      45184
      -----
 56564 .241600
       226256
       ------
 565682 .1534400
        1131364
        -------
 56568547 .40303600
```

We can dispense with any further decimals and call the square root of 8 — 2.8284. Suppose now, we have to find the square root of a decimal fraction and a whole number, we proceed just the same. The figures before the decimal point are spaced off in twos from right to left, and those after the decimal point from left to right. The root is then extracted in just the same way as before.

Find the square root of 25.25:

```
25.25(5
  25
  --
   25
```

Here, we have found the complete root of the integral part of the number, and now have the decimal part remaining. Multiply the root already found for the trial divisor, and place a decimal point after the first figure of the root. We then have the sum in the following form:

```
25.25(5.
  25
  --
10   .25
```

As we cannot divide 10 into 25 and still provide for the second figure of the root, we add a cipher to the quotient and one to the trial divisor, and add two ciphers to the dividend, giving us:

```
25.25(5.0
  25
  --
100  .. 2500
```

We can now divide, 2 being the figure to add to the root, and then proceed as usual:

```
25.25(5.02493
  25
  --
1002  2500
      2004
      ----
10044  49600
       40176
       -----
100489 .942400
       904401
       ------
1004983 .3799900
```

The square root to 5 places of decimals is 5.02493 which is not an exact result, but is very slightly in error, as a simple proof will show.

```
   5.02493
   5.02493
  --------
   1507479
  4522437
 2009972
1004986
2512465
--------
25.2499218049
```

Leaving off all decimals after the fourth the error is $25.25 - 25.2499 = .0001$ or $\frac{1}{10000}$. The square root of a decimal quantity is found in the same way. The square root of .5 will be found in this way.

As there is only one figure after the decimal point, we add a cipher and make it .50. The nearest square root is .7 and we have:

```
50(7
49
--
14   .100
```

We must add a cipher in the quotient and one in the divisor, adding two to the dividend, thus getting:

```
50(7071
49
--
140   10000
1407   9849
----  -----
14141 ..15100
        14141
        -----
        ..959
```

the root is then .7071.

If we had to find the root of .05, we would be able to go straight ahead, as we would then have two figures after the decimal point. The reason there must be two figures after the decimal point is obvious after a little thought. When we multiply decimals, the product will have as many places of decimals as there are in multiplicand and multiplier. Therefore in the case of .5, the square root cannot be .2 as .2 multiplied by itself gives .04. On the other hand, the square root of .05 is .2236. The square root of .005 would again be different. Pointing off, the first two figures would be ciphers. We would, therefore, put a cipher in the quotient after the decimal point and bring down the next two figures. There is only one, 5, so we add a cipher to that, and then take the nearest root. The work is as shown:

```
.005(.0707
00
--
  50
  49
  --
1407 .10000
       9849
     -----
14    ..151
```

This should be sufficiently clear to all by now.

In taking the square root of a fraction, the square root of denominator and numerator are taken separately. For instance, the square root of $\frac{25}{36}$ would be $\frac{5}{6}$. When a fraction is to be raised to a power, it is indicated by enclosing it in a bracket and putting the exponent or index at the top right-hand corner, as:

$$\left(\frac{5}{6}\right)^2 \text{ or } \left(\frac{3}{6}\right)^3, \text{ etc.}$$

When the root is to be extracted, it is written $\sqrt[5]{\frac{}{6}}$ or $\sqrt[3]{\frac{}{6}}$ as the case may be. Find the fourth root of $\frac{625}{1296}$ would be written $\sqrt[4]{\frac{625}{1296}}$. First find the square root of $\frac{625}{1296} = \frac{25}{36}$. Then take the square root of the latter $\sqrt[2]{\frac{25}{36}} = \frac{5}{6}$.

We could give examples indefinitely, but feel that the foregoing should serve all practical purposes.

A Series of Articles on Power Plant Management

This Article Deals with Boiler Feed Water Heaters, the Merits of the Open and Closed Types Being Compared.

By ROBERT JUNE

Feed Water Heaters

WHAT does a feed water heater accomplish? If I have not a feed water heater in my plant would it be profitable to install one? These are questions, the answer to which is of considerable interest to the manager or superintendent of a factory producing its own power.

As its name implies, the feed water heater is an apparatus for increasing the temperature of the feed water before it is admitted to the boiler. Generally speaking, for every 11 to 12 degrees the feed water is heated, there is a gain in heat of 1 per cent. and a corresponding saving of coal, provided the heat which warms the feed water would otherwise be wasted. The fuel saving effected by preheating feed water is shown in Table I. It will be noted that the savings effected range from 1 to 15 per cent, with 7 to 12 per cent. as the most probable amounts to be effected in practice. The table has been worked for a boiler pressure of 1 lb. as well as for a pressure of 200 lbs., and it will be seen that boiler pressure is a factor of practically no importance in the matter, inasmuch as there is only a difference of ½ per cent. or less in savings with 1 lb. pressure as compared with 200 lbs.

TABLE 1.

Fuel Saving Effected by Pre-heating Feed Water.

Increase in temperature of feed water.

	32 to 212	40 to 212	50 to 212	60 to 212	70 to 212	80 to 212	90 to 212	100 to 212	110 to 212
					Degrees.				
Boiler Pressure—					Per Cent.				
1 (one) lb.	15.48	14.79	14.08	13.35	12.60	11.83	10.92	10.12	9.32
Boiler Pressure—									
200 lbs.	14.94	14.28	13.60	12.75	12.04	11.31	10.56	9.68	8.92
					Degrees.				
	120 to 212	130 to 212	140 to 212	150 to 212	160 to 212	170 to 212	180 to 212	190 to 212	200 to 212
					Per Cent.				
Boiler Pressure—									
1 (one) lb.	8.46	7.60	6.72	5.82	4.90	3.96	3.00	2.02	1.02
Boiler Pressure—									
200 lbs.	8.10	7.28	6.44	5.58	4.65	3.76	2.85	1.92	.97

Increased Boiler Capacity

The heater does part of the boiler's work. With the same quantity of coal burned a considerable increase of boiler output is assured by heating the feed water, since the latter enters the boiler with a part of its heat supplied. A greater evaporation will take place with the same amount of heat transmitted through the boiler-heating surfaces.

Thus, for example, with an initial temperature of 60 degrees, and a boiler pressure of 120 lbs., the total heat that must be supplied is 1163.6 B.t.u. per lb. of water. If, however, the feed water temperature is raised to 210 degrees, which is an increase of 150 degrees, we find that only 1013.6 B.t.u. per lb. of water is required. This is a difference of 150 B.t.u., which is equivalent to 13 or 14 per cent. increase in capacity of the boiler with the same amount of fuel.

The feed water heater reduces boiler strains and damage to boiler plates. When cold feed water is precipitated into the boiler, sudden violent strains are almost sure to occur. When the cold water strikes the hot plates the rivets may become loosened, and as the strains are local the plates and tubes may be directly injured as well as the joints become loosened. It is almost axiomatic that good service and long service cannot be had from any boiler supplied with cold feed water. The advantages of relieving boilers of the violent strains caused by the admission of cold water are not measurable by the saving in wear and tear but are nevertheless very marked.

The Economic Utilization of Steam

Efficient and inefficient engines have one characteristic in common, that is, that neither abstracts any large amount of heat from the steam. This is an important point to remember in connection with the possible use of a feed water heater and is a point directly connected with the choice of an engine and decision as to whether it shall operate condensing or non-condensing.

The answer depends upon what use can be made of the exhaust steam. Thus, if we can use exhaust steam for heating purposes, for drying materials, or in the various plant processes, the steam economy of the engine may not be important, but in preference to installing an expensive and elaborate condensing engine we may find it better economy to put in a low-priced non-condensing engine, using 30 to 40 lbs. of steam per hour and to utilize a part of the exhaust steam for the purpose of pre-heating feed water.

Classification of Heaters

Feed water heaters are generally placed in one of the following classifications:

1. Open Heaters.—In which steam and feed water mingle and the condensing gives up it heat directly to the water.

2. Closed Heaters.—In which the steam and water are in separate chambers and the steam gives up it heat to the water by conduction.

To further classify heaters, they are sometimes separated according to the pressure of the heating steam, as:

(a) Vacuum of Primary.—In this type the pressure is less than atmospheric. These are the heaters using an exhaust

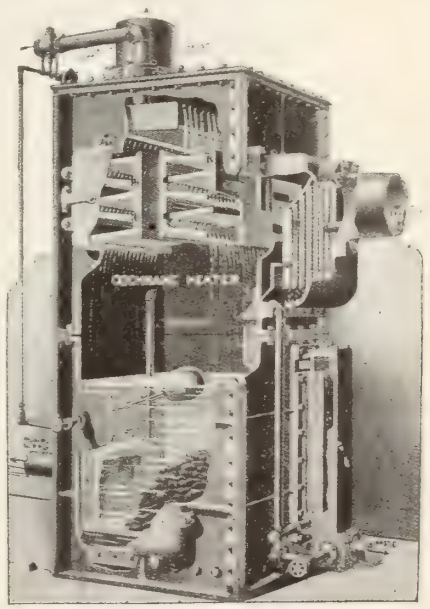


FIG. 1—COCHRANE OPEN FEED WATER HEATER.

of condensing engines and are always of the closed type.

(b) Atmospheric or Secondary.—In this type the pressure is atmospheric, or, to be exact, the pressure corresponds to the back pressure on the engine and pumps.

(c) Presure Heaters.—In this type the pressure corresponds to that in the boiler. These heaters are used primarily for purifying purposes.

Among well-known closed heaters of the atmospheric type are Cochrane, Hoppes, Stillwell, Webster, Elliott and National.

Among well known heaters of the closed type are Wainwright, Wheeler, Otis, National, etc.

Essential Requirements of Open Heaters

The principal objection to the use of

the open heater is that the oil in the exhaust steam may reach the boilers, but when the oil separator really takes out the oil, a most serious objection is removed. Therefore, the open heater should have an effective oil separator large enough to form a part of the heater and should be so designed as to eliminate all the oil before the exhaust steam enters the heater. It is not commercially practical to remove the oil or emulsion from water and the filter bed should never be depended upon for this work.

To operate satisfactorily, the oil separator should have port areas of ample size and unrestricted passage. It should be self-cleaning.

The water carrying capacity should be large; in fact, it is what really determines the rating of the open heater. Best results in purifying are assured with a large volume of water, and when there is an ample supply the fluctuations in demand for boiler feed water will cause no trouble and the boiler feed pumps will run smoothly. There should be, at least, a five-minute supply in the feed water heater, although of course local conditions may alter this amount.

The purifying of feed water in an open heater demands that the construction allow an even facility for cleaning. The interior should be accesible without disturbing piping conditions, and it should be possible to renew filter material without breaking a single connection.

The Cochrane, Fig. I, is a typical example of an open heater. Exhaust steam enters the heater through a fluted oil separator, as indicated, and passes out at the top, while the oil drips are automatically drained to waste by the suitable ventilated float. The feed water enters through an automatic valve and is divided over a series of copper trays, so arranged and constructed that the water is forced to fall in a finely-divided stream before reaching the reservoir in the bottom. The steam, coming into contact with the water particles, gives up latent heat and condenses. Some of the scale-forming element is deposited on the surface of the trays from which it must be removed. The suspended matter is eliminated by a coke filter in the bottom of the chamber and the floating impurities are decanted by a skimmer or overflow weir. The particular heater shown in the illustration is especially designed for use in a steam heating plant, i.e., besides performing all the functions of an open heater it provides for the reception and heating of the condensation returned to it from the heating system.

Fig. II. shows a section through a Hoppes open heater, illustrating the "pan" type. Exhaust steam enters at H, passes through oil filter first and completely surrounds pans T, T. The feed water enters at B, and the rate of flow is regulated by valve F, which is controlled by a suitable float in the lower part of the chamber. Water, in flowing over the sides and bottom of the pans comes in direct contact with the steam. The National heater is illustrated in Fig III, which shows the oil separator of the same diameter as a shell of the heater, forming its back head.

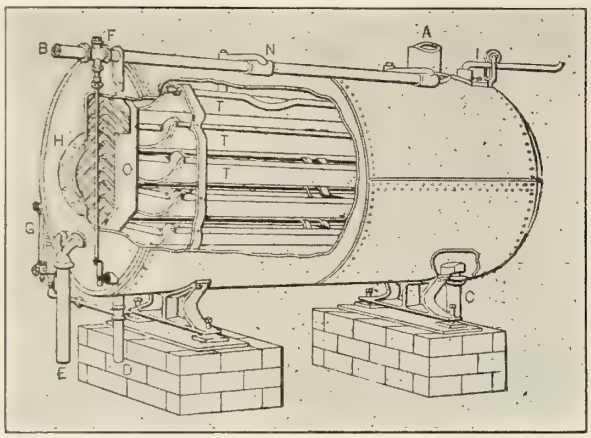


FIG. 2—HOPPES HORIZONTAL FEED WATER HEATER

There is very little of special moment which can be said with regard to the performance or economy of any particular make of feed water heater as compared with the others. Any open type feed water heater in which the sizes of openings are properly designed to admit steam and water and to discharge water, and which has a proper arrangement of perforated trays for breaking up the water for close admixture with the steam, will utilize all of the exhaust steam possible and will increase the temperature of the entering water to a temperature within two to five degrees of the temperature of the steam which is used for heating the water.

There are other possible economies to be obtained from the use of a feed water heater besides that of heating feed water; such, for instance, as the retaining of solids made insoluble at the temperatures of the hot water within the heater rather than to let these solids go on to the boilers. There are various constructions on the market for which it is claimed that a large quantity of such solids will be retained in the heater, but the truth of the matter is that the largest part of these solids cannot be retained on the heating trays or in the filter section of any of the so-called standard types of heaters. It is necessary to provide a water storage capacity of such volume that the heated water may remain practically motionless for a period of one-half hour to one hour before any real depositing action will be obtained in the feed water heater. Such a construction means a tremendous use of valuable floor space or head room in the power plant for the installation of such a storage compartment and is usually not considered economical practice except where the water conditions are unusually bad.

Closed Heaters

What of the closed heater? The essential requirements of the closed heaters are as follows:

1. That they may be easily and thoroughly cleaned.
2. To heat the feed water to the boiling point without causing any back pressure.
3. That they will not foul with scale if properly taken care of.
4. That they will separate and carry off the water of condensation from waste.
5. That they will extract the oil from the exhaust so that the steam can be used for heating purposes and the condensation from the heat coils be returned to the boilers without injuring them.
6. That they will collect and carry off any scum on the surface of the water.
7. That they shall be so constructed that any individual tube can contract and expand independently of the others.
8. That they be made of the best materials and be thoroughly tested before leaving the factory.

Fig. 4 illustrates the Wainwright heater. The body of the heater is cast iron and the tubes of corrugated copper. The water passes through the tubes and the steam surrounds them. The feed water and exhaust steam do not mingle, and hence the oil in the exhaust does not contaminate the water. Water chambers are divided into several compartments, as shown in the illustration, and the partitions are so arranged that the flow of feed water is directed back and forth through various groups of tubes in succession. This arrangement gives a higher velocity of flow than the non-return of heaters and therefore increases the rate of heat absorption. The mud and impurities settle at the bottom and are discharges through the mud blow-off, and such impurities as rise to the surface are removed by the surface blow-off. The tubes are corrugated and allow for expansion and at the same time increase the transmission of heat.

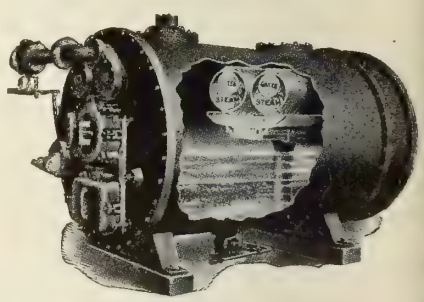


FIG. 3—NATIONAL OPEN HEATER.

In the National closed heater, which is not illustrated, efficiency in heat transmission is secured by the use of a small curved or coiled tube in increased frequency of contact the particles of water with the wall of the tube. Even distribution of the water to the tubes is secured by the large manifolds or tube chambers into which the ends of the tube coils are expanded. The tube ends are accessible through their plugged holes on the top of the tube chambers in the large heaters.

One of the most common experiences in connection with the operation of closed heaters is to find them leaking water from the bolted flange joints. Upon inquiry in such cases one is invariably informed that it is not always an easy matter to pack the flange, it being a job that must frequently be done on Sunday or at night. In nearly all such cases it will be found that the leakage is due to the fact that there is no relief valve to take care of the increased water pressure caused by heat and expansion when the feed water valves are closed. It has been found that the pressure of the water when the feed water valves are closed will, at times, reach a pressure of 500 lbs. In such circumstances the importance of the relief value can be readily appreciated, and it will be found that the use of such a valve will remedy the cause of closed heater leakage.

Open Versus Closed Heaters

Which shall it be, the open or the closed heater? Each type has its advantages, and heaters of both types are made by a number of concerns. A careful study of the particular plant conditions for an intelligent choice is necessary. The following parallel comparison brings out a few of the important factors:

Open Heaters	Closed Heaters
Efficiency	
Feed water may be brough to same temperature as the steam, by employment of sufficient exhaust steam.	Feed water will always be two degrees or more lower than the temperature of the steam.
Scale and Oil	
Do not effect the heat transmission.	Will lower the heat transmission.
Pressure	
Seldom subjected to more than atmospheric pressure.	Water pressure slightly exceeds that in the boiler as it is customary to place closed heaters on pressure side of the pump.
Safety	
Sticking of the back pressure valve may cause the open heater to blow up if provision for relief is not made.	Will safely withstand any pressure likely to occur.
Purification	
Oil in exhaust steam comes in contact with feed water and must be removed.	No oil comes in contact with feed water.
Removal of Precipitate	
Scale and other precipitate readily removed.	Scale and precipitate removed with difficulty.
Location	
Must always be placed before the pump suction on the suction side.	May be placed anywhere on the pressure side of the pump.
Pump	
With supply under suction, two pumps are necessary and one must handle hot water.	One cold water pump necessary.

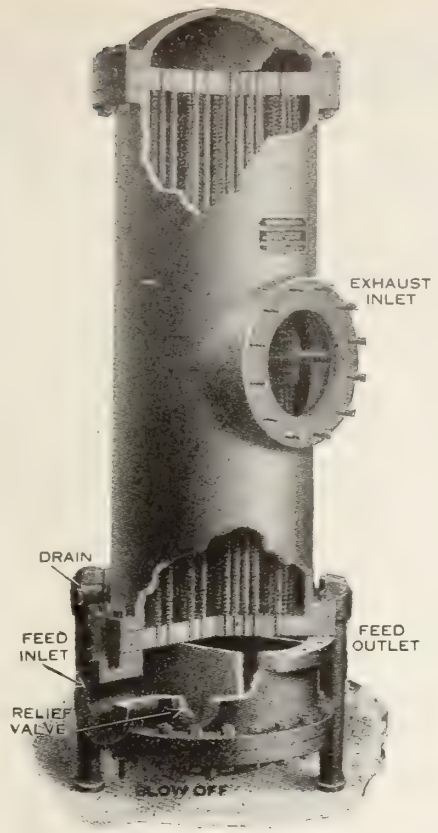


FIG. 4—WAINWRIGHT CLOSED HEATER.

A further advantage for the open heater claimed by manufacturers of this type of equipment is that there is a marked saving in water. Thus, in the open heated 6 lbs. of water and 1 lb. of steam combine to make 7 lbs. of feed water, but in the closed heater there is no mingling of the steam and water, consequently 7 lbs. of water and 1 1-6 lbs. of steam are required to produce the result. That is to say, the closed heater uses 14 per cent. more water than the open heater. This point may be important in some plants and of no moment in others. Finally, the thing to be emphasized in connection with the prospective purchase of heaters is, first, that such equipment makes for economical operation, and second, that the proper choice of the heaters will depend upon individual conditions.

C. A. S. E. CONVENTION

Continued from page 275

above the town, on one of the highest spots in that part of the country. We would recommend the visitors to the convention to take a drive up to this spot if the weather is clear, and enjoy the beautiful scenery which is unfolded below. It is truly a delight to the eye.

The reservoir was built in 1906, and has a capacity of 1,000,000 gallons. It was originally built in one part, but in order to facilitate cleaning, a dividing wall was later built across it. In order that those in the station may know if the water has reached the high level when pumping up, or the low level when pumping has not been done, an electric alarm is installed. This consists of two diaphragms, to which are connected rods, and the variation in the pressure caused by the varying height of the water above the diaphragm will force it up or allow it to come down, making or breaking the circuit, which lights a lamp in the pumping station.

Looking down from the walls of the resorvoir, one gets an excellent idea of the clarity of the water. At a depth of twelve feet, the bottom can be seen as plainly as if there were no water there. Woodstock is certainly fortunate in her water supply, and the only fly in the ointment is the fear that with the expansion that must come to the city, the supply will not be adequate. However, that is a fear for the future. It is interesting to note that while in 1885 the mains had a total length of 6.3 miles, and the hydrants numbered 60, at the end of 1917 there were 20 miles of water mains, and 175 hydrants, and these are being added to as occasion requires.

Before closing this article the writer wishes to express his gratitude for the courtesy extended to him by Mr. J. G. Archibald the superintendent of the water works.

PERSONAL

Mr. W. Reese of Hamilton, has lately returned from England, where he secured the selling rights for Canada for the British Hele-Shaw Patent Clutch Co., of Oldham, England, and the W. R. Patent C. O_2. Recorder Co., Leeds, England. Mr. Reese spent four years in England during the war, being engaged on the testing and treatment of materials for heavy artillery in the inspection department of the British Ministry of Munitions. Previously he was for 8 years master mechanic of the Consolidated Mining and Smelting Company, at Trail, B.C., and Rossland Mines, B.C.

We have received bulletins descriptive of the "Universal Unaflow" engine, built by the Skinner Engineering Co., Erie, Pennsylvania. One of these is devoted to the economical aspect of the engine, and several diagrams are shown comparing the performance of the "Unaflow" under different conditions of steam pressure and superheat, condensing and non-condensing. Another of the bulletins is devoted to examples of the "Universal Unaflow" in actual service at various plants, and the results achieved by them. A third bulletin describes the principle on which the Unaflow engine is designed, its history, details of construction, and steam distribution.

Messrs. Burlingame and Gardner who have taken up the manufacture, installation and sale of the Bernitz method of furnace lining, have secured office location at Room 110-123 Bay street, Toronto. The firm will occupy their new office premises about the middle of June.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone 8971 Rector. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, JUNE 21, 1920 No. 12

PRINCIPAL CONTENTS

Woodstock the Scene of C.A.S.E. Convention	273
Discussion of the Uniflow Engine—Part II.	276
How Many Sizes of Shafting Should We Have?	278
Trouble Caused by Moisture in Compressed Air	279
Some Examples of Economiser Tube Failures	282
A Coure of Instruction	287
Power Plant Management	289
Editorial	292
Programme of the C.A.S.E. Convention	293
Development in New Equipment	294

THE THIRTY-FIRST CONVENTION

BEFORE the next issue of Power House is off the press, the 31st convention of the C.A.S.E. will be a matter of history. The programme for the three days is before us as we write this, and if all the events featured on that are carried through, there are three strenuous days ahead of the delegates, their wives and families.

It is rather interesting to note that the purely engineering side of the convention seems to have been pretty well side-tracked. The exhibitors of engineering supplies and specialties will be on hand, and a strong exhibit is assured, but for the delegate who attends the convention hoping to gather something of educational improvement, there is little provision made. What the reason is we are not sure, but possibly it is on account of the small amount of interest displayed on past occasions to this side of the convention. Stationary engineers are a class whose nose is kept pretty well to the grindstone, and it is perhaps natural that they should wish to make the convention a time of play instead of a serious effort. This is quite in order but it seems that a little more time could have been devoted to the reading and discussing of papers than has been allotted, without unduly interfering with the lighter side of the programme.

In the majority of cases the meetings and conventions of the different engineering societies devote the greater part of their time to the advancement of the engineering knowledge of their members. This devolves to the benefit of the engineering world in general, through the publication of their deliberations in the technical press. It would seem that a gathering composed of delegates from the various lodges of the C.A.S.E., men who are encountering operating problems of all kinds and in all sorts of plants, should have a wealth of experience which they could give for the benefit of their fellows. It is through problems arising in every-day operation, and the efforts to overcome them, that most of the improvements in steam engineering come about.

Apart from the actual operating of steam plants, one would have expected to see stationary engineers taking an interest in general engineering developments. The fuel situation, and its probable effect on future conditions, the development of Hydro-Electric power, the coming of the internal combustion engine, and the probable field before it, are all matters of vital interest to the power plant man. What better opportunity can he wish to discuss these matters than at a gathering of representative men of his own class drawn from all parts of the country.

These are matters, undoubtedly, worth consideration, and while it is true that all work and no play makes Jack a dull boy, there is no time when play can be better enjoyed than after work well done.

The visitors will find Woodstock a pleasant city to visit, and the members of the local lodge and the citizens generally are anxious to give the convention a warm reception. The convention hall will not be quite as warm as was the hall at last year's convention, but perhaps no one will mind that. We are pleased to see that the name of A. M. Wickens, the grand old man of the C.A.S.E., is on the programme, and we hope that it will be prominent at many more conventions.

We look forward to meeting many old friends and making many new ones between June 22 and 24, and feel sure that after the event we shall be able to write in the classic phrase of the country correspondent, "A pleasant time was had by all."

THE UNIFLOW ENGINE

THE Uniflow type of steam engine, though a comparatively new comer to the ranks of prime movers, is making some very strong claims to consideration. The European practice has been chiefly to design these engines for condensing operation, and some very fine results in steam economy have been obtained. It is claimed to be more economical than the triple expansion engine, with the advantage of being contained in one cylinder. On this Continent the practice is largely to run non-condensing, due to the heating necessary over a large part of the year. This necessitates some modifications in the design, to relieve the extra compression which takes place in these designs when exhausting at atmospheric pressure. An engine built in the United States for both condensing and non-condensing loads, has achieved some remarkable results, the steam consumption at full load being 13.8 pounds per I.H.P. per hour when condensing, and 18.8 pounds when non-condensing. It would seem that here we have a worthy representative of the steam-driven class of prime movers, and the competition that is beginning between the steam-driven type and the internal combustion type should be of great value in ensuring the conservation of natural resources. Every improvement made in either is a clear gain to the whole world.

An idea of the amount of money the people of New York City are spending for amusement can be gleaned from figures made public by William H. Edwards, Collector of Internal Revenue, which show that the theatres of Manhattan collected $783,891.42 in war taxes during January and $695,626.70 in February. The tax on all theatre tickets is 10 per cent., so Mr. Edwards' figures indicate that the income of Manhattan theatres during January was $7,838,914.20 and the following month it totalled $6,956,-267. The collector declared his office checks up all box office receipts and that the auditors have not discovered any attempt to cheat Uncle Sam.

Programme of the C.A.S.E. Convention June 22, 23, 24

Tuesday, June 22

10.30 a.m.—Meeting Executive of C.A.S.E.
2.00 p.m.—Meeting Executive of C.A.S.E.
—Exhibition open all day.
8.00 p.m.—Movie show for ladies, guests of Woodstock Lodge.
—Educational session and smoker (men only), with smokes supplied by local lodge. Geo. E. Moll, chairman.
—A few parallel lines by W. H. Auger.
—Combustion Engineering by Hartley B. Gardner, with the discussion opened by A. M. Wickens.

Wednesday, June 23

9.00 a.m.—Meeting C.A.S.E. Executive.
—Exhibition Hall open morning and evening, but closed in afternoon for the picnic.

Wednesday Afternoon, June 23

2.00 p.m.—Auto drive around city by Woodstock Automobile Club from Exhibition Hall.
2.30 p.m.—The engineers and their friends will be entertained at Southside Park, Woodstock, by the Exhibitors' Association. Ice cream and lemonade will be served during the games. Let all the engineers bring their families. The more the merrier.

1.—Association football, Engineers vs. Supplymen.
2.—100 yard dash (open).
3.—50 yards race for the wives of engineers.
4.—Wheelbarrow race for men.
5.—Clothespin race for ladies.
6.—Donkey race for men.
7.—Soap race for married ladies only. Ladies keep the soap they secure and the one securing the greatest number will be given a valuable prize.
8.—Peanut race for unmarried ladies.
9.—Men's smoking race.
10.—Little boys' race.
11.—Skiff race (singles).
12.—Canoe race (singles).

Director of games, E. B. Curzon, assisted by Geo. E. Moll.
Presentation of prizes by President J. S. Mock at the conclusion of the games.

Wednesday Evening

The Exhibition Hall will be open until 8.30 to permit the members of the Grand Lodge and others to examine the exhibits.

8.30 p.m.—Entertainment in the City Hall. The program will start exactly on time.

1.—Speech by Mayor A. J. Gahagan, chairman. The Mayor will be introduced by J. S. Mock, president of the Exhibitors' Association. After his speech, Geo. E. Moll will reply.
2.—Solo by William Coutts.
3.—Solo by Miss Doris Leggo.
4.—Solo by Bob Jones, New York.
5.—Comic by P. Wilson.
6.—Song by Harry Curtis.
7.—Vocal by Miss May McCauley and Mrs. Sticker.
8.—Solo by E. B. Curzon, Montreal.
9.—Comic by Mr. Downs.
10.—Song by Earl F. Hetherington, Galt.
11.—Speech by the celebrated New York orator, Jack Armour.

(There will be no encores).
Heintzman piano kindly loaned by Ye Olde Firme Heintzman & Co., Ltd.

10.00 p.m.—Prize drawings. Everyone registering has a chance to win a valuable prize.
Ladies' lucky numbers are 1, 3, 7, 11 and 15.
Men's lucky numbers are 1, 4, 8, 13, 19 and 23.
Drawings will be made from a hat by a young lady chosen from the audience.

10.30 p.m.—Dancing.
—Buffet refreshments supplied by the Exhibitors' Association.
—Miss Watson's Orchestra.
The badge will admit to the City Hall. Badges may be secured by registering at the Exhibition Hall adjacent to the City Hall.

Thursday, June 24

9.00 a.m.—Meeting C.A.S.E. Executive.
10.30 a.m.—Annual meeting Exhibitors' Association.
2.30 p.m.—Installation of officers of C.A.S.E. Executive.

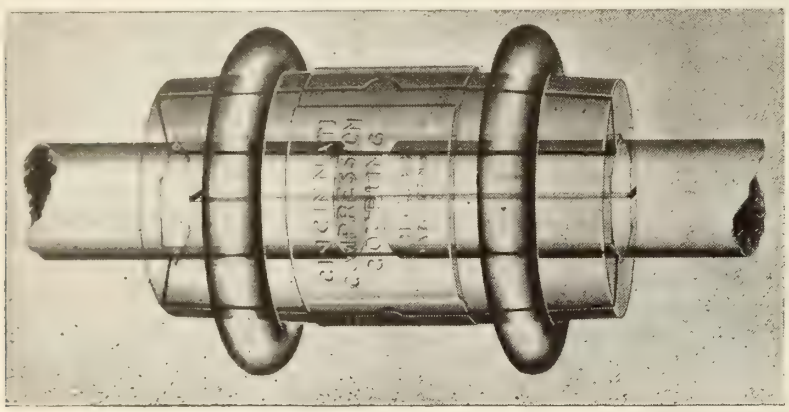
In 1919 Ontario had fire losses of $9,500,000. These were manufacturing places, 447 fires at a loss of $2,275,000; stores, 1,008 at $1,900,000; dwellings, 5,695 at $1,650,000, and farm barns, 748 at $1,100,000. Officials say that fully half of these were from pure carelessness. We are certainly paying a fancy price for letting our ears grow long.

JAMES S. MOCK,
President Exhibitors' Association.

Progress in New Equipment

NEW COMPRESSION COUPLING

The Cincinnati Ball Crank Co., Cincinnati, Ohio, have placed on the market a new type of compression coupling for use in connecting line shafting. The



VIEW SHOWING CONSTRUCTION OF COUPLING.

illustration herewith gives one a good idea of its appearance and its outstanding feature is simplicity. It can be installed on any kind of shaft in five minutes' time. It is adapted for use in every industry where power is transmitted by means of line shafting.

The construction of this new coupling constitutes a radical departure from the old type flange and bolt connection. It consists of five pieces—three jaws, and two clamping rings. The jaws of the coupling are placed in position about the shaft, and held in place by the longitudinal grooves and notches that lock them together. The forged clamping rings are pushed on over the tapering ends of the jaws, and hammered tight.

A hammer is all that is required for installing the coupling—no dismantling or machining of the shafting is required. It is only necessary to have sufficient clearance between the two loose ends of the shaft to allow the passing of the clamping rings.

The coupling grips the joined sections of the shaft, holding them in alignment. The round, machined sections of the tapered end of the coupling jaws form lines of contact for each ring, and once driven into place it is impossible for the coupling to become loose. It is stated that many of these couplings have been in use three years without a single adjustment since they were installed.

The assembled coupling forms a clean, compact shaft joint. There are no projections on its outer surface to catch a workman's clothing. When used as a reducing coupling, the only additional parts needed are three strips of cold rolled steel to fit between the smaller shaft and the inside of the coupling jaws. These couplings are made in sizes from 15/16 to 3 inches.

SMOTHERING THE FIRE

Fires are something which are much to be avoided, and all precautions are generally taken to eliminate them, yet we are well aware that they persist in cropping up in spite of all precautions.

The next best thing is to be prepared for the fire when it does come, and on this assumption the Canadian Firefoam Co., Hamilton, Ont., have placed on the Canadian market what is known as Foamite Firefoam. To illustrate the uses of this product they have issued a very attractive booklet, entitled 60 seconds and out. They show various instances of fires, and how they were extinguished by means of their product. One outstanding example is a huge 55,000 barrel tank fire at its height. In spite of a strong wind this fire was smothered in 48 seconds, or less than one minute after it had reached its worst.

Briefly, the principal of firefoam is as follows: It is based on the well-known fact that carbonic-acid gas is fire's most deadly enemy. Cover any burning surface with this gas and the fire is quickly smothered. Working on this fact, firefoam was so constructed that the gas was kept over the burning surface in the form of millions of minute bubbles.

The illustration herewith depicts what is termed their 40-gallon Foamite Firefoam engine, and its contents expand to 320 gallons of firefoam upon release. The contents can be discharged on any burning surface at a distance of 50 ft. or more. The type of engine shown is one recommended for plants, buildings and other places where hand extinguishers would be of insufficient capacity.

Larger engines of 250, 500, and 800 gallons and upwards are made, all depending upon where they are to be used. Hand extinguishers and fire pails are also handled by this concern, all equipped with the Foamite Firefoam.

One particular advantage, as claimed for this product, is the fact that the

THIS VIEW ILLUSTRATES THE 320-GALLON CAPACITY ENGINE.

foam is comparatively dry compared to water, therefore resulting in less damage. The use of this material is not confined to oil fires, but to fires of any nature in the industrial world.

Extend Working Day.—Canada Foundries and Forgings, Limited, announce that their Canadian Billings and Spencer plant at Welland, after two weeks shut down on acount of strike, has once more resumed operations in full; the Employees having agreed to the company's terms, which include an extension of the working day from an eight to nine hour basis.

OFFICERS OF THE EXHIBITORS' ASSOCIATION, C.A.S.E.

Business Conditions Are Sound

BUSINESS conditions in United States and Canada are fundamentally sound. Circumstances are not the most favorable, and there are many troubles that will not be removed for weeks and months to come. But, allowing for all that, there is nothing of the blue-ruin type in sight.

A representative of this paper attended a meeting of the Editorial Conference of Associated Business Papers in Chicago last week, where business conditions in all the fields represented were discussed by experienced business editors who were in close touch with the trade in their varied fields.

Many of the speakers made the point that the railway situation in United States, following the switchmen's strike, was the root of the trouble. The strike had been a vicious attempt to paralyze the nation's business in the shortest possible way, and for a time success was with the strikers. Canadian industries have a lot of raw material coming from United States. They can look for improvement before long, but the improvement will not be sudden, and it is likely that many months will pass before traffic is passing with the necessary speed between points in the two countries.

One point was brought out that shows a wheel within a wheel, in that the inability of the railroads under present circumstances to transport material to the shops making cars and engines would delay rapid recovery in the railroad problem. In other words, the poor physical shape of many of the roads is making it hard for them to help themselves.

The iron and steel industry has a large volume of perfectly good business on its books. Production is now around 75 per cent. of capacity, but when it is considered that capacity increased some 40 per cent. during the war, it will be seen that 75 per cent. production now is really greater than 100 per cent. capacity in the pre-war days.

The lumber trade reported declining markets, but there were factors that had been in operation to keep the markets from being filled up when these declines were on. Strikes and poor weather had kept the cut down. One expert on the situation claimed that the policy of the larger dealers in a declining market is to force the situation as much as possble and reach bottom at once, depending on past experience of reactions after sharp declines to bring them safely out of any troubles.

The feeling was also expressed that stability could be lent to the present situation in a marked way by a feeling that prices had gone their worst. Of course, there are exceptional cases where this cannot apply. In the main, though, it is worth serious consideration. Several cases were cited where large projects were hung up for the present, because those behind them were not inclined to go into the market for building or equipment, because they knew that costs would be so high that they would be unable to compete with the product of plants that had been built in pre-war times.

Business and banking circles reported that credits were being tightened rather than extended, but they claimed that the general effect was regarded as good. Makers of touring cars were being notified to cut down on their output, while builders of trucks and tractors were being assisted to go ahead. The reason was that the building of the latter would result in a greatly increased area of land being worked on the farms, and thus the new wealth of the country would be added to from year to year.

In all the reports that were delivered, there was nothing to shake confidence, or to cause one to feel that the future had in store anything that sane commonsense could not surmount.

The Use of Chain Drives on Grooved Drums

This Article From "Practical Engineer" Emphasizes the Importance of Studying Lead of Chain Before Going Ahead With Layout of Drive, in Order to Minimize the Wear on the Chain and Drum

By G. H. Roberts

THE lead of a chain or rope from a grooved winding drum is a matter which, in the opinion of the author, is seldom given the full attention and consideration that it should have, with the inevitable result that when haulage takes place much more wear and tear occurs on the chain, drum, and fair-lead than would actually be the case if greater thought had been given to the original lay-out of the arrangement. While admitting that site conditions or requirements do not always lend themselves to the ideal scheme, as referred to later, nevertheless a better compromise between theory and practice could have been applied to innumerable saving in wear and tear and considerable saving in wear and tear effected, with its consequent increase in life of the various parts directly affected.

Before dealing with the different chain leads, it may be advisable to briefly refer to certain features in regard to the drum itself, and also the chain. The diameter of the drum has much to do with the useful life of the chain, and, although there appears to be no predetermined or recognized ratio between the two—as there is in deciding the minimum diameter over which a steel rope should work—still it should be kept as large as circumstances will permit. If too small a diameter drum is introduced with heavy loads, the links will be subjected to considerable distortion in their attempt to adjust themselves to the surface of the drum barrel.

Fig. 1 shows in a slightly exaggerated sense the tendency of the horizontal links to bend when stressed in working. Theoretically this condition will always occur, no matter how large the diameter of the drum or sheave, but the possibility of fracture in the link through this cause will practically disappear if reasonable sized drums and short-link chain are used in conjunction with heavy loads.

Again, the length of the drum may have something to do in settling its diameter, as the whole should be so designed that any possibility of the chain coiling up on itself is obviated. A long barrel is objectionable, as will be observed later; this, however, should not be cut so fine that no latitude is provided for an additional coil or two—this should always be allowed for, even though the need appears unlikely to arise when the machine is in use. Two or three "dead" turns are frequently provided for at the fixed end of the chain; these, as the name implies, never pay off, their duty being to relieve the stress on the anchorage and prevent any irregularity at the beginning of the haul. The "live" coils are those whose total length are equivalent to the possible travel of the load. The length of the drum is therefore made up of three distinct parts, as indicated on Fig. 8. With regard to the grooving, care must be taken that the running clearances are no more than actually required; if the channel is made too wide, an insufficient seating is obtained for the links, and they are likely to bind in the groove, as shown in Fig. 2. There is always a tendency for a chain to do this, due to the twisting effect which occurs when winding begins. Cast grooved wheels are the greatest defaulters in this respect. In Fig. 3 are indicated four of the most common chain lead arrangements, where a fair-lead wheel is introduced to deflect the chain in the desired direction. These are enumerated as follows :—

(A) Horizontal lead with pull downwards.

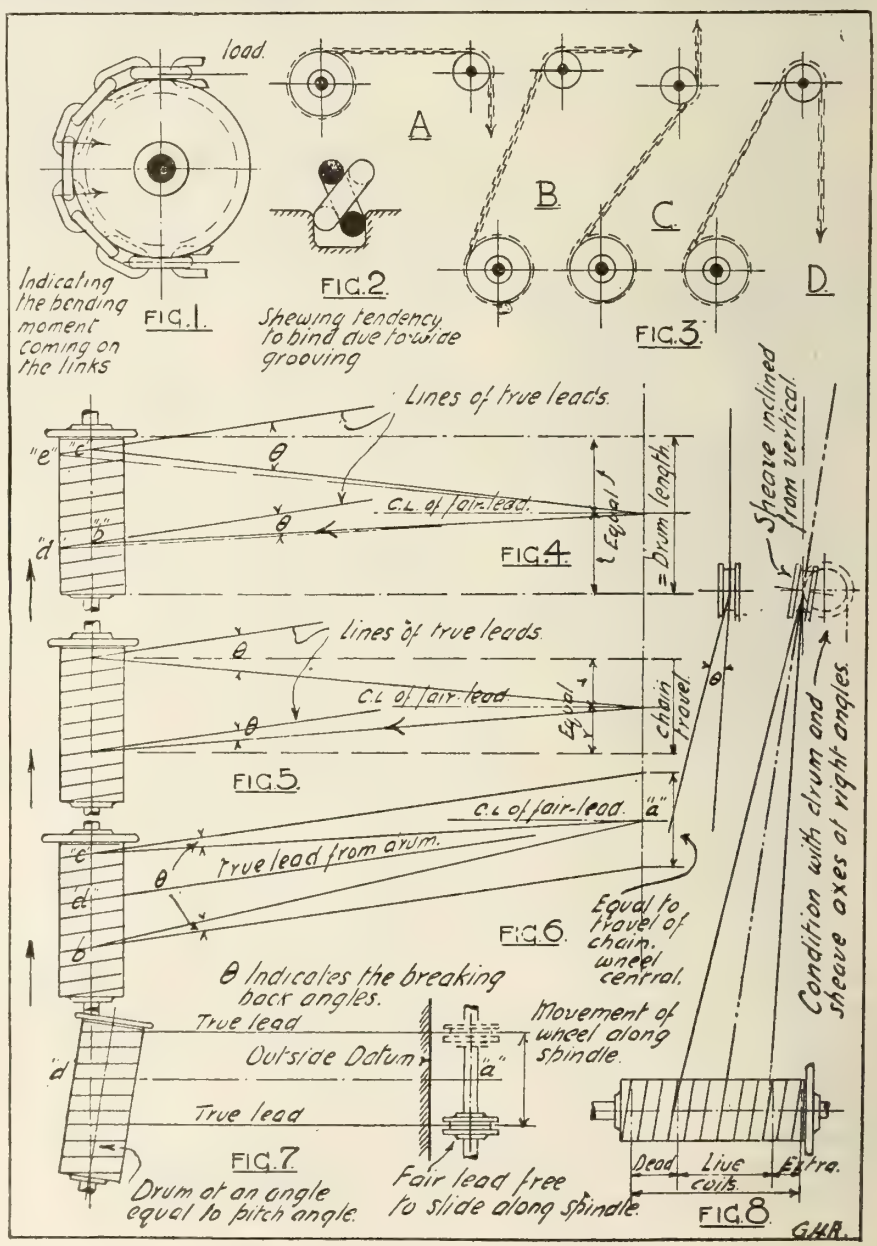
(B) Inclined lead with horizontal pull.

(C) Inclined lead, chain deflected upwards.

(D) Inclined lead with downward pull.

There are, of course, other arrangements, but the foregoing will be sufficient for the purpose of this article.

With diagram A it will be found that in numerous cases the relative positions



in plan of drum and lead wheel will either be as Figs. 4 and 5. What is the effect on the chain and grooving ? In Fig. 4 the fair-lead has been placed practically central with the total length of barrel, winding being in the direction indicated by the arrow head. Assuming that, say, three "dead" turns have been allowed, then at the beginning of the haul the chain follows the line a b, and at the end of the full travel will be as a c. These, as will be readily seen, do not represent the true lines of force, these latter geing respectively a d and a e, and to which the chain is continually trying to align itself, but prevented from doing so by the grooving in the drum. The detrimental effect of this is at once apparent, the resultant pressure increasing as the chain works its way along the drum, as will be observed on reference to the diagram in question. As a result, excessive friction and wear to the groove sides and the links is constantly taking place, and the heavier the load the greater will be the adverse conditions under which the machine will have to work. In Fig. 5 an improvement is made. Here the lead wheel occupies a position central with the total travel of the chain along the drum. This reduces the breaking-back angle o, and consequently lessens the wear and tear on chain and grooving. Scheme 6 represents the best practical solution with a fixed lead sheave, i.e., a sheave limits of chain travel along the barrel having been settled, the distance between is halved and a line produced parallel to the helix line of the pitch angle, as a d, point a being the first point of contact with the guide sheave. If points a, b, and c are now triangulated, it will be observed that the breaking-back angle at start and finish is considerably reduced, while at mid-travel a perfectly true lead is obtained. The working conditions on drum and sheave are therefore very much improved by this arrangement. Where the fair-lead can have freedom to slide along its spindle, and the lead is also free to adapt itself to varying horizontal positions, then a very satisfactory arrangement is arrived at, and one which can be further improved if the spindle of the sheave is moved round until it is at right angles to the chain lead, as indicated. This considerably reduces the running friction between sheave and spindle, the only wear now occurring being due to the sliding action along the shaft. If such an arrangement of guide sheave is applied to the former examples, it will undoubtedly help matters, but never entirely eliminate the breaking-back of the chain as it winds on or off the drum. The three diagrams just described are drawn to the same scale, so that they indicate proportionately the different conditions, the pitch angles being increased for the sake of comparative clearness.

Fig. 7 illustrates the practical application of Scheme 6, wherein the winding drum is shown moved round until the lead wheel spindle is parallel with the outside datum.

For various reasons it is not always practically convenient to apply the last scheme on the skew, as indicated, because, as a general rule, the lengthwise centre line of the machine must be at right angles to the loading face, taking an ordinary runway cat-head hoist as a case in point. In order to meet such requirements and still maintain arrangement No. 6, it is adjusted until the centre line a d is in the desired position, the angle through which it is moved being, of course, equal to the pitch angle, as shown in Fig. 7. The drum now occupies the angular position, but this, in the majority of cases, will not be found a practical objection ; generally the other parts of the gear and supports can readily be arranged to meet this particular feature.

Considering now the three remaining leads B, C, and D, it will be noted that the scheme shown, Fig. 6, still retains superiority over the other two, although with an inclined or vertical lead to sheave; skewing the drum on its base a small amount does not help matters much, but if it is turned round until the axes of drum and sheave are at right angles to each other, then the conditions illustrated in Fig. 6 with fixed sheave are obtained, with the added advantage that no breaking back on the sheave groove occurs. This relative arrangement of drum and wheel, as will be conceived, is equally applicable whether the chain is led upwards or horizontal or has a downward pull. With parallel axes there will always be a certain amount of breaking back on the fair-lead sheave; this is unavoidable. But with a fairly long lead between drum and sheave this does not amount to much, and is to all intents and purposes practically the same in all the cases referred to. The fixed sheave could, of course, be inclined to suit the central lead, if so desired, but no real practical purpose is served in doing so unless the chain has to follow such paths as indicated by the chain-dot line in Fig. 8, and then circumstances must decide if such a modification is necessary.

Too often conventional methods are blindly followed, with the result that Schemes 3 and 4 are continually perpetrated ; the introduction of arrangement 5 may disturb previous routine, but it is a good thing to create a precedent sometimes that has distinct advantages.

EDITOR, *Power House*,

Sir:—

Now that coal has reached the price it has, should not school boards or city councils appoint men, who are experts in the construction of heating apparatus, also who have made a study of the combustion of coal, to act as inspectors for the schools and public buildings of our cities, as a means for reducing expenses to the School Boards and ratepayers. Also as a means for the conservation of our coal. Which cannot be denied is of most vital importance.

It is possible that the heating systems for such buildings are managed by faithful men, but as any handy man can handle a shovel it cannot be denied but that many are appointed as caretakers and firemen that have not the practical experience necessary in order to obtain the highest rate of efficiency from their plants. At least this is the opinion I have formed after a life's experience in the heating trade, which has often brought me in close contact with many heating systems in such buildings.

Very many furnace rooms of such buildings, I have gone into where I have noticed from 25 to 50 per cent. of the coal used, going to waste. There are so many causes where such waste can come from that when these are added together, tests have proved the truth of my statement to be 25 to 50 per cent.

The fault was sometimes in the method of firing the furnaces. In others, due to the deterioration or unsuitable equipment, but in most cases, a combination of both.

Many men who fired furnaces in such buildings when coal was less than half the price it is to-day, are still resorting to their antiquated or old time methods of firing. How is it possible to reduce the coal consumption under such conditions. A few visits from such an inspector would soon enable them to see where they could save unnecessary labor for themselves, also coal for their department.

Then there is the equipment. In many cases, even if the caretaker is a practical engineer his suggestions for repairs, or slight alterations are not considered seriously, or it may be taken that as he is not an expert, he may be asking for something that is not necessary. But in the case of a practical inspector, who is working to show results of his office, matters would be very different.

Such a man would find his time fully occupied all the year round. During summer he could make thorough examinations of every part of each system. See that the condition of each boiler, also furnace was such that there would be no loss of heat generated from the coal, and that top notch efficiency could be obtained when buildings required heat. During the winter to give practical instructions and demonstrations on firing to prevent waste of coal or the products of combustion.

There is not the least doubt in the writer's mind but that such inspectors salary would be saved many times over by the saving of coal, which may yet reach such prices that it will be necessary to further increase the rate of taxation, and cause less coal for those who come after us.

J. G. KINGSTON.

For the purpose of clearing away the debris in the headings of a tunnel being constructed in California, steam navvies worked by compressed air are being used. The tunnel, 3¼ miles long, is for a hydro-electric scheme, has a section 17ft. by 17ft., and is driven largely in solid granite. The shovels have dippers of 21 cubic feet capacity on 13ft. booms, and, on the average, clear away the 150 cubic yards of rock brought down at each blast in eight hours.

Recent Developments in Oxygen Cutting*

IN presenting the most recent developments in the art of cutting with oxygen we have concluded that the most interesting development which has occurred recently in connection with cutting is, without doubt, the successful cutting of cast iron.

More than a year or two ago, there were rumors heard now and then in the industry, of some genius who stated that he had cut, or could cut cast iron. These rumors were not given much credence because it was thought that in most instances the man who believed he had cut cast iron had, in reality, cut something else which he thought was cast iron.

About this same time our Engineering Department began to think more deeply upon the subject, with a view to learning more of the basic principles underlying cutting, particularly with respect to cast iron. We began to experiment and detailed Mr. F. J. Napolitan to the work. He has continued his efforts in this direction, until we believe he has developed some very interesting theories, and has evolved some principles which are of extreme importance to the art. In compiling this paper we have worked together to lay before the Society, an outline of these theories and principles, which we believe will be of interest, and which may explain some of the conditions well known by men practised in cutting, but which had never been clearly understood by the majority of cutters.

When we succeeded in cutting cast iron, it must disturbed our dignity in that we were obliged to reverse our former opinions and beliefs, and to take back the statement often made, that cast iron could not be cut with the oxy-acetylene torch. Unfortunately, our experiments are by no means concluded, so that we are not free to disclose all that we would desire. Frankly, our investigation of cast iron cutting was inspired by nothing more noble than to seek a better explanation of why cast iron could not be cut. Most of us, and I am no exception, have expressed at some time or other in our experience, the solemn opinion that cast iron could not be cut, because the oxide of iron melted at a temperature higher than cast iron itself. Not only does cast iron burn to form an oxide, but the higher melting point of the oxide probably assists the reaction.

While we are rather skeptical of the commercial value of a cast iron cutting torch, and are convinced that, financially, we will never be repaid for the expense of our experiments, yet there are undoubtedly occasions when the cutting of cast iron would be of great value. In the ordinary scrap-yard, or in instances where the cutting process would be used as with steel, it is so easy to break cast iron, that it would hardly be economic to use the cutting torch. Were we not to further develop cast iron cutting, however, we should feel remiss in the work of our Engineering and Research Department.

You are all aware, of course, of that application of oxygen cutting used largely in blast furnace practice, the opening of a "frozen" tap hole. You could not quite reconcile this more or less common application of the process with the pet theory that cast iron could not be cut.

One of the usual methods for releasing a frozen tap hole in a blast furnace, is substantially as follows: A piece of one-quarter inch iron pipe with a brass handle, at least ten feet long, is attached to a manifold of several oxygen cylinders. Oxygen is delivered through this pipe at a pressure of approximately 100 pounds per square inch. A hole is started with a star drill or diamond point, until it is about three inches deep. The metal adjacent the hole is heated with a fuel oil burner or by other means. The end of the iron pipe is ignited and the composite stream of molten iron slag and oxygen caused to impinge against the frozen cast iron.

A spectator to this performance of infernal fury, is readily convinced that the heat is not all due to the combustion of the wrought iron pipe, but that the cast iron is burning with a violence equal to that of steel. This reaction inspired some inventors to incorporate a device in an oxy-acetylene torch for cutting cast iron, which would feed a steel wire between the cutting jet and the cast iron piece being cut. Ignition of the wire carried a stream of molten slag on to the cast iron and it was hoped thus to propagate the cut. In a second process, a plate of steel of definite and predetermined thickness, was placed on top of the cast iron. It was hoped that the slag incidental to the oxidation of the steel, would exercise some influence over the cast iron and enable it to be cut.

Unfortunately for those responsible for the exploitation of these devices, the inventors were more concerned with converting cast iron into iron oxide by means of the oxy-acetylene torch, than they were in constructing a practical process and a practical tool. It was next proposed to simplify the reaction by supplying an apparatus with a mixture of pulverized slag and iron powder, and in fact a number of patents were issued covering various applications of such a device. Crude and elementary as such devices were, they actually produced combustion of the cast iron and went a long way in stimulating us in our endeavors to find a successful method.

Experimental work was continued with a torch having a good many different tubes leading to the head, so that almost any combination of gases at varied pressures might be obtained. Mr. Napolitan has evolved from these experiments, interesting theories pertaining to the reactions which take place in cutting, together with their relation to our success in cutting cast iron. He has noted these theories in the article which follows. We are presenting these theories for what they are worth. We can actually cut cast iron and we do it by *preheating the oxygen.* We have endeavored to tell our conclusions pertaining to the reactions which take place. We will now take up the subject of metallography of iron and steel with reference to oxygen cutting.

Points Discovered

From the ease with which wrought iron is cut, we may conclude that an aggregate of ferrite combines with oxygen with greatest avidity, and permits the propagation of a cut with least interruption. As the carbon content is increased, there is a material change in the nature of the metal. In place of the preponderance of ferrite grains, we recognize the formation of cementite, and its union with some of the ferrite to form pearlite—the original mass of pro-eutectoid ferrite rapidly diminishing in prominence. As we should anticipate from the nature of pearlite, no material change is noticed in the performance of these alloys under the cutting torch. Of course, an ultra-precise consumption test would probably indicate a lowering of the efficiency coefficient, but from all appearances, no unusual difficulty is experienced in cutting carbon steels up to about 80 to 90 point carbon. But here, a definite transition is indicated by a distinct laboring of the cutting torch. While the torch will begin a cut with practically the same effort, and proceeds to completion without interruption or unusual delay, yet the kerf is wide and ragged and undeniably distinguished from that of a mild steel cut. It is recognized practice, now, to preheat the piece to be cut, to a black or dull red heat, when the impediment, whatever it was, seems to have been entirely eliminated.

But let metallography explain the sudden change of properties of the steel. As the carbon content of the hyper-eutectic steel was increased, and the proximate mass of pearlite increased, and the pro-eutectoid ferrite correspondingly diminished in volume, until eventually, a point was reached where all of the cementite and ferrite existed in the stratified or laminated relationship of pearlite. This state is

*Paper read before the American Welding Society by Stuart Plumby and F. J. Napolitan.

recognized as existing where the carbon content is between 80 and 90 point—the approximate analysis of pearlite is yet undefined. As the carbon content is further increased, there appears a constituent that we know as pro-eutectoid cementite—in fancy, the cementite which has been ejected from the pearlite growth. It is circumstantial that the presence of this pro-eutectoid cementite is directly responsible for the increasing difficulty of our cutting. But why did preheating of the steel before cutting make such a remarkable difference in the results? To be sure, the rise in temperature might affect the stability of any martensite, troostite, or even sorbite that might have existed, but the temperature was too far removed from the Ac_{321} point to affect the characteristics of the pearlite. And surely the pro-eutectoid cementite was unchanged—and it was this same constituent that we blamed for the difficulty.

Again, as the carbon content is substantially increased, an equivalent interference with cutting is apparent, until, when the carbon content approaches 2.5 per cent., cutting becomes so labored as practically to cease, and no amount of preheating short of incipient fusion will permit it to propagate. As you are aware the metal is now termed "cast iron," and a micro-analysis indicates that in addition to the presence of a certain amount of pearlite and pro-eutectoid cementite, as well as certain foreign and to our discussion, unobtrusive substances, we recognize the presence of the final and most stable state of carbon—graphite. The pearlite constituent exercises a favorable influence upon the operation of cutting—and the pro-eutectoid cementite, while it impedes cutting, is readily compensated by a slight preheating—but the graphite presents an entirely new problem.

We might digress from the subject enough to present some remarks that would prove the fallacy of at least one of the stereotyped explanations of why cast iron cannot be cut—that the melting point of the slag is appreciably higher than the melting point of cast iron. A micro-analysis of the structure of an average cast iron—and by average we refer to a gray cast iron of about three to four per cent. carbon—would indicate a structure identical with that of a hypothetical steel of the same carbon content, except that some of the carbon seems to have been precipitated as graphite. But should that identical pour of cast iron have been cast against a cold iron mold, or otherwise chilled, the carbon would not have been precipitated as graphite and we should have had what we shall call a "chilled cast iron," or a "white cast iron,"—and it would actually have been a hypereutectic steel. Such alloys are not uncommon in commerce, and the fact that operators have been able to cut them with no extraordinary effort, has been responsible for innumerable false claims that cast iron has been cut. Unfortunately, the nomenclature of steels and irons is not clearly defined, and undoubtedly, a chilled cast iron is but an extension of the hyper-eutectic series. The melting point of an iron-carbon alloy is a constant of its composition, whether, in the solid state, the metal exists as a typical cast iron or as a steel. Long before the point of fusion, the carbon and the iron exist in one relationship, that of austenite. The conditions affecting the pouring of a melt of cast iron would determine the final state of its constituents—and we might as readily produce a gray cast iron or a chilled white cast iron—the carbon as graphite or the carbon as in cementite. In either event, the melting points of the resulting products would be identical. We agree that chilled cast iron can be cut with comparative ease, notwithstanding that its melting point is lower than the melting point of the slag produced. It is evident, then, that the melting point of slag is not responsible for the difficulty encountered in cutting cast iron.

We had concluded that while the existence of pro-eutectoid cementite appreciably retarded cutting, the presence of but a comparatively small amount of graphite completely prevented cutting. The phenomenon, if it were true, is unique, for it would pre-suppose the incombustibility of carbon. Science contradicts us immediately. In fact, our own welding practice belies us. We might point to the reaction accompanying the removal of carbon from automotive cylinders by the oxygen method—or, leaving our immediate field, we might mention the explosive combustion of carbon in ordinary gun-powder. We are forced to conclude then, that far from retarding the combustion of the steel matrix, the graphite of cast iron should actually assist it.

We investigated further to determine how much graphite influenced cutting. We obtained specimens of so-called malleable castings of the characteristic "black heart" structure. Such a structure is made in this country by the annealing of white cast iron in which all of the carbon exists in cementite or pearlite, the latter in some cases entirely removed. The treatment decomposes the cementite to precipitate the carbon in minute particles, differing from the graphite of gray cast iron in their extreme subdivision and uniform distribution throughout a ferrite matrix. In making a black heart casting, an oxidizing packing is used in this country, so that while the core is that of a black heart casting, the mass near to the surface is ferrite. We removed this shell of ferrite so that our materials indicated, under the microscope, a uniform aggregate of ferrite and temper carbon. By preheating this piece to a dull red heat, it was cut with the characteristics of a high carbon steel. Then we were satisfied that carbon as such did not prevent cutting, but that the physical state of that carbon was responsible. As plates of graphite, cutting was prevented—but as finely divided particles, cutting was scarcely impeded.

Reconsidering our previous observations in the light of this development, we began to substantiate our first logical hypothesis. We found, to summarize, that ferrite permitted most readily to be cut. Pearlite with pro-eutectoid ferrite did not materially affect the conditions. A completely eutectic composition first suggested a transitory stage. The existence of pro-eutectoid cementite retarded cutting; but preheating of the piece to a red heat readjusted the conditions so that cutting was again as efficient as in the case of ferrite. As the comparatively low temperature produced by preheating was insufficient to effect any change in the physical state of the constituents of the alloy, we were forced to conclude that the addition of heat units affected a definite constant, which we assumed was the heat of combustion of the iron, as the two forces were of like characteristics. Then a constant result from a variable, made axiomatic the existence of a second variable. Our second variable, then, we concluded, was the cooling effect of the stream of cutting oxygen, and a further thought suggested a third variable in the time of chemical reaction between the iron and oxygen. The preheating flames ignited the steel—the cutting oxygen produced combustion—and the propagation of the cut was a natural consequence. But as the carbon content was increased, the speed of the reaction was materially lowered; however, the velocity of cutting oxygen to insure a continuity of oxygen and slag to the bottom of the cut, was a constant. Then, eventually, a point was reached where the rate of combustion between the iron and oxygen was so slow that the heat units liberated from the reaction were dissipated to such an extent as no longer to ignite adjacent masses of metal—and cutting ceased. By preheating the piece before cutting, we add to the forces on the weakening side of the equilibrium, and cutting once more obtained. The heat units so obtained, compensated for the relatively less heat units liberated from the chemical combination of the iron and oxygen in a definite unit of time.

While the pearlite and pro-eutectoid cementite are readily compensated, the graphite carbon effectively prevents cutting by the ordinary means. No addition of heat units short of incipient fusion, by preheating the object, restores the equilibrium. We cannot strengthen further one side of our equilibrium, but we have not attempted to affect the other side. We have made no attempt to reduce the cooling effect of the cutting oxygen. We therefore experimented in this direction, and found that we could so effectively preheat the cutting oxygen that we could restore the equilibrium without preheating the object.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6 25

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	40
Black Oil, per gal.	15
Cylinder Oil, Capital	58
Cylinder Oil, Acme	45
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	08

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	10%
Standard	10%
Cut leather lacing, No. 1	2 75
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 50
Linseed oil, raw, single bbls.	2 90
Linseed oil, boiled, single bbls.	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$77 00	$76 00
Spelter	12 50	12 00
Lead	12 00	12 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

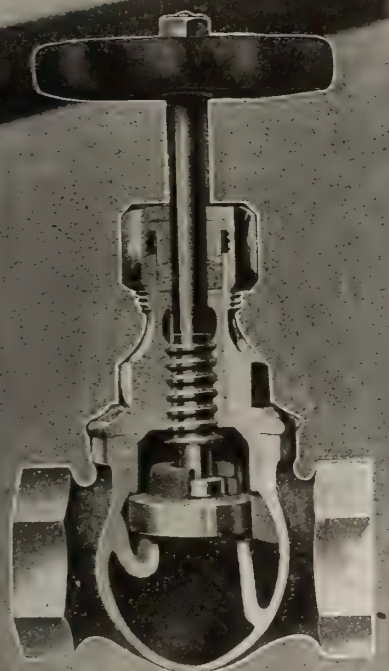
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

FAIRBANKS-MORSE



An Achievement in Mechanics

EACH individual department of The Canadian Fairbanks-Morse Company, Limited has given industrial Canada a new conception of achievement in mechanics. Each department has established a 100% quality and service standard. This is what enables Fairbanks valves to stand pre-eminent wherever valves are used.

When an engineer specifies Fairbanks valves, he knows that he has selected not only quality of material but workmanship that guarantees perfect operation.

He is satisfied with the reputation and service of the institution that stands behind them. He acknowledges an achievement in mechanics.

Wherever pipe lines are laid—in Canada's great industrial plants—in her immense water systems—in mines and mills—Fairbanks valves are giving a service that is marked by the 100% seal of quality, the standard of The Canadian Fairbanks-Morse Co. Limited.

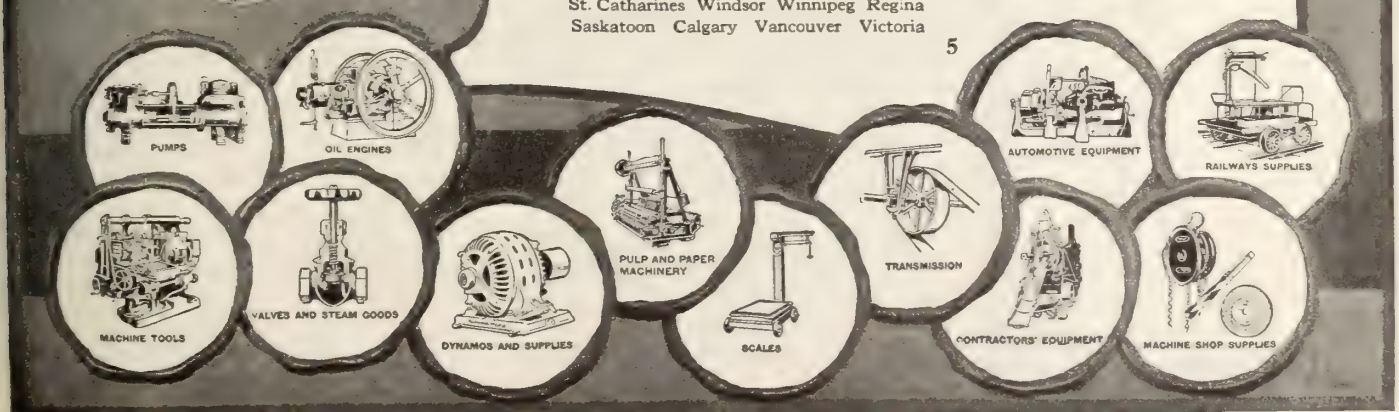
Our nearest branch will give you the benefit of this service, Our experts will help you in selecting valves and everything mechanical that you require. Make our catalogue your buying guide.

The Canadian Fairbanks-Morse Co.
Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

5



Temperature Control with the Uncertainty Cut Out

The ordinary temperature regulator is an uncertain proposition at best. It operates by compressed air, electricity or water. It often contains complex or perishable parts which get "out of whack" or require replacement. You are never sure that it will operate.

All uncertainty as to temperature regulation is instantly set at rest with the installation of a

SARCO Temperature Regulator

The principle on which this scientific regulator is built insures positive action at all times. It is self-operated—independent of all outside agencies. No levers, gears, diaphragms or complex parts of any kind. Nothing that requires watching or adjustment.

A rise or fall in temperature causes the expansion or contraction of a hydro-carbon oil within a metal spiral. A rod from the spiral operates the valve. Nothing could be more simple—or more certain.

On account of its simplicity the Sarco costs less to make than complicated regulators, a saving that is passed on to you. Sold with the privilege of return after a 30 days' free trial. Write our nearest branch for booklet J-58.

SARCO Co., Inc.

239 Broadway
New York City

Buffalo
Cleveland
Philadelphia
Chicago
Detroit
Peacock Bros., Montreal

TRADE GOSSIP

Montreal.—Through the inability of the company to procure castings, the Canadian Vickers Co. have been compelled to lay off nearly five hundred men. The shortage is due to labor troubles at Warden King's and the Montreal Locomotive Works, which firms supply the Vickers Co. with their castings.

Dominion Briquette Research. — The Government's lignite briquetting plants established by the Research Council to produce lignite fit for consumption, will be producing by August. It is the opinion of Dr. A. B. Macallum that the new fuel will prove so much cheaper and more efficient than anthracite, that the market for the latter in Western Canada will be closed, and private capital attracted to the lignite fields.

Duluth.—Arguments in favor of the proposed deep waterway from the lakes to the sea were heard at the final hearing of the International Joint Waterways Commission. It was stated that a channel to the sea could be completed in shorter time than the Eastern Atlantic ports could improve their facilities. The commission will hold sessions at Superior, Wis.; Ashland, Wis.; Milwaukee, and finish up at Toledo.

Brockville.—Catching fire at the wharf of the New York Central Railway, at Morristown, the steamer "H. P. Bigelow," owned by the Morristown-Brockville Transportation Co., was totally destroyed. The fire burned the steamer's mooring lines, and she drifted away from the wharf out of reach of the fire department's hose. She burned to the water's edge and then sank. Another vessel will be purchase to carry on the service.

BRANTFORD FIRM SOLD THE BUSINESS

Brantford Emery Wheel Co. Has Been Bought Out by the Waltham Grinding Wheel Co.

Brantford.—Recent transaction places the control of the Brantford Emery Wheel Company, Limited, in the hands of those whose interests are identical with the Waltham Grinding Wheel Company of Waltham, Massachusetts. The Brantford Company has been operating for the past ten years in the manufacturing of grinding wheels and it is felt that the new interests will enlarge immediately production facilities and be a factor of service to the grinding wheel users of Brantford and other parts of Canada.

Colonel Frank A. Howard is to continue as managing director.

The Waltham Grinding Wheel Company is one of the oldest and largest companies of the United States, the originators of the so-called elastic wheel process and have a record of 50 years of service and quality.

The new owners expect to greatly enlarge their production at Brantford.

Use The LONG STEAM for TRAP SATISFACTION

kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with great success. **Read this letter.**

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson, Superintendent

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

J. T. LONG
48 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.

CATALOGUES

The Wellman-Seaver-Morgan Co., of Cleveland, Ohio, have issued a bulletin descriptive of their Wellman mechanical Gas producer. It contains a number of splendid illustrations and a vast amount of information on gas production generally. In the Wellman producer the fuel is fed into the top by mechanical feeders which regulate the rate of fuel, and the arrangement is such that a practically continuous flow of coal is received in the producer, according to rate of gasification. The data given are so complete that the bulletin will be found a useful book for a gas engineer to have at hand for easy reference.

The Bernitz method of furnace lining, which has had very successful applications in a large number of plants both in the U.S. and Canada will be sold, manufactured, and installed in Canada by Messrs. Burlingame & Gardner, who will be located in Toronto. The chief advantage of the Bernitz system is that of decreased cost of maintenance, as the system of introducing air through the furnace lining prevents the adherence of clinker to the wall, thus extending its life far beyond that of the ordinary fire brick. There are also features connected with better combustion, but the Bernitz system bases its claim chiefly on the maintenance feature.

D. K. McLaren's Leather Belting

Good Belting is Not a Matter of Chance

That most important feature of a belt—dependability—is not secured by any haphazard method. Each detail contributing to its manufacture must be as nearly perfect as possible.

Consider these factors of D. K. McLaren's Belting.

The Hide—Selected from the **backs** of the choicest steers. The back is the strongest part.

The Tanning—Genuine British Oak tanning by skilled workmen impart to the leather that mighty toughness and flexibility characteristic of D. K. McLaren's Belting.

The Result—A belting that can be depended upon at all times—a belt with minimum stretch and minimum slippage.

GENUINE OAK

Look for this Sign of Quality

D·K·McLAREN LIMITED

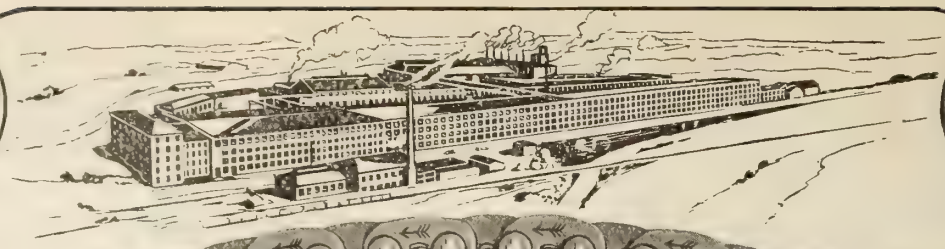
HEAD OFFICE AND FACTORY:

351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

VANCOUVER, B.C.
334 Cordova St. West

TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 Germain St.



The Sign of Efficiency — The Sign of Durability

MORSE DRIVES

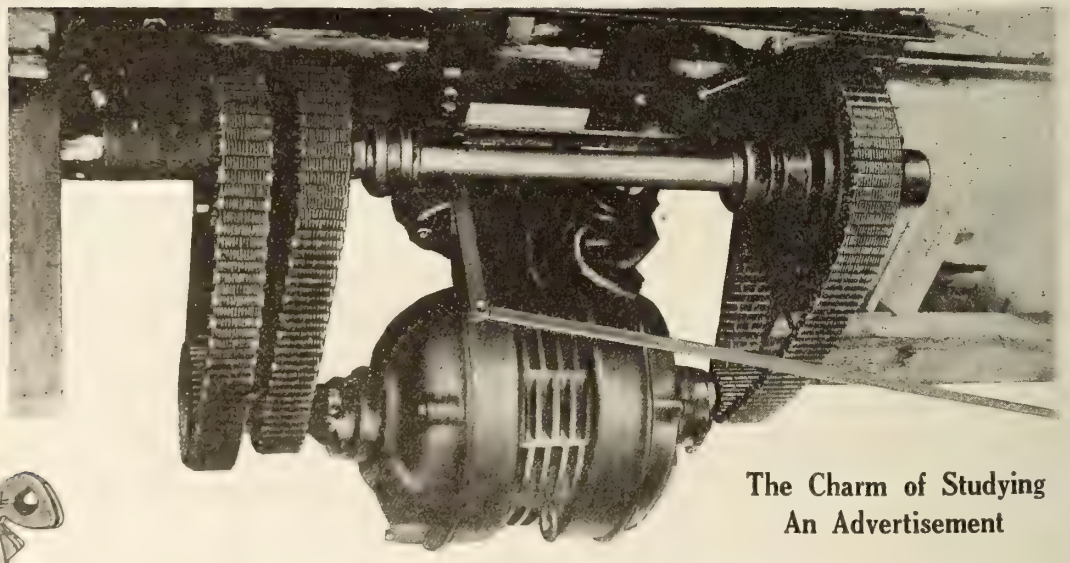
THE MORSE "ROCKER JOINT"

Positive as Gears — Flexible as a Belt

Longer Life

3 IN 1

THE 7½ H. P. constant speed motor with the 3-Speed Chain Drives pictured below, replaces a 15 H. P. motor with friction, variable-speed belt drive.



The Charm of Studying An Advertisement

picturing a successful achievement lies in the vision it brings of the possibilities of adaptation for overcoming deficiencies, improving quality, increasing production. The lowering of cost.

In these strenuous times early specifications of requirements are very desirable to insure prompt deliveries.

MORSE CHAIN CO. — Largest Manufacturers of silent chains in the world — **ITHACA, N.Y.**

MORSE ENGINEERING SERVICE — ASSISTANCE WITHOUT OBLIGATION

Address Nearest Office

Baltimore, Md.....1402 Lexington Bldg.
Boston, Mass.....141 Milk St.
Chicago, Ill.,
Merchants Loan & Trust Bldg.
Detroit, Mich.....1003 Woodward Ave.
Charlotte, N.C.,
404 Commercial Bank Bldg.
New York City
50 Church St., Hudson Term. Bldg.
Philadelphia, Pa.....332 Harrison Bldg.
Pittsburgh, Pa. .....Westinghouse Bldg.
San Francisco, Cal.....Monadnock Bldg.
Atlanta, Ga.,
Earl F. Scott, M.E., 702 Candler Bldg.
Canada.....Jones & Glassco, Reg'd.
Montreal, St. Nicholas Bldg.
Toronto, Trader's Bank Bldg.
Kansas City, Mo.,
Morse Engineering Co., Finance Bldg.
Minneapolis, Minn.,
Strong-Scott Mfg. Co., 413 Third St., S
St. Louis, Mo.,
Morse Engineering Co., Chemical Bldg.

"MORSE" is the Guarantee Always behind our Service, Efficiency and Durability.

VULCABESTON

1300 lbs. Compressed Air— and No Leaking Joints

If you pack with Vulcabeston Red Fibre Sheet Packing, there will be no lost compression through leaking joints in your entire system. Vulcabeston gaskets stand a 1300 lb. air pressure without trouble.

VULCABESTON
RED FIBRE SHEET PACKING

acts the same with steam or hydraulic pressure, compressed ammonia, carbonic gas and other acids. In fact, the strength of the long asbestos fibre that forms the body, and the resiliency of the binder are equal to every test.

With Vulcabeston in your supply room you need no others. It is "The Universal Packing."

The Johns-Pratt Company
Hartford, Conn. U. S. A.

Dealers in all large cities

VULCABESTON RED FIBRE STEAM SHEET PACKING COMPRESSED ASBESTOS

20-6

THE Bond SERVICE

THE ABOVE PHOTOGRAPH OF A RECENT ORDER ILLUSTRATES

THE SERVICE

WE ARE ABLE TO GIVE TO LARGE INSTALLATIONS

This order was turned out in 14 working days in our up-to-date plant, without interfering with our regular business. This was possible by our modern equipment, and well trained help. In planning your new factory

LET US HELP YOU

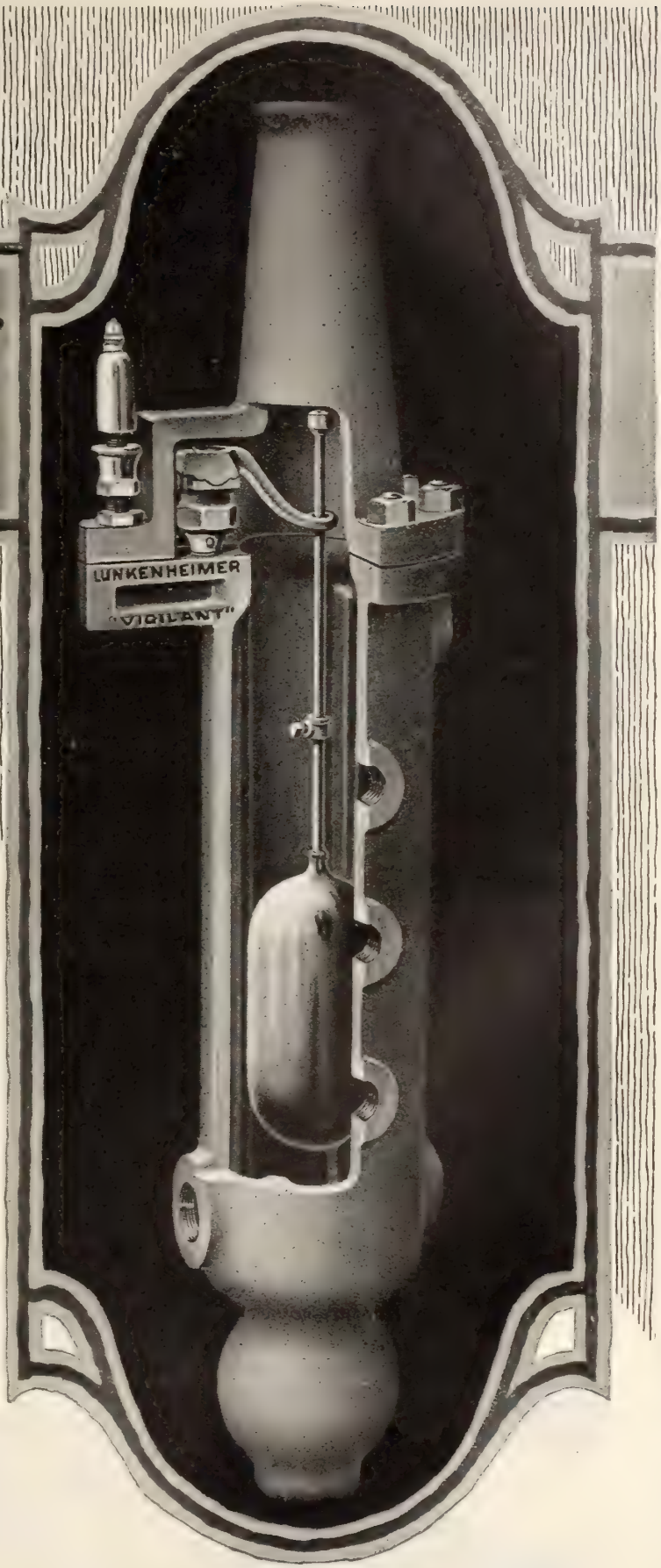
Write for catalogue 38PH illustrating The Bond Double-Sure line of Power Transmission

BOND ENGINEERING WORKS LIMITED
POWER TRANSMISSION MACHINERY

TORONTO, ONTARIO, CANADA

Made in Canada

Safety —always



The safety of the steam boiler depends in a large measure on the maintenance of the proper water level, it being apparent that an excessively high or low level will result disastrously. To insure this safety —*always* is the purpose of the

LUNKENHEIMER "VIGILANT" SAFETY WATER COLUMN

which will sound an alarm and notify the attendant should the water approach either danger limit. It thereby protects life and property and by assisting in the maintenance of a uniform water level contributes to economy in the use of fuel.

The "Vigilant" Safety Water Column is a boiler appliance of merit, and is specified when safety and economy are paramount.

Made in a variety of sizes to suit all makes of boilers and from the extensive line of Lunkenheimer Water Gauges and Gauge Cocks a combination can be selected to suit every individual installation.

Specify LUNKENHEIMER and insist on having the genuine. Your local dealer can furnish them; if not, write us.

The complete line of Lunkenheimer Water Columns, Water Gauges and Gauge Cocks is illustrated and listed in Booklet No. 519—DC. Write for a copy.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862

20-13-43

Don't Fail to See Our Exhibit

AT THE

C.A.S.E. Convention
Woodstock, June 22, 23, 24

Let's all become better acquainted.

If you do not happen to be there, write us for interesting literature on the "Cole" System of Heating, Transmission and Condensation Drainage.

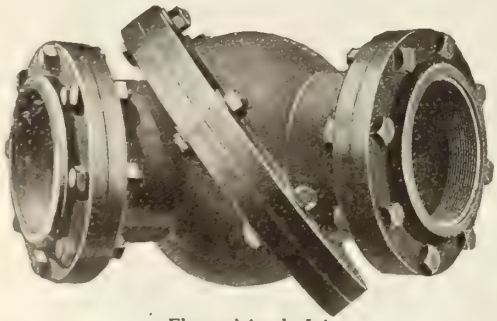
Geo. W. Cole, Limited

2002-4 Dundas St. West
TORONTO

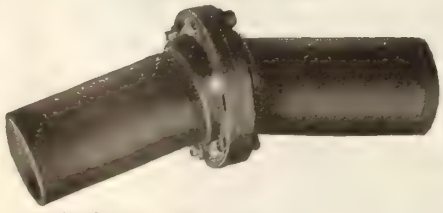
Western Representative:
GEO. A. YOUNG
203 Scott Block - Winnipeg

Eastern Sales Office:
76 St. Gabriel Street
Montreal

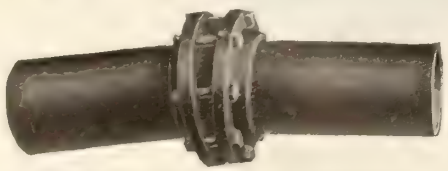
Save Time and Money—
Simplify Your Difficult Piping Problems



Flanged Angle Joint



Application of Slotted Angle Flanges



Application of Adjustable Annular Wedges

Labor costs can be cut down, much time saved, many difficulties overcome, and perfect jobs secured by the use of "Adsco" Angle Fittings. A large number of styles are made in addition to those illustrated here.

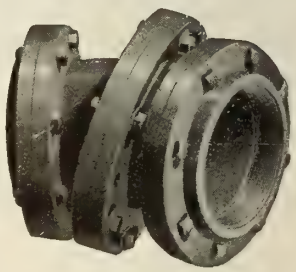
This company makes a complete line of everything used in the distribution of steam; Expansion Joints, Insulation, Variators, Valves, Manhole Curbs, Companion Flanges, Separators, Steam Traps, Meters, Regulators, Heaters.

We have a large stock of W.I. Pipe, Flanged Fittings (made from (sweep-angle patterns to standard dimensions), "Adsco" Specialties for the "Adsco" System of Atmospheric Heating.

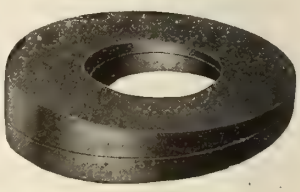
Let us quote on your requirements
Write for Catalog 9-PH

AMERICAN DISTRICT STEAM COMPANY

General Offices and Works:
North Tonawanda, N. Y.
Representatives:
A. R. Williams Machinery Co., Ltd.
TORONTO, ONT. and Branches

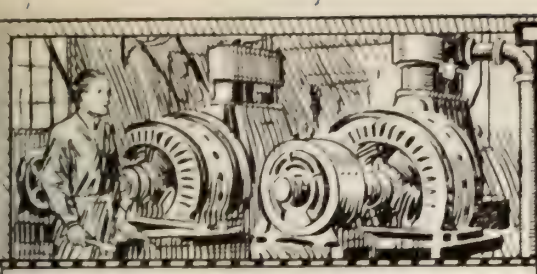


Angle Joint



Adjustable Annular Wedges

Slotted Angle Flanges



MINISTRY of MUNITIONS

G R

The Disposal Board have

STOCKS

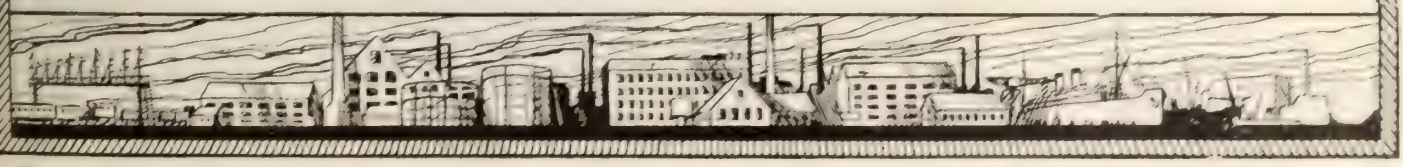
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

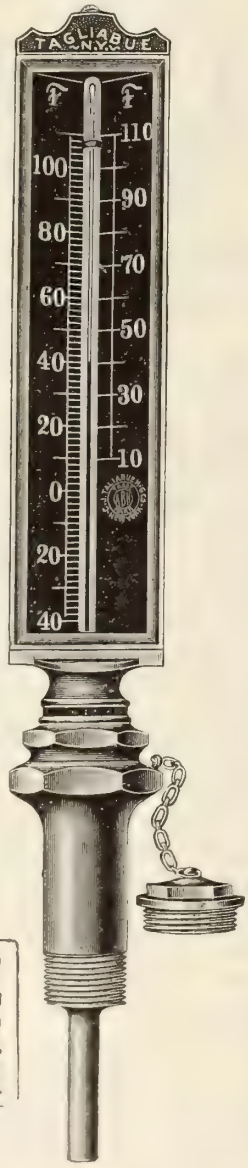


TAG
Self - Operating Pressure Controller

It wouldn't be economy to lose steam through leaking joints, nor is it economy to supply more steam than is needed.

The TAG Self-Operating Pressure Controller prevents the second form of waste.

On any feed pipe, no matter what form of energy or power, the TAG Controller automatically regulates the supply. You can't supply too much and, unless the quantity or pressure fails, you can't supply too little.



The TAG Controller is simple and strong in construction and operates with positive accuracy.

Unlike the hand valve, the Controller allows no more variation than a small fraction of a pound, and you don't have to watch it. It operates itself.

It saves fuel; it saves labor.

Bulletin P-388 explains

C. J. TAG LIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark
Reg. U. S. Pat. Off.

"MEAD-MORRISON"
CANADIAN MM ©
CANADIAN MM ©

COAL and ASH HANDLING MACHINERY

Manufactured in Canada

DEPENDABLE SERVICE

Coal Handling Bridges
Weighing Lorries
Coal Crushers
McCaslin Conveyors
Clam Shell and Orange Peel Grab Buckets

Put Your Problem Up to Us!

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Mr. Jos. W. Hays, *Author*

Mr. Joseph Harrington
Chicago
Formerly Advisory Engineer, National Fuel Administration for State of Illinois

Mr. Fred R. Low
New York City
Editor of Power

Prof. S. W. Parr
Urbana, Ill.
Department of Chemistry, University of Illinois

Mr. Arthur L. Rice
Chicago
Editor, Power Plant Engineering

W. L. Abbott,
Chief Operating Engineer, Commonwealth Edison Co., Chicago, Ill.

Mr. David Moffat Myers
New York City
Formerly Advisory Engineer, National Fuel Administration

These Men are America's Leading Combustion Experts

Every step of the training has their careful censorship, giving you the fruits of their broad and successful experience.

Hays School of Combustion
1108 State-Lake Bldg.
Chicago, Ill.

Better Jobs— Bigger Salaries

Let These Men Show You How to Get Them

Are you interested in sure and rapid advancement to a really worth while position in one of the best paying professions in the country today? If you are it will pay you well to read this announcement. It tells how you, with or without previous training, can prepare yourself in a short time for an attractive position that insures a lucrative salary and an assured future.

Remember—this profession is a new one—unlike all others, it is still uncrowded—and the demand for trained men far exceeds the supply. That's why your services will be in demand when you have acquired the necessary training. That's why you can count every effort a sure and wonderfully profitable investment.

Easy to Learn— No Experience Necessary

In most professions, to become proficient, long periods of intensive study, followed by years of hard training, are necessary. In this new profession—Combustion Engineering—the necessary training can be acquired in a few short months. Why? Because all the knowledge and experience—all the scientific research and experiments—all the labor and study of seven of America's leading Combustion Engineers have been condensed and classified to such a remarkable extent that what formerly required years of study can now be learned in a fraction of that time.

This training from the very first can be applied to the practical every-day problems of any power plant. At some point in the course you must spend some time in power-plant work if you have not already had the experience. That may prove to be your field or you may make it the stepping stone to an executive position. In either case your services will increase in demand and value as you progress in the training.

America's Leading Combustion Engineers Teach You

On this page are photographs of our educational staff. Probably you know some of these men personally. At least, all or most of them, are known to you by reputation.

Jos. W. Hays is the author. His reputation as a writer on Combustion Efficiency is world wide. In this course he has surpassed himself. Every lesson, every chapter, is written in such an interesting, comprehensive way, that the reading of the course is as pleasant as it is profitable.

Associated with Mr. Hays as reviewing and advisory editors are **I. E. Moultrop, W. L. Abbott, Jos. Harrington, Fred R. Low, David Moffat Myers, Prof. S. W. Parr and Arthur L. Rice.** These names alone are proof positive of the thoroughness and completeness of the course.

Especial attention has been given to make this course easily understood by everyone. It is stripped of all unnecessary technicalities and is written in a way that you can quickly grasp and understand. It is prepared especially for the man on the job—the busy man in office or boiler room who can commence putting his knowledge into practice the moment he starts the course.

Send for this FREE BOOK—TODAY

To enable you to get a better idea of just what this course is—just what it covers—why it is a guide to a better job and a bigger salary—why it enables *you* to cash in on the big salary awards that fall to the Combustion Expert—to make all these things clear to you, we have prepared the book "Opportunities for the Combustion Expert." Send for a copy of this book today. It's free.

Mail the Coupon

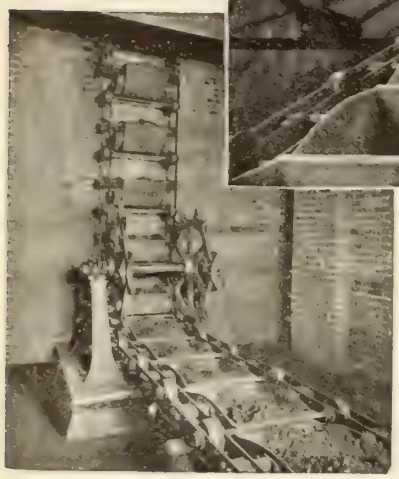
Simply fill in the coupon and mail it to us. We'll send you a free copy of "Opportunities for the Combustion Expert" by return mail. Time is valuable. Get started today while the opportunities are greatest. Mail the coupon—Now.

HAYS SCHOOL OF COMBUSTION
109 North State St., Chicago

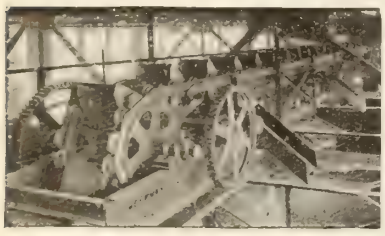
Without obligation, send me a free copy of "Opportunities for the Combustion Expert and details of the Hays Course.

Name.....
Street.....
City.....State.....
Firm.....
Position.....

Upper Run of Pivoted Bucket Carrier over coal bunkers.



Lower run of Pivoted Bucket Carrier.

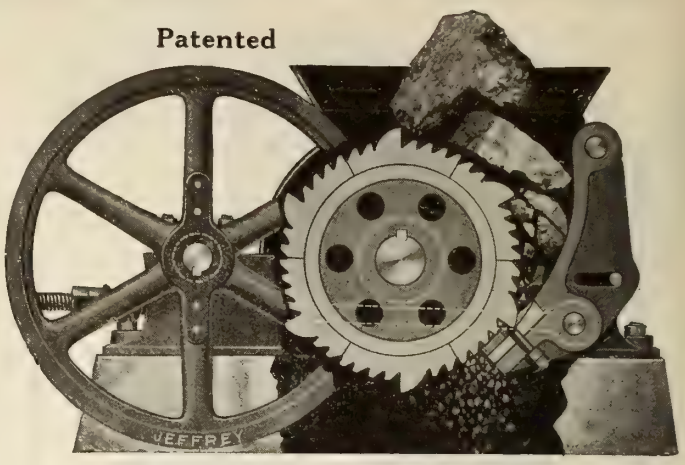


V-Bucket Elevator—Conveyer over bunkers.

Drag Chain Ashes Handling Conveyer.

Steel Apron Type Conveyer handling coal from track hopper to boiler house.

Patented



Single Roll Crusher for reducing coal to stoker size.

Jeffrey Equipment

Is Adapted For Handling Coal And Ashes In All Sizes Of Power Plants

Your requirements can be economically met by some of our standard types of Pivoted Bucket, V-Bucket, Chai Scraper, Belt, Steel Apron or Drag Chain Conveyers, Bucket Elevators or other types of equipment.

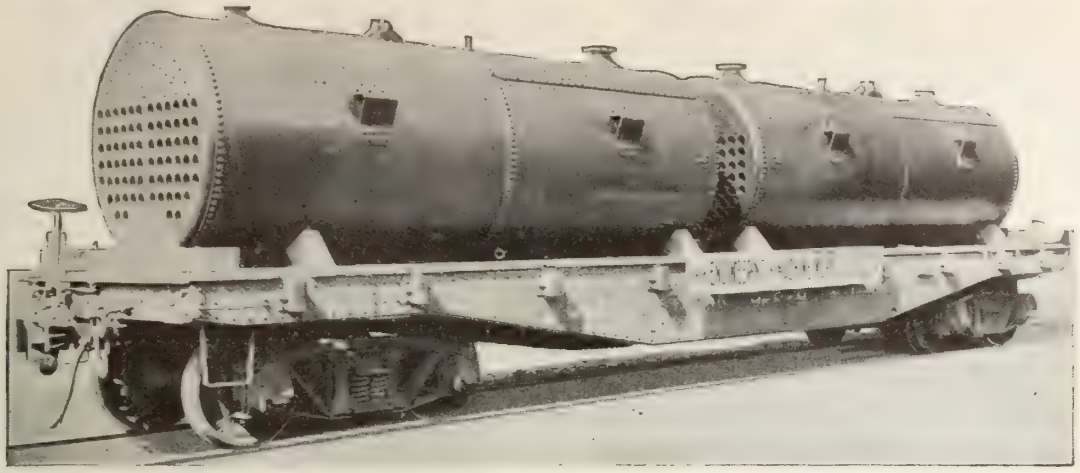
Engineers with years of operating and field experience will make a study of your individual problems and recommend the "right equipment" to place your coal and ash handling on an economical basis. Send for latest catalogs.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms, MONTREAL

Chain Scraper Type Conveyer over bunkers.

Belt Conveyer and Tripper distributing coal to bunkers



Good Service to Orders—Now!

It happens that our materials supply and our facilities stand at high water mark just now. If you will need Boilers (any type), tanks, plate work of any kind in the next few months, now is the time to tell us.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Coal is Scarce!

You know that as well as we do—we emphasize the fact merely as a reminder and to bring to your attention that this scarcity means high prices. The high prices will have to be met in some way. Would a ten per cent. saving interest you? This is quite a big coal-saving and it is a saving that is possible by the use of **Nonpareil Shaking and Dumping Grates.** We will prove this to your entire satisfaction if you will get in touch with us.

Nonpareil Grates

THE W. R. SEXTON BOILER SETTING COMPANY

670 Shaw St. or 127 D'Arcy St.
TORONTO

Established 1900 Phone, College 682

We Supply Grate Bars and make Repairs to all Shaking Grates. Fire Brick Work and Boiler Repairs of all kinds.

Used Oil Suitable for Use on the Finest Bearings

That's what the Anderson Pressure Filter does to drip pan collected oil! Makes it as clean and pure as new. The treatment it undergoes is identical to that used by the refiners.

Without the Anderson more than half the oil you buy is wasted. With the Anderson there is practically no waste. Thus your oil bill is cut at least in half.

Is not this economy of great importance to you? Our catalog contains full particulars. Shall we send you a copy?

The V. D. Anderson Co.
West 96th Street, Cleveland, Ohio

Anderson
Pressure Oil Filter

Have You Complaints of "No Steam?"

Is the inferior coal of to-day unable to make steam enough to care for the increased demand? Is your coal bill mounting? If so, you need a

Jones Underfeed Stoker

A Jones Stoker will increase the steaming capacity of your boiler—with an immediate saving of 15 to 20 per cent over hand fired conditions.

Have us tell you how the Jones eliminates smoke; how it responds to sudden demands—even fluctuating loads and its other advantages. Write to-day.

Some Canadian Users

Dryden Pulp & Paper Co., Ltd., Dryden, Ont.; E. B. Eddy Company, Ltd., Hull, P.Q.; Canadian Packing Co., Toronto, Ont; Halifax Electrical Tramway Co., Ltd., Halifax, N.S.; Cornwall & York Cotton Mills Co., Ltd., St. John, N.B.; Canadian Pacific Railway Company; Canadian Consolidated Rubber Company, Limited, Montreal; O'Keefe Brewery Company of Toronto, Toronto, Ont.; William Neilson Limited, Toronto.

JONES UNDERFEED STOKER CO., LTD.
81 Victoria St. Toronto, Ont.

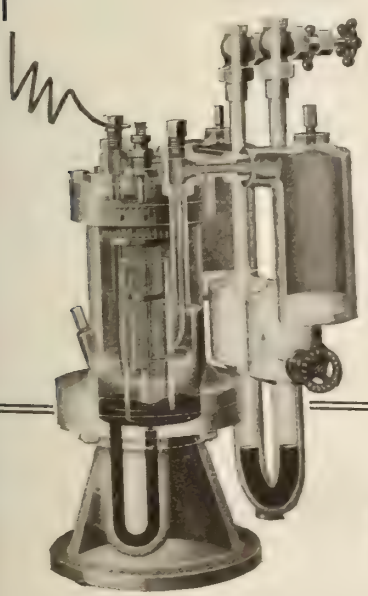
Republic Flow Meters

The Electrically Operated

Electrical Operation Means Accuracy!

Accuracy Means Lower Costs!

You are ready to concede that flow measurement is a great advantage to any steam plant. But do you know of the advantage that the electric method of operation has over any other system.



Dependable records where they can be conveniently read under all conditions! There in a nutshell you have the advantage of the electrical system—that exclusive feature of Republic Flow Meters. It matters not how inaccessible the points of measurement may be, the Republic System assures **convenience** and **accuracy.**

Where there's **accuracy** there's economy—particularly in fuel. Where there are Republic Flow Meters less fuel is consumed, which is an important factor in these days of fuel shortage.

Republic Flow Meters claim your attention. Study the illustrations herewith and then write to us for complete explanation of their application to your plant.

See Our Booth at the Convention

Republic Flow Meters Company of Canada, Ltd.

145 Wellington Street West

TORONTO

ROBB

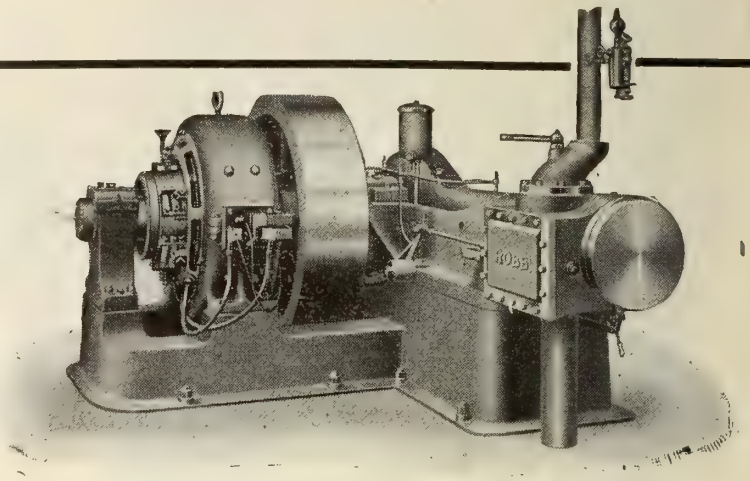
POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



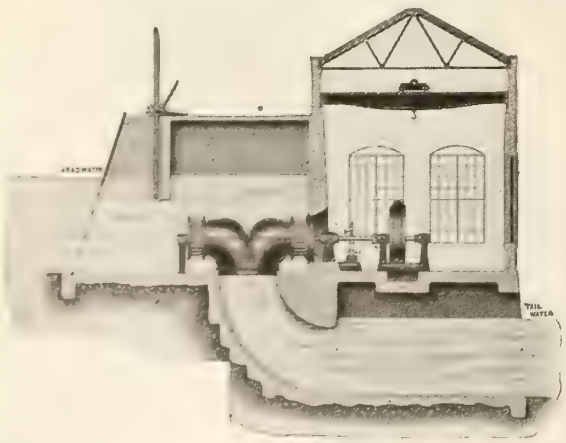
Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
Phone
Westmount 6800

Toronto Office:
20 Victoria
Street

Water Wheels and Hydraulic Power Plant Equipment



Horizontal Twin Turbine in open concrete flume.

Hydraulic Turbines
Governors
Head Gate Hoists
Stop Log Winches
Steel Feeder Pipes
Trash Racks
Butterfly Valves
Surge Tanks

Send for Bulletin No. 54

William Hamilton Co., Limited, - Peterboro, Ont.

ANNOUNCEMENT!

Burlingame & Gardner, Engineers

announce the opening of offices in the Stair Building, Room 110, 123 Bay Street, Toronto, and will specialize in the

BERNITZ SYSTEM

of

Furnace Wall Construction

It consists of new and scientifically designed furnace wall construction for the purpose of eliminating clinker formation. Clinker formation is disastrous to furnace linings, and restricts the capacity of the furnace. The Bernitz System effectually prevents clinkers from attaining a shelving.

Our new offices in Toronto place us in a convenient position to fully explain the system and its merits. When we install the system a competent staff of engineers superintend the construction and the placing of the boiler in service. The installation is then guaranteed to give the service for which it is recommended.

The installation of the Bernitz System is inexpensive—and that it is effective is attested by its use in numerous large and small boiler plants throughout the country.

A competent engineering staff is ready to co-operate with you at all times on your individual combustion problems.

We have issued an interesting and instructive booklet on furnace efficiency—May we send you one?

BURLINGAME & GARDNER

Room 110 Stair Building, 123 Bay Street

TORONTO, ONTARIO

Is There an Alien Menace in Canada?

IN THE years of war, people were quick to grasp the possibilities of danger that lie in Alien sympathies. But people quickly forget, and therein lies the danger for it is in the insidious breaking down of the ties of loyalty, that goes on in the piping times of peace, that makes the menace of the days of war.

In "The Stranger in Our Midst" the simple story of a school teacher's experience in foreign settlements in the West there lies a reproach and a warning, a reproach in that such things can be, and a warning that they may not happen again.

This is only one of the many stories and articles that make the June 15th issue of MacLean's Magazine of outstanding interest.

These are some other points of interest:

FICTION

"The Little Warrior"—Pelham Grenville Wodehouse's inimitable story.

"The Parts Men Play"—Arthur Beverly Baxter.

"The Sunset Homesteader"—Will E. Ingersoll.

"The Beetle and the Butterfly"—C. W. Stephens.

ARTICLES

"What Must Be Done?"—Mrs. Murphy's suggestions of a remedy for the drug menace.

"We Must Reform Dress"—Marian Keith.

"Gentlemen of the Fourth Estate"—The story of men who begin life in newspaper offices.

The Best From Everywhere

In the Review of Reviews department will be found the best articles from all magazines and periodicals the world over. Look at these titles and authors:

"Belgium Has Come Back"—by Frederick Palmer.

"How the English Came to Be"—by Rudyard Kipling.

"Eight Billions Wasted"—by Thomas V. Merle.

"Mankind Needs Change of Heart"—by Sir Philip Gibbs.

"Give Labor a Square Deal"—by Charles M. Schwab.

"The Slow Conquest of America"—by Forrest Crissey.

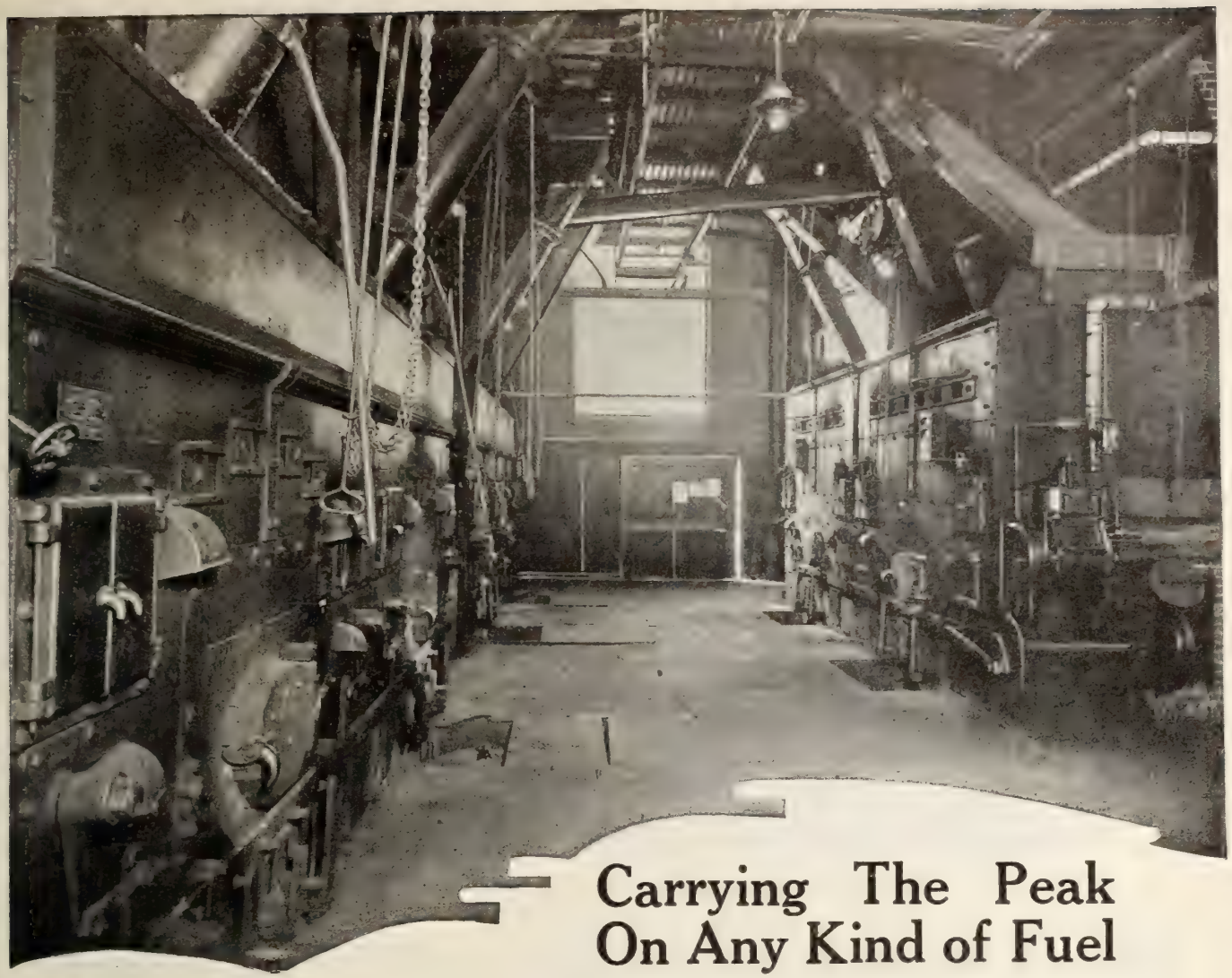
"Know Your Own Car"—by Alexander C. Johnson.

"Sending Pictures by Telegraph"—by Milton W. Stoddard.

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

June 15th Issue Now on Sale at All Newsdealers



Carrying The Peak On Any Kind of Fuel

A difficult Problem was solved at the Spicer Mfg. Corp., South Plainfield, N.J.

Four boilers can easily carry heavy overloads and maintain the steam pressure at 175 lb. gauge regardless whether bituminous, straight anthracite or a mixture is being burned by their six.

DETROIT "V" Type STOKERS

Four of these stokers (at the left) were installed under the 150 horsepower boilers in 1916. Their satisfactory performance in burning the poor quality coals available at that time, resulted in a repeat order for two additional Detroit Stokers (at the right) with Detrick Flat arches for the 300 horsepower boilers that were installed in 1918. The plant was designed by Henry R. Kent & Co., Engineers of New York City.

Detroit "V" type Stokers save coal and labor. They will burn low quality coals smokelessly on natural draft up to 200% boiler rating. Constantly increasing repeat orders are indisputable evidence of satisfactory performance under widely varying operating conditions.

Consultation with our engineers regarding your specific combustion requirements is invited. Catalog "P" gives full details. Write.

Detroit Stoker Company

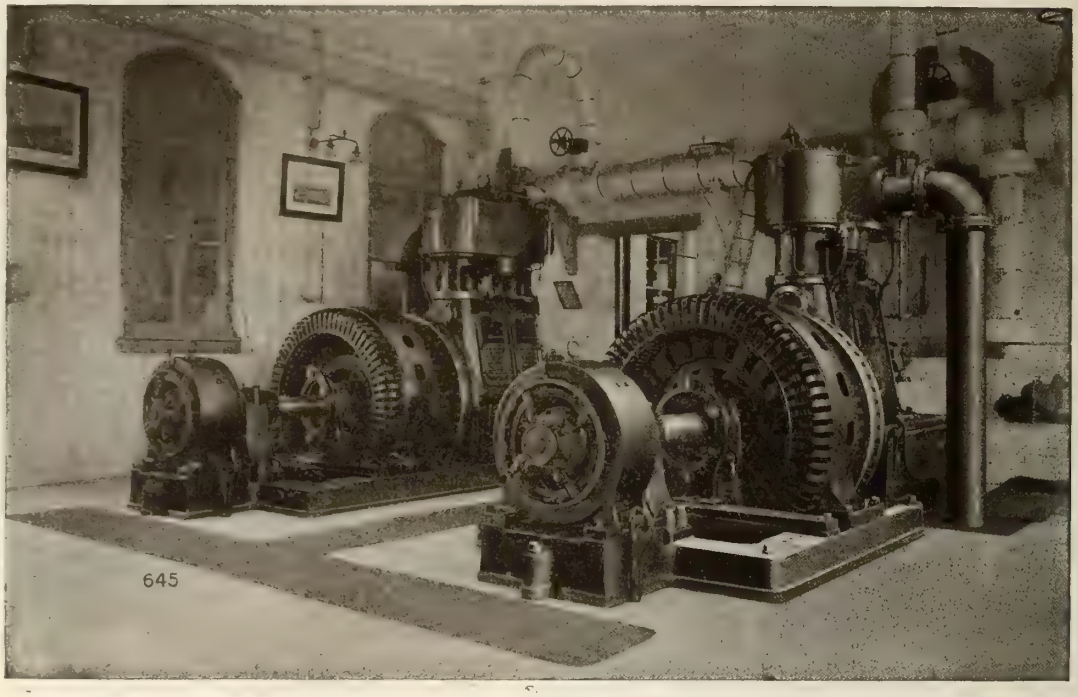
Detroit, Mich.

BRANCHES:

Chicago Cincinnati Pittsburgh Philadelphia
Cleveland New York Atlanta Boston

LAURIE & LAMB

Power Plant Equipment



Belliss & Morcom Engines installed in McGill University Power House. Total Horse Power, 1010 B.H.P.

Belliss & Morcom, Ltd., Engines and Air Compressors

To the Engineers at the Convention

Your attention is directed to the high standard of quality represented in the design of Bellis and Morcom Engines and Air Compressors, which is characteristic of all Laurie and Lamb power plant equipment.

Our engineers are experts on power plant economy and efficiency. They are at all times prepared to advise and co-operate in every way to secure the best results in your plant. Put your most difficult problems up to them.

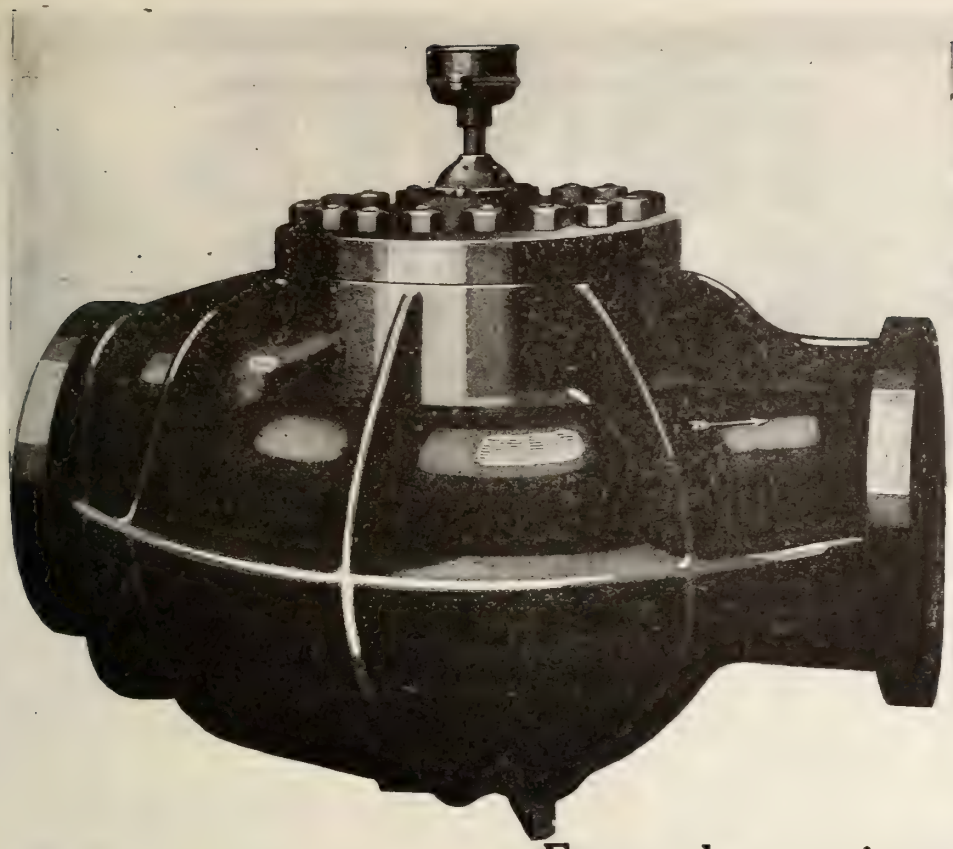
A Partial List of Laurie & Lamb Equipment:

Steam Engines	Condensing Plants	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Prompt Shipments and Installations

LAURIE & LAMB

211 Board of Trade Bldg. Montreal, Que., Can.



Worthington Hot Water Turbine Meter

Every three minutes a completely assembled Worthington Meter

FOR checking up on boiler performance, a Worthington Hot Water Turbine Meter is absolutely essential. It is companion apparatus to CO_2 recorders, coal weighing scales and similar efficiency promoters.

Worthington meters are standard Worthington equipment, working in close co-operation with Worthington condensing apparatus and power plant equipment to force boiler room efficiency. Each Worthington meter is representative of 80 years of Worthington experiment, improvement and manufacture of pumps and pumping machinery for power plant service.

For any liquid and every measuring condition, Worthington can furnish meter service. And the advice and service of the Worthington engineering department is to be had for the asking.

Other Worthington Products:

Steam, Power, Centrifugal and Water Works Pumps, Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

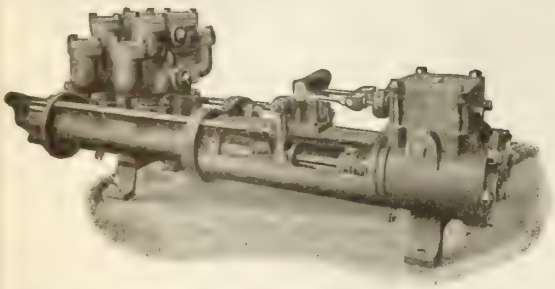
Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.

Epping-Carpenter, *Pittsburgh, Pa.*

Laidlaw Works, *Cincinnati, Ohio.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.

HINTS TO BUYERS



PUMPS that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded
WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

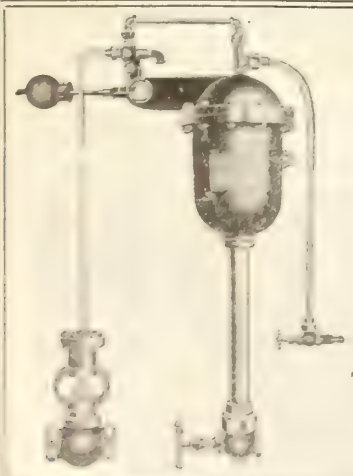
The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO
Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.
MAKERS OF THE "LITTLE GIANT" TURBINE
Put Your Water Wheel Proposition Up To Us

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.



Safety or Worry?
CHOOSE
Would you rather worry about your fireman's inattention to the boiler feed water, or be absolutely assured of continuous middle gauge lever control by VIGILANT FEED WATER REGULATORS?
We will gladly furnish full information
The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor

CRANE VALVES

CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

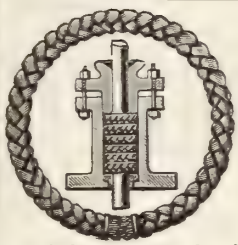
MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal

ECONOMIC Carling BLOWERS SUPERIOR

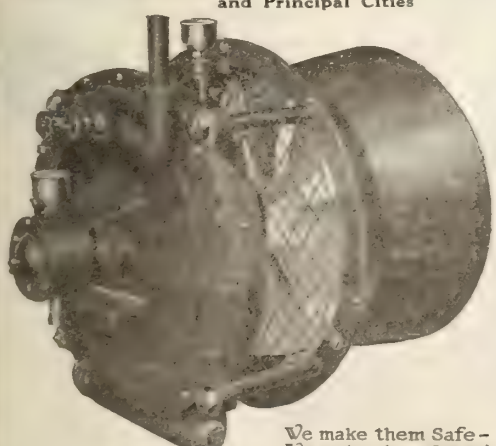
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

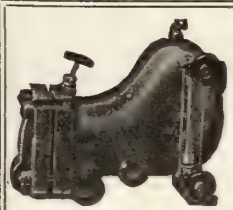
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong



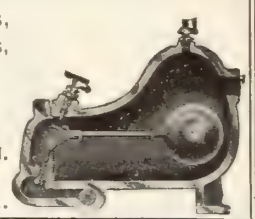
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Showing ease with which Plibrico is laid in place.

PLIBRICO

A Jointless Fire Brick Lining

under your boiler is a sure determinable saving of one of the largest preventable losses of economy in any boiler plant. Plibrico is also unexcelled for baffle construction and repairs.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory: 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives

Trade Mark
Reg. U.S. Pat. Office

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

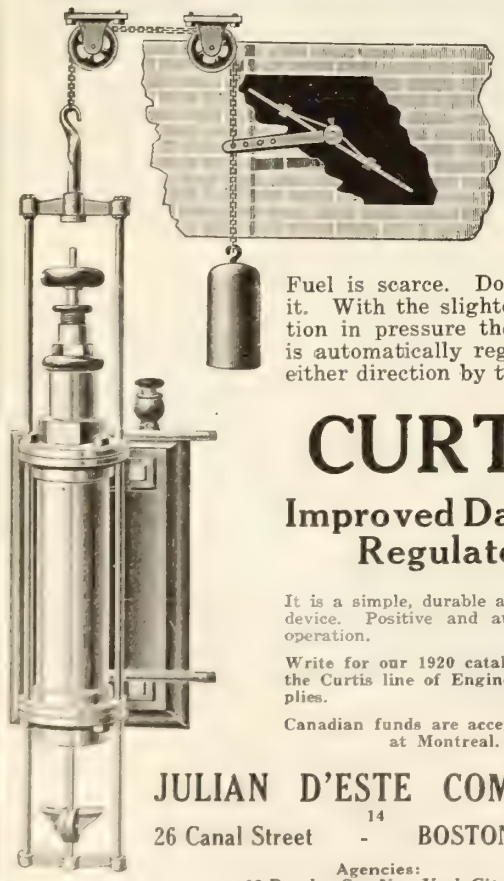
BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1920 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

14

26 Canal Street - BOSTON, MASS.

Agencies:
83 Barclay St., New York City
174 North Market Street, Chicago, Ill.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

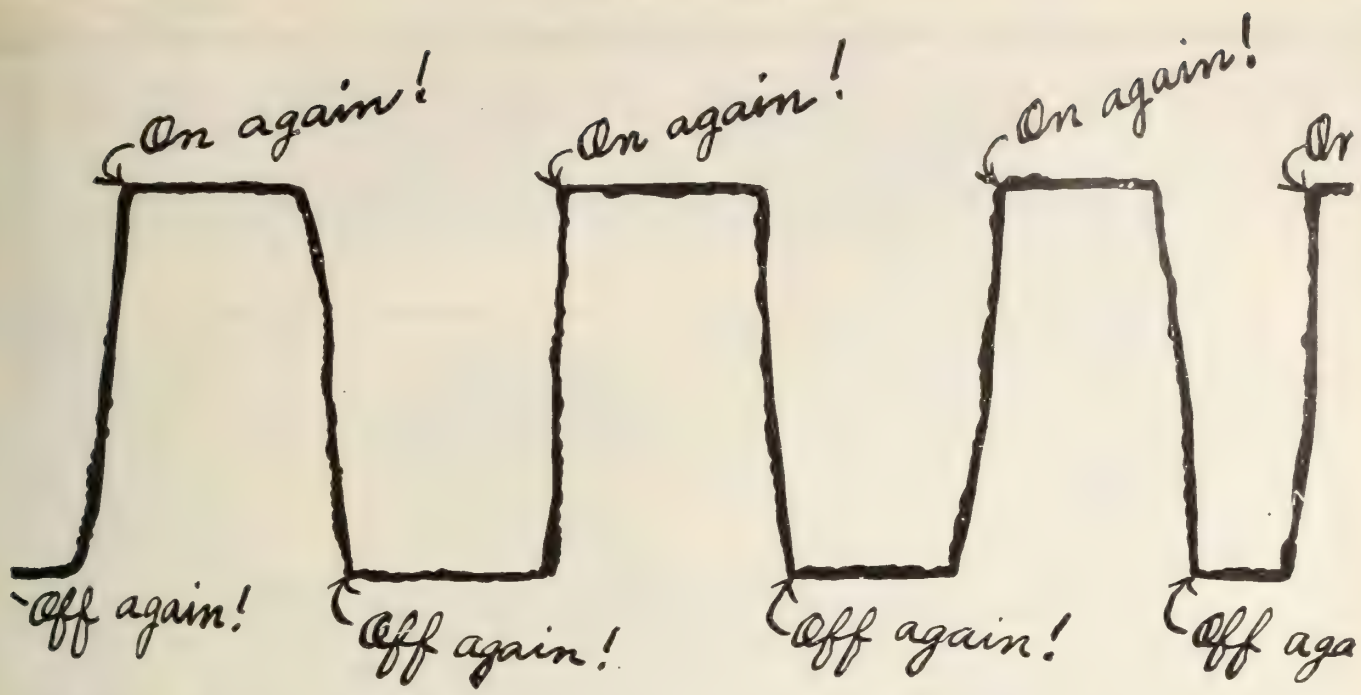
Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.



Off Again, On Again, Gone Again, Finnigan. That's Hand Regulation in the Average Pulp and Paper Mill.

Above we show exactly what happens when you attempt to control boiler feed by hand. It's simply a case of "off again" and "on again."

Hand regulation cannot give economical results because the operator does not know what is going on inside the boiler. The Copes takes care of every fluctuation automatically. It stores heat when heat should be stored. It gives up heat when heat should be given up.

PAPER AND PULP MILLS

find the Copes to be an excellent investment because the Copes automatically takes care of the large quantities of steam that are used suddenly and periodically. The Copes does it EFFICIENTLY.

Slugs of water in steam frequently spoil the "batch." Copes prevents this spoiling because with the Copes there are no slugs.

BIG PAPER MILL USERS

Ha! Ha! Bay Sulphite Co.
Price Bros. & Co.
St. Maurice Paper Co.
Belgo-Canadian Paper Mills
Laurentide Co. Pacific Mills
Brompton Pulp & Paper Mills
Spanish River Pulp & Paper Co.
La Compagnie de Pulp de Chicoutimi
Abitibi Paper Co.
Mead Pulp & Paper Co.
Miami Paper Co.
Kingsport Pulp Corp.
Berlin Mills
Hammermill Co.
Union Bag & Paper Co.
United Paperboard Co.
Kalamazoo Paper Co.

98% of the large modern central stations of the United States now use the Copes Regulator. Specified by all leading chief, consulting and efficiency engineers.
No floats, springs, pilot valves, diaphragms, displacement members, boiling liquids, or complicated parts to give trouble. The simplest of all regulators. Strong, Reliable, Safe.

Fully described in Bulletin B.

NORTHERN EQUIPMENT COMPANY

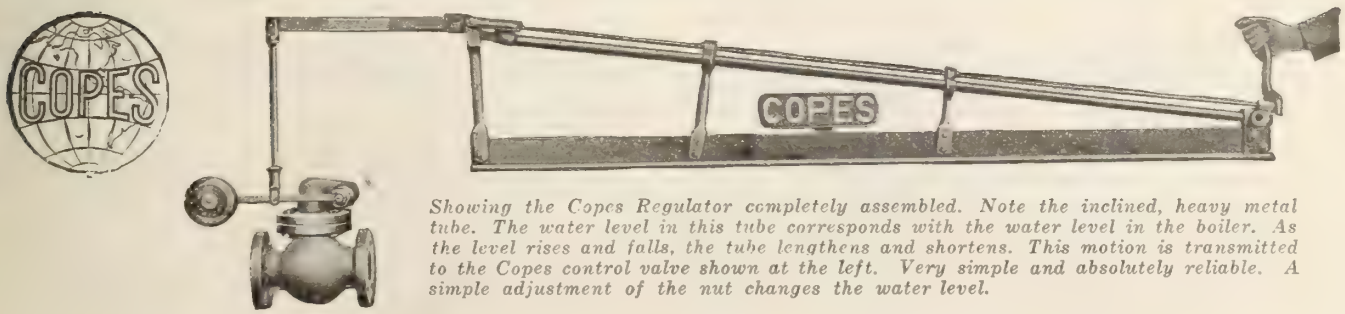
The World's Largest Manufacturers of Feed Water Regulators

Main Office and Works: 112 W. 11th Street, Erie, Pa.

Branch Works: Manchester, England; Paris, France. Sales Representatives in all Industrial Centres in the United States, Canada, Mexico, England, Scotland, France, Belgium, Japan, China, India, South America.

CANADIAN REPRESENTATIVES:—Allen General Supplies, Ltd., Toronto, Ont.; H. N. Brown, P.O. 620, New Glasgow, Nova Scotia; Mason Regulator & Eng. Co., 153 Dagenais St. (St. Henry), Montreal; Engineering Apparatus & Supply Co., 210 Confederation Life Bldg., Winnipeg, Manitoba.

Write Chas. C. Moore & Co., Engrs., 618 Mutual Life Bldg., Seattle, Wash., if you reside in British Columbia.



Showing the Copes Regulator completely assembled. Note the inclined, heavy metal tube. The water level in this tube corresponds with the water level in the boiler. As the level rises and falls, the tube lengthens and shortens. This motion is transmitted to the Copes control valve shown at the left. Very simple and absolutely reliable. A simple adjustment of the nut changes the water level.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken. but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co., Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn

BRASS GOODS
Crane's Limited, Montreal.
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

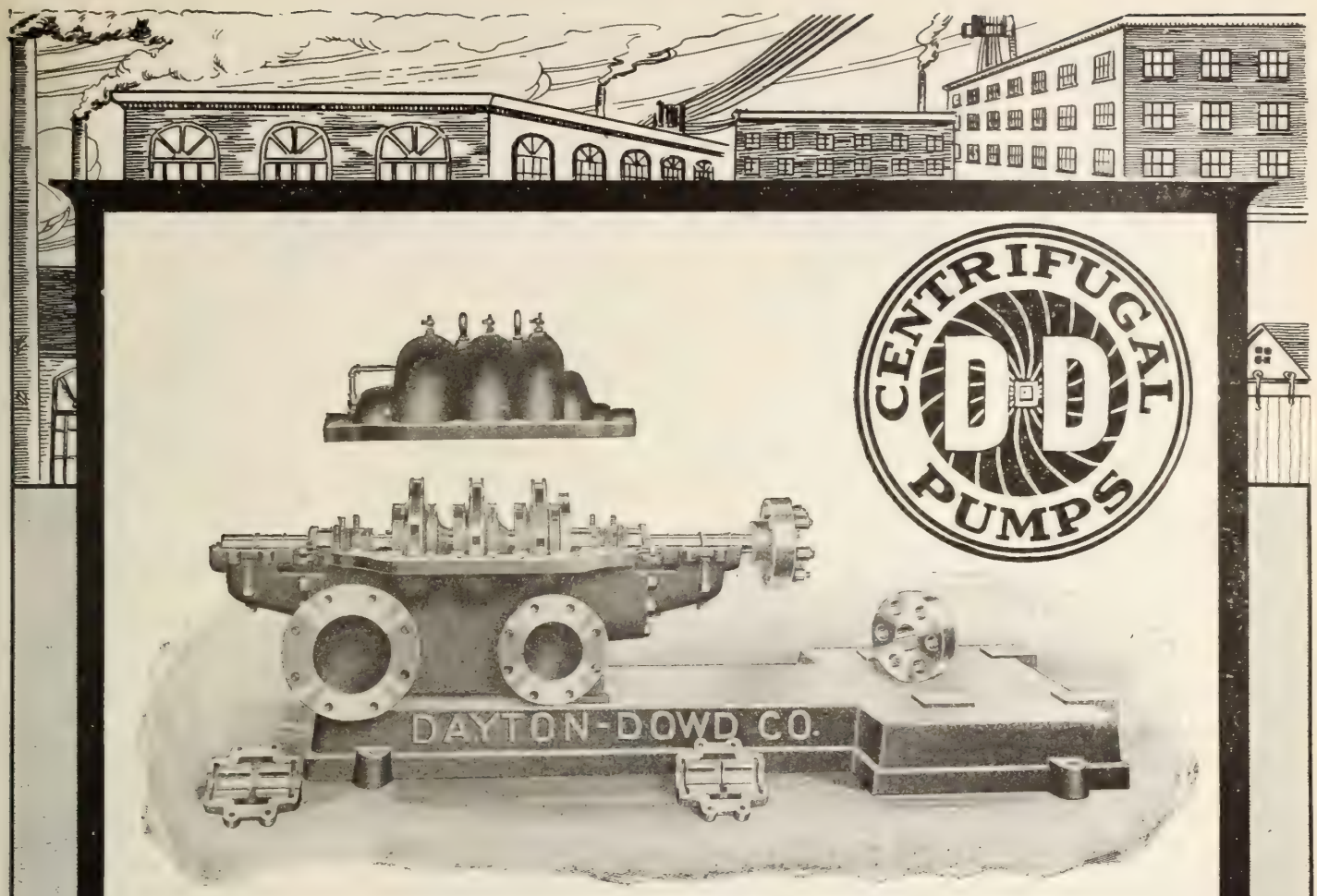
CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.



Dayton-Dowd Type CSU Automatically Balanced Three-Stage Centrifugal Pump

Illustration shows upper half of casing lifted. Note ease of access to all working parts. This is but one of the few points of merit of this type of Dayton-Dowd CSU Centrifugal Pump. Simple in design and rugged construction insures reliability in service and durability. Absence of diffusion vanes adds greatly to its life and reduces maintenance expense. Original and advanced in design and absolutely guaranteed to perform the service for which it is sold.

Type CS Single Stage, Double Suction Volute Centrifugal Pump

Non-overloading type, and so designed that the power consumed under any conditions of variation will not exceed the power required under normal operation. This feature protects the motor from being overloaded. This pump contains all the good features of Dayton-Dowd construction.

In Use in Prominent Plants

Parliament Buildings, Ottawa, two 2″ type CSU, 2 stage centrifugal pumps.
Toronto Union Station, Toronto, eleven type CS, single stage pumps.
Bridgeburg Water Works, Bridgeburg, two 5″ single stage, type CS pumps.
St. Thomas Water Works Pumping Station, St. Thomas, three 8″ 2 stage, type CSU pumps, each direct connected to 150 h.p. motors.

Send for Bulletins

THE ARTAUR S. LEITCH CO.

1001-2 Kent Building, TORONTO, ONTARIO

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Eacher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

POSITIVE EFFICIENT

HANS RENOLD OF CANADA LIMITED

SOLE
CANADIAN
REPRESENTATIVES
for

RENOLD STEEL DRIVING CHAINS

ALL ENQUIRIES SHOULD BE ADDRESSED

to

11 St. Sacrament Street

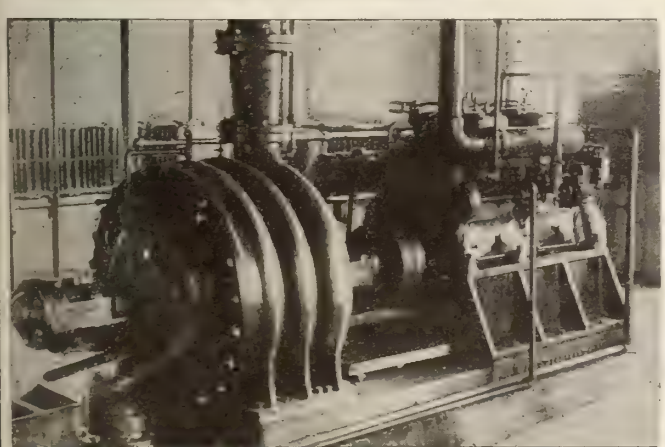
MONTREAL

DURABLE TELEPHONE MAIN 6297 COMPACT

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

What Emergency Power Do You Employ?

If your main steam powered pumps or generators are supported by a smaller steam powered unit for stand-by service; if your main electric pumps or generators are supported by a smaller electric unit—You are only half protected against breakdown.

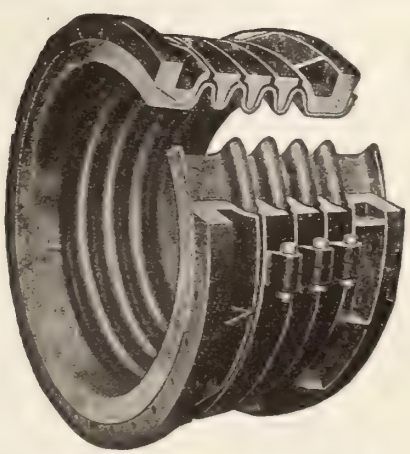


A high power Sterling gasoline engine—an independent source of power—will give you 100 per cent. protection.

These engines start like a high grade motor car and operate dependably at centrifugal pump and electric generator speeds.

CATALOGUE ON REQUEST.

Sterling Engine Co., Dept. C-4, Buffalo, N.Y. U.S.A.
12 to 300 H.P. Speeds 400 to 1400 R.P.M.



BADGER
SELF-EQUALIZING EXPANSION JOINTS

are the best joints for absorbing pipe expansion—Note the corrugations that expand and contract, thus preventing leakage.

Write for our new book today

E. B. BADGER & SONS CO.
81 PITTS ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Hasse Co., Inc., New York, N.Y.
Can. Steam Boiler Equip. Co., Toronto.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Boyles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

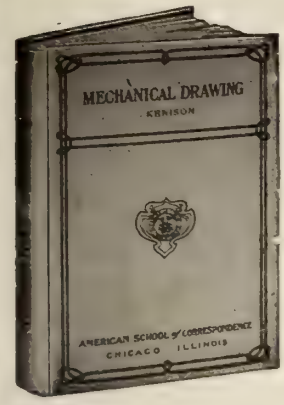
LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont



Clearance Sale of High Grade Technical Books

FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

Title of Book.	Name of Author.	Binding	Number of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	....
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	275	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Gas and Oil Engines	L. E. Brookes	Cloth	192	Yes	.85
Ford Car	V. W. Page	Cloth	288	Yes	....
New Catcehism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Setting Valves of Canadian-made Engines	G. C. Keith	Paper	31	Yes	.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
How to Run Gasoline Engines	C. Von Culin	Paper	144	Yes	.50
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkin's Indicator	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Aids to Engineers Examinations	N. Hawkins	Cloth	222	No	1.50
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy of $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

153 UNIVERSITY AVENUE, TORONTO, ONT.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Phillip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Phillip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Phillip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg Co. Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

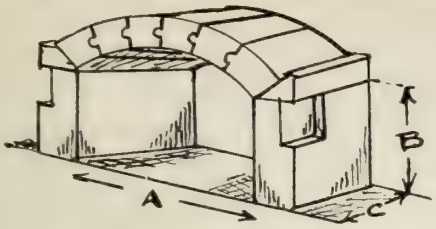
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



BOILER LININGS AND DOOR ARCHES

We specialize in all kinds of Power Plant Brick Work.

Boiler setting, furnace building and oven work are our specialties. Our engineers are at your service; call on them at any time for any information you may require —without obligation to you.

We are able to supply refractory linings for all purposes. If we have not the size and shape you desire in stock, we will make it to order.

GATES REFRACTORIES LTD.

Head Office: 382 St. James St., Montreal

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co

27 COTE St MONTREAL, QUE

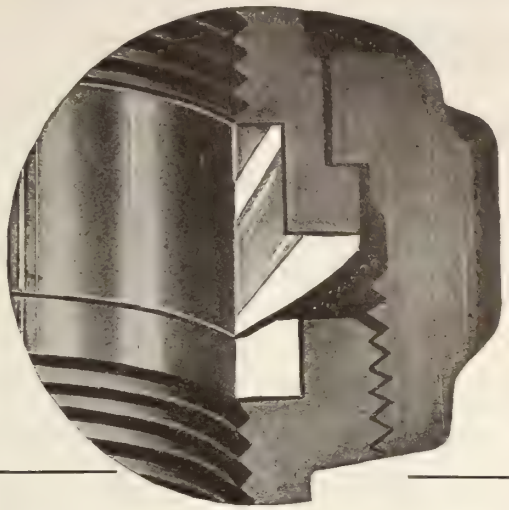
LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

See Page 70 Of This Issue

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS
BOILERS & TANKS, WATER FILTERS THERMOMETERS, GAUGES
E. J. Philip & Sons, Engineers 57 Queen Street, West, Toronto, Canada



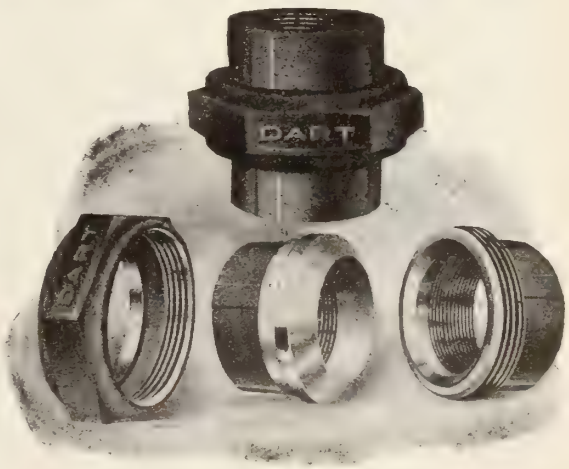
The Joint is BRONZE to BRONZE
(Both Face and Seat)
NO DETERIORATION

DART UNIONS

Never Loosen Up and Leak

By using Dart Unions you can make connections easily and quickly—without bother—whether pipes are in or out of alignment.

There'll be no upkeep cost, no replacement cost—and no loss from leaks.



Your Jobber Sells Them

Manufactured By
Dart Union Co., Limited, Toronto

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Jones & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

Canadian Letters Patent

The George T. Ladd Company, Pittsburgh, Pa., U.S.A., Owners of the Improvements in the Ladd Vertical Water Tube Boilers, covered by Letters Patent of the Dominion of Canada, Nos. 162,401 and 162,402 dated May 4, 1915, also Nos. 185,247 and 185,348 dated July 2, 1918, issued to Wm. H. Ritts and assigned to the George T. Ladd Company, have granted licenses to

The Goldie-McCulloch Company, Limited
GALT, ONTARIO

to manufacture and sell Vertical Water Tube Boilers, embodying the improvements claimed in said Letters Patent, and parties desiring to purchase this type of boiler can obtain them from this Company.

GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN, U.S.A.

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES
Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.
Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

Self-Lubricating

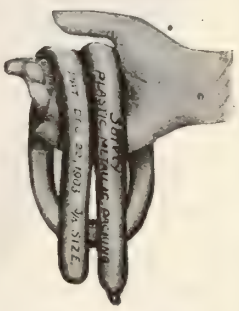
SAFETY PLASTIC
METALLIC PACKING
FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS
WITHOUT RENEWAL

Practically Frictionless

In Bulk



In Cotton Tubes

Drop us a line and let us tell you all about this Remarkable Packing.
STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899
AGENTS WANTED

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall. Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall. Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

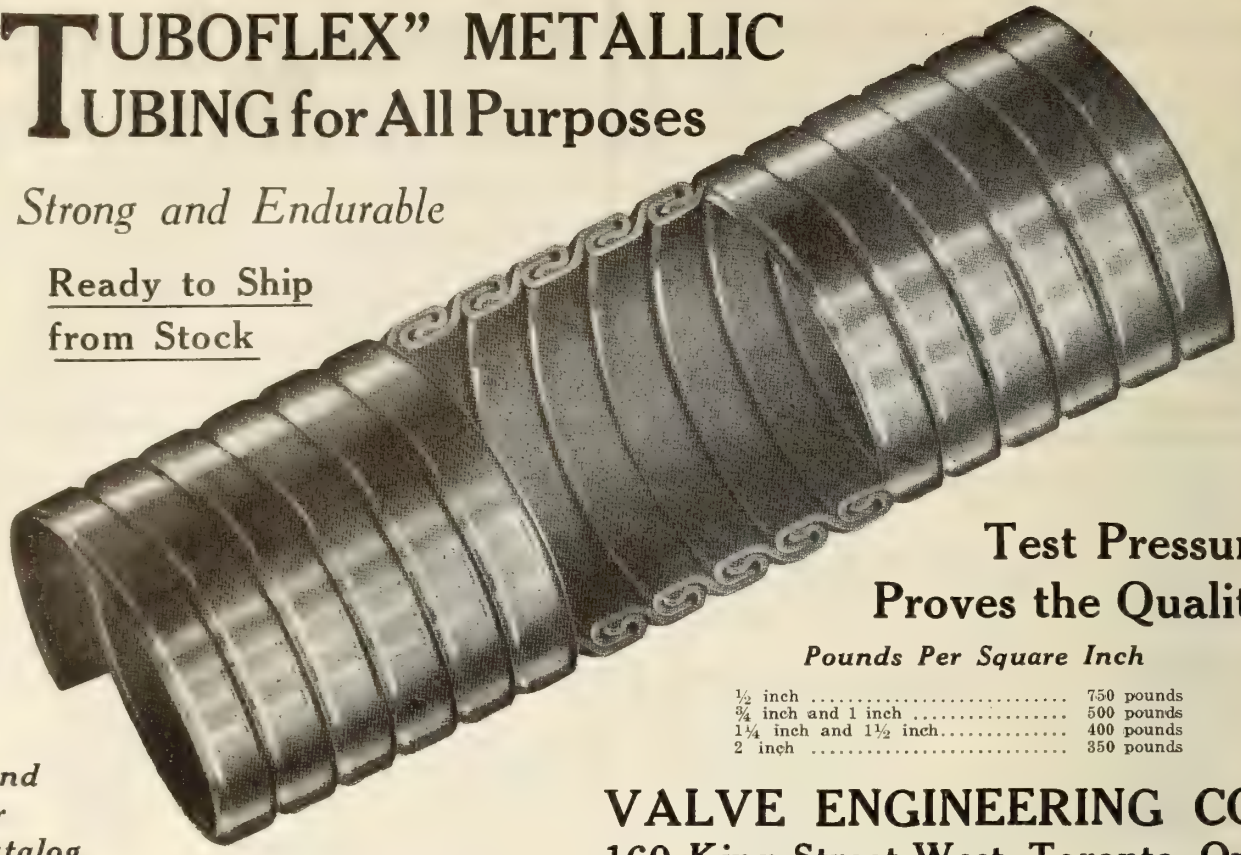
WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

"TUBOFLEX" METALLIC TUBING for All Purposes

Strong and Endurable

Ready to Ship from Stock



Test Pressure Proves the Quality

Pounds Per Square Inch

½ inch	750 pounds
¾ inch and 1 inch	500 pounds
1¼ inch and 1½ inch	400 pounds
2 inch	350 pounds

Send for Catalog

VALVE ENGINEERING CO.
160 King Street West, Toronto, Ont.

INDEX TO ADVERTISERS

All-Way Oiler Manufacturing Co. 12
American District Steam Co. 52
Anderson, The V. D. 58

Badger & Sons Co., E. B. 73
Betson Plastic Fire Brick Co. 7
Bishop & Co., S. & C. 79
Bond Engineering Co. 50
Burlingame & Gardner 61
Busch-Sulzer Bros.—Diesel Engine Wks. 68

Can. Fairbanks-Morse Co. 45
Can. Farnsworth Co. ....Inside back cover
Can. Mead-Morrison Co. 54
Carling Turbine Blower Co. 67
Chaplin-Fulton Manufacturing Co. 66
Cole, Limited, Geo. W. 52
Coppus Eng. and Equipment Co. 9
Crane, Limited 66

Dart Union Company 77
Darling Bros. 66
De Laval Separator Co. 75
Department of Labor 66
Detroit Stoker 63
D'Este Company, Julian 68
Dominion Belting Company 2
Dunlop Tire & Rubber Goods Co. .....
Inside front cover
Durabla Manufacturing Company 11

Electric Welding Company, The 66
Eng. and Mach. Works of Canada, Ltd. 57

Federal Engineering Company 77

Gates, W. W. 77
Gilman, Frank 68
Goldie & McCulloch Co. 16
Goodyear Tire and Rubber Co. 13

Hamilton Co., Ltd., Wm. 60
Hans Renold of Can., Ltd. 73
Hays School of Combustion 55
Holden Co., Ltd., The 8
Homestead Valve Manufacturing Co. .. 12
Hoyt Metal Company 2

Imperial Oil Company 3

Jeffrey Manufacturing Co. 56
Jenkins Bros. .....Front cover
Johns-Pratt Company, The 49
Jointless Fire Brick Co. 68
Jones Underfeed Stoker Co. 58

Ladd Co., The George T. 79
Laurie & Lamb 67
Leitch Co., The Arthur S. ..... 71 and 64
Leonard & Sons, E. 15
Long, J. T. 46
Lunkenheimer Company 51
Lyman Tube and Supply Company 62

Manny Co., The E. S. ..... 66 and 67
Mason Regulator and Engr. Co. 6
McLaren, D. K. 47
Morrison Brass Manufacturing Co., Jas.
Outside back cover
Morse Chain Co. 48
Ministry of Munitions 53

Murphy Iron Works 5

Norwalk Iron Works Company 11

Page-Hersey Iron, Tube and Lead Co. .. 4
Penberthy Injector Co., Ltd. 1
Philip & Sons, E. J. 77
Pilley Packing and Flue Brush Mfg. Co. 67

Republic Flow Meters of Canada, Limited 59
Robb Engineering Works 60

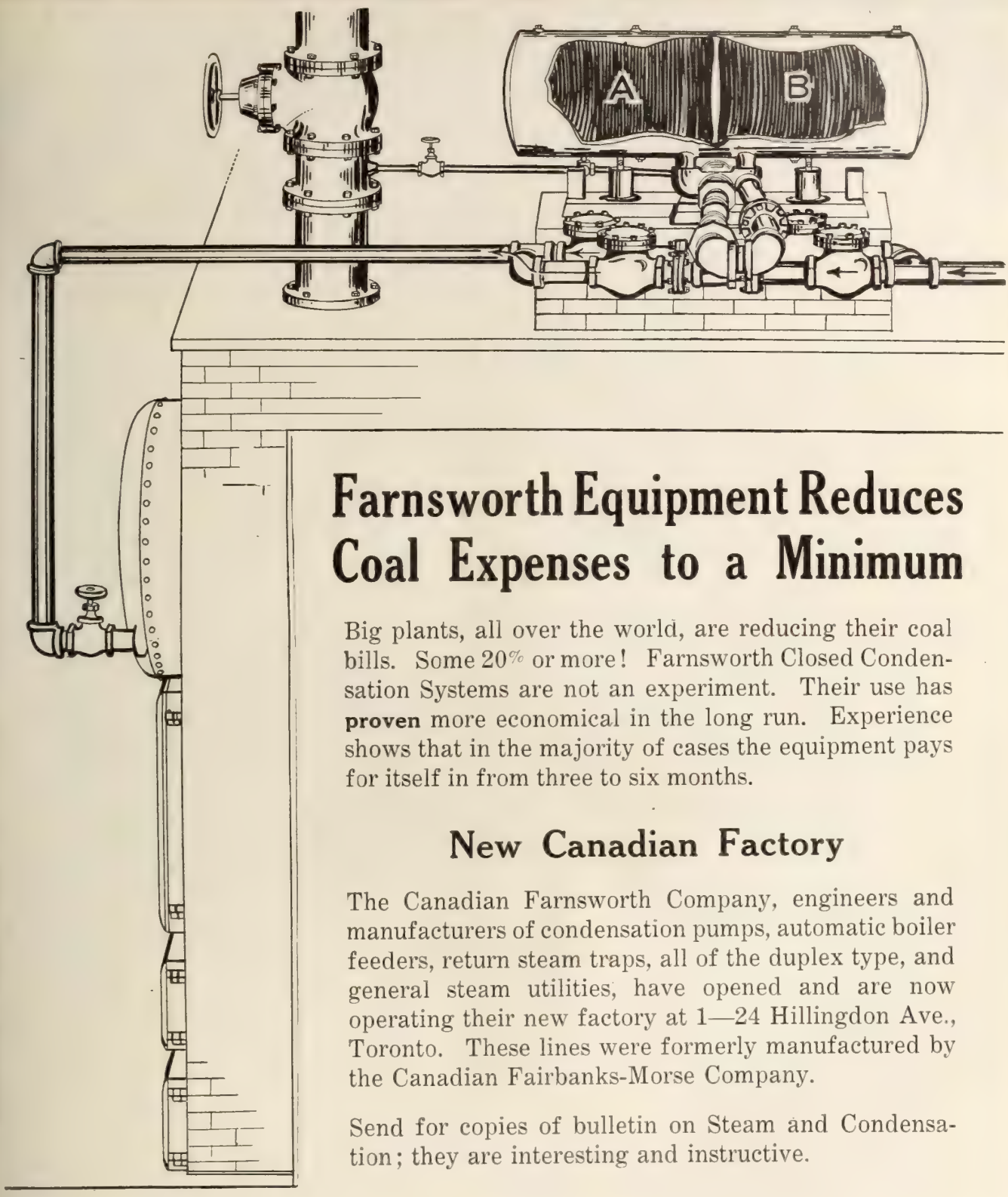
Sanford-Riley Stoker Company 5
Sarco Company, Inc. 46
Scaife, Wm. B., & Sons Co. 80
Sexton, W. R. 57
Shell-Bar Boico Supply, Ltd. 12
Smart-Turner Mach. Co. 66
Starrett Co., L. S. 7
Steel Mill Packing Company 79
Sterling Engine Company 73

Tagliabue Company, C. J. 54
Taylor Instrument Company 7
Technical Books 64

Valve Engineering Co. 80
Victoria Foundry Company 66
Vulcan Soot Cleaner Co., The 14

Wall, J. W. 67
Watson & McDaniel Co. 67
Wilson Manufacturing Co., J. C. 66
Williams Co., J. H. 10
Worthington Pump and Mach. Co. 65
York Manufacturing Company 10

WATER WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



Farnsworth Equipment Reduces Coal Expenses to a Minimum

Big plants, all over the world, are reducing their coal bills. Some 20% or more! Farnsworth Closed Condensation Systems are not an experiment. Their use has **proven** more economical in the long run. Experience shows that in the majority of cases the equipment pays for itself in from three to six months.

New Canadian Factory

The Canadian Farnsworth Company, engineers and manufacturers of condensation pumps, automatic boiler feeders, return steam traps, all of the duplex type, and general steam utilities, have opened and are now operating their new factory at 1—24 Hillingdon Ave., Toronto. These lines were formerly manufactured by the Canadian Fairbanks-Morse Company.

Send for copies of bulletin on Steam and Condensation; they are interesting and instructive.

The Canadian Farnsworth Company

1-24 Hillingdon Ave., Toronto, Ont., Canada

W. H. Rose, Gen. Mgr. **Telephone : Beach 825**

MORRISON'S STEAM GOODS

There is but one straight road to success and that is outstanding merit. Nothing else could have given Morrison products their prestige and enabled them to hold and increase it during the past fifty years. The merit of Morrison Steam Goods is demonstrated every time a specialty is installed.

The James Morrison Brass Mfg. Co., Limited

93-97 ADELAIDE ST. W., TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 13. Publication Office, Toronto—July 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE PENBERTHY MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY

The Magic Name that Brings to You

QUALITY - SERVICE - DEPENDABILITY

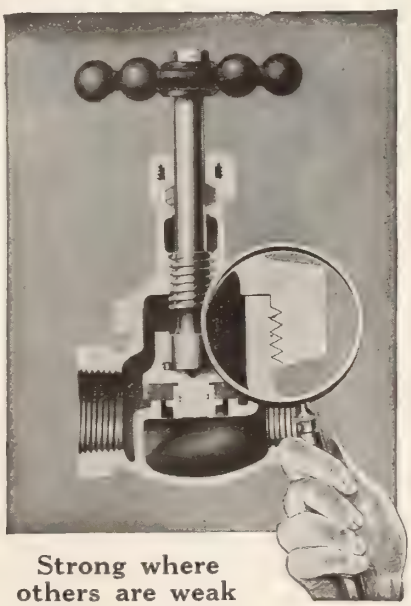
All PENBERTHY Valves Are Government Approved

The
OUTSIDE BONNET CONSTRUCTION
is found in all PENBERTHY VALVES, viz.:

COMPODISK REGRINDING GATES

In order to get this improved design you will have to insist on the Genuine with our name cast on the body of the valve, or you may get a substitute. Therefore—

"Look for the Name"



Strong where others are weak

Manufactured by

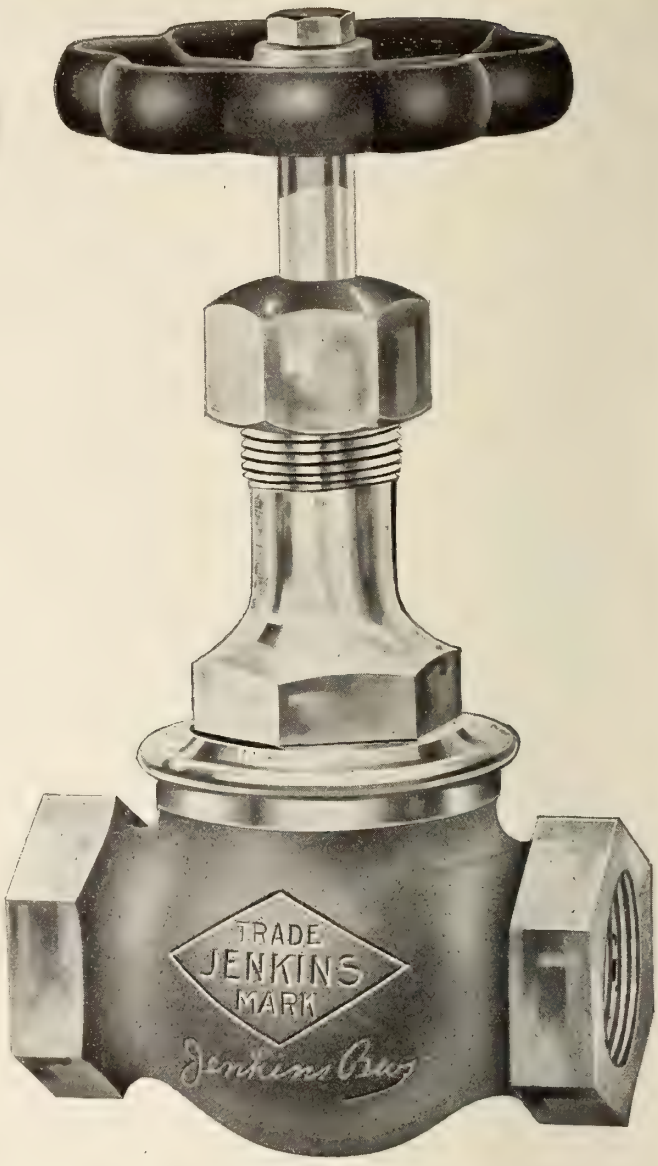
Penberthy Injector Company, Limited - Windsor, Ont.

JENKINS VALVES

TRADE JENKINS MARK

Jenkins Bros

are imitated but never equalled



With more than half a century's record of satisfactory service behind them, it is but natural that Jenkins' Valves should have a host of imitators.

But the imitation is confined to *Appearance* only. The *Service* that Jenkins' Valves give, and upon which their enviable reputation has been built up, can only be secured from the genuine Jenkins' Valve with the Diamond Trade Mark cast on the body.

It will pay you, therefore, to look for this trade mark when selecting valves for every condition of usage. Whether the valves are to be used in connection with a battery of Boilers, a heating plant or a plumbing installation, Jenkins' Diamond Trade Mark Valves will give dependable service.

Catalog No. 8, picturing and describing the complete Jenkins' line, will be mailed you on request—free of charge.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal, can.

EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG.

Agencies in all the Principal Countries of the World

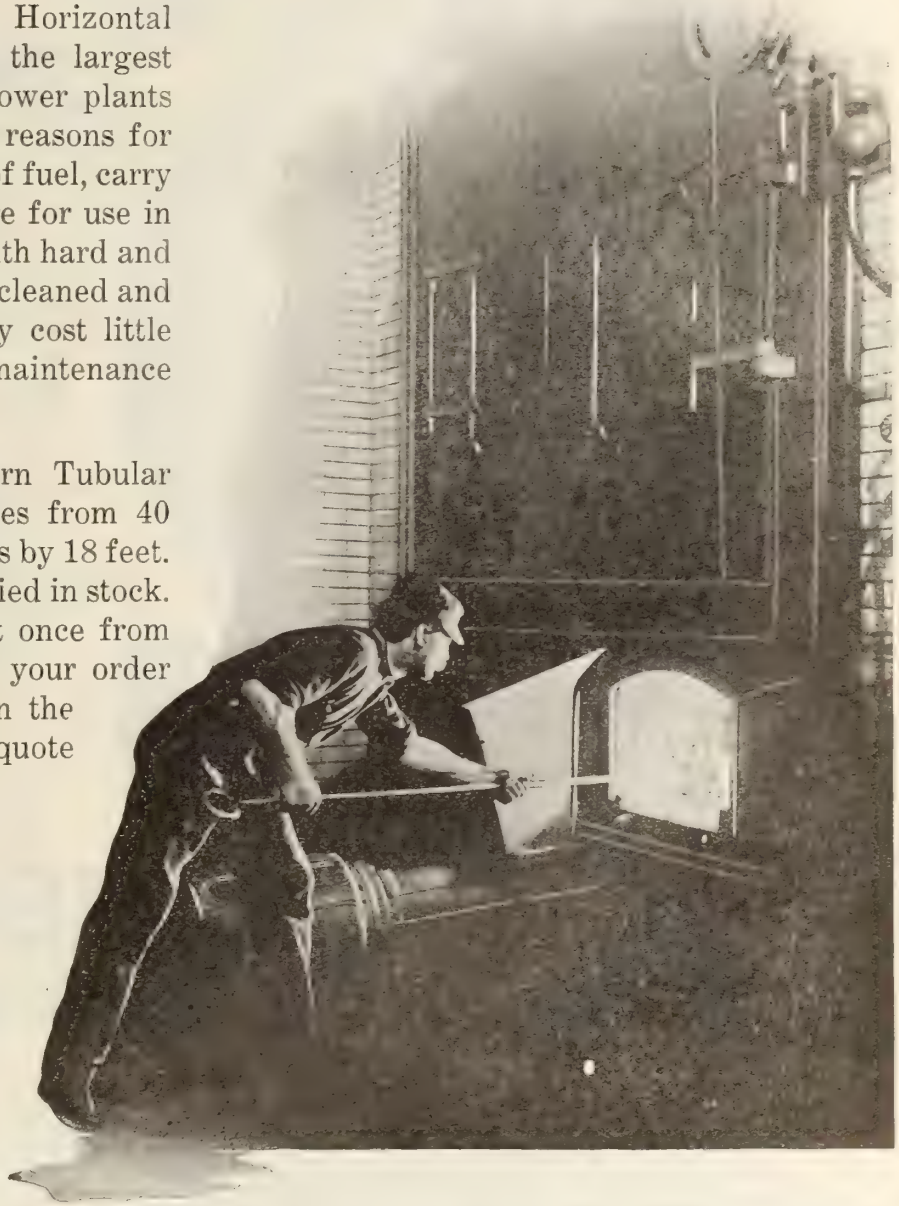
POWER HOUSE, July 5, 1920, Vol. XIII., No. 13. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

BOILERS

FOR POWER AND HEATING PURPOSES

You will find Waterous Horizontal Return Tubular Boilers in the largest industrial and municipal power plants in the country. There are reasons for this. They are economical of fuel, carry a big reserve steam pressure for use in emergencies, can be used with hard and dirty water, and are readily cleaned and easily taken care of. They cost little new; their upkeep and maintenance expense is negligible.

Waterous Horizontal Return Tubular Boilers are built in all sizes from 40 inches by 10 feet to 72 inches by 18 feet. Most standard sizes are carried in stock. If we cannot supply you at once from our yards we can turn out your order for you in quick time. On the next boiler you need let us quote you prices and delivery.



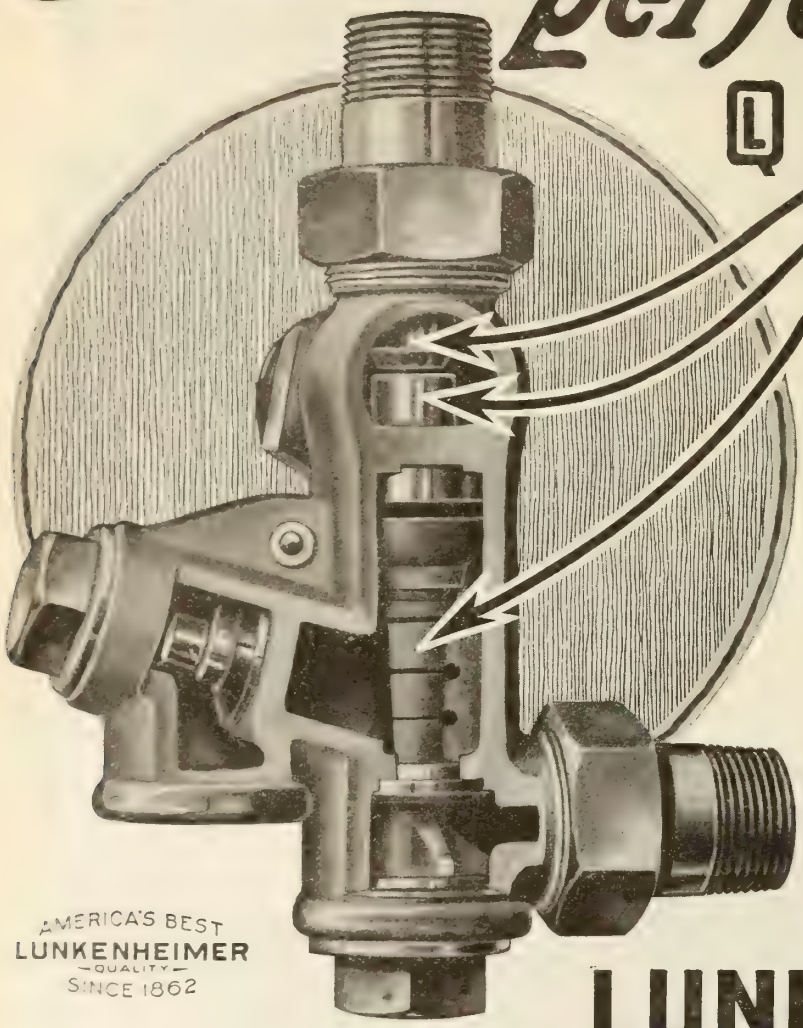
Boilers in Stock

1—54 x 14 Horizontal
2—60 x 14 "
4—66 x 16 "
14—72 x 18 "
2—40 H. P. Locomotive

Waterous

BRANTFORD, ONTARIO, CANADA

Consistent performance



The correct design of the tubes and the large areas through the body of

LUNKENHEIMER
AUTOMATIC INJECTORS

account for the excellent service which they give. They deliver more water per pound of steam, have full capacity at higher steam pressure, and their capacity is diminished in a lesser degree by long lifts and hot feed water than any other.

The tubes being made of a *special hard bronze,* resist the severe erosive action of the saturated flow at high velocity, and the Lunkenheimer design of "spill" eliminates the uneven wear of the combining tube which is the cause of most injector trouble.

Lunkenheimer Injectors are highly efficient, reliable and economical boiler feeders. Their wide range of operation, instantaneous re-starting after a temporary interruption of the steam or water supply, their durability and the interchangeability of all parts, merit consideration and recommend their installation.

Specify LUNKENHEIMER and insist on having the genuine.

Distributors of Lunkenheimer Products situated in every commercial centre.

THE LUNKENHEIMER CO.
—"QUALITY"—

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

Lunkenheimer Products are registered in Canada.
Write for list of Registration Numbers 575-43.

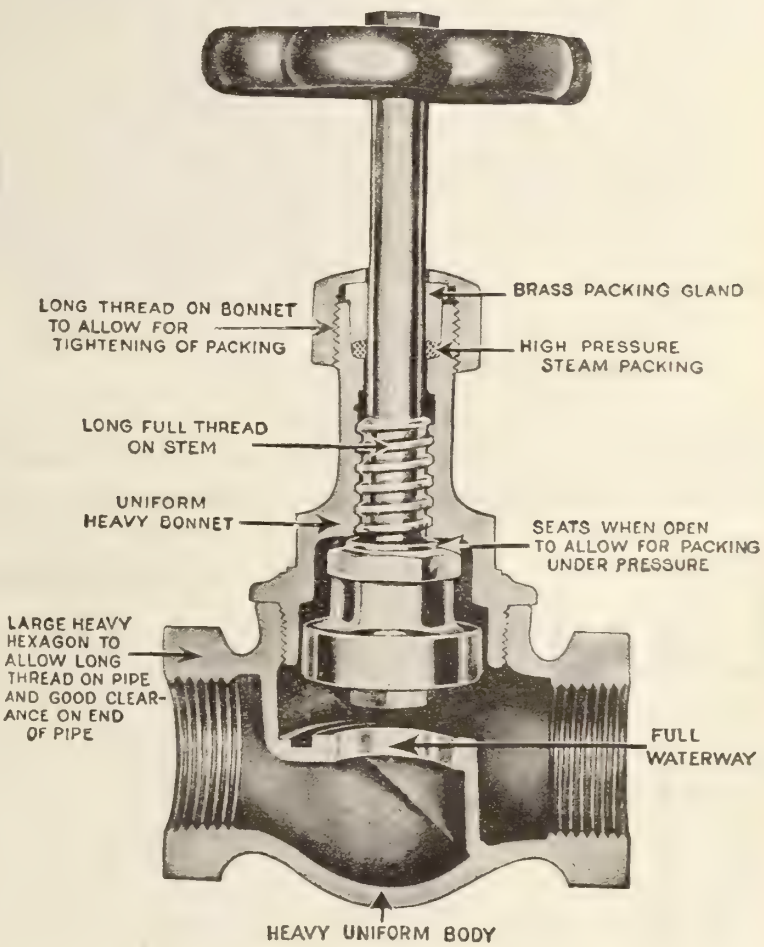
"EMCO"---The Better Valve

Registered in Canada as follows:

Globe Valve	–A 840
British Columbia	No. 2590
Alberta	No. 1102
Saskatchewan	No. 2365
Ontario	No. 1755

"Emco" is a superior valve. It is rigidly Hydraulic Tested before leaving our factory. It has reserve strength and durability. Select it for your needs.

When buying, specify our lines. They are carried in stock by the larger and more progressive jobbers in Canada.


LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
BRASS PACKING GLAND
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREAD ON PIPE AND GOOD CLEARANCE ON END OF PIPE
FULL WATERWAY
HEAVY UNIFORM BODY

"If It's an 'Empire' Product You Know It's Right"

EMPIRE MANUFACTURING CO.,

LIMITED

London and Toronto, Canada

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

Binary alloys are classed as solid compounds, but in trinary and quarternary alloys only two of the elements are said to form a compound, as, for instance, in a tin-lead-antimony combination only the tin and antimony form the compound. Other characteristics in this connection will be discussed further on.

We give below the principal ingredients used in babbitt metals, and the approximate melting points, as we shall deal with these figures as we progress, viz:

Tin, 446° Fahrenheit; Lead, 619° Fahrenheit; Antimony, 1166° Fahrenheit; Copper, 1992° Fahrenheit. It is axiomatic that good conditions will favor an inferior metal and adverse conditions militate against a good metal; hence it is not always possible to form an off-hand opinion as to the relative values of babbitts in actual service as careful comparative tests and records are generally necessary to reach a conclusion. In laboratory tests, however, comparative values can be determined quickly and accurately as maximum stresses can be applied and both water and oil lubrication used.

Genuine Babbitt was the first white metal alloy used for lining bearings and derived its name from Isaac Babbitt, who first used it. He did not patent the mixture and was even uncertain as to its being the best, hence his patent merely covered the process of soldering alloy to the shell. However, his composition is about as good as can be made, and was used exclusively until lead base alloys appeared. Babbitt users naturally favored Genuine through force of habit and inherited custom and therefore when Magnolia was first introduced there was considerable opposition and mistrust regarding it.

(Continued next month.)

For copy of complete article:

"New Truths and Old Fallacies"

Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:

Montreal: 225 St. Ambroise St.

Coal Crisis At Hand!

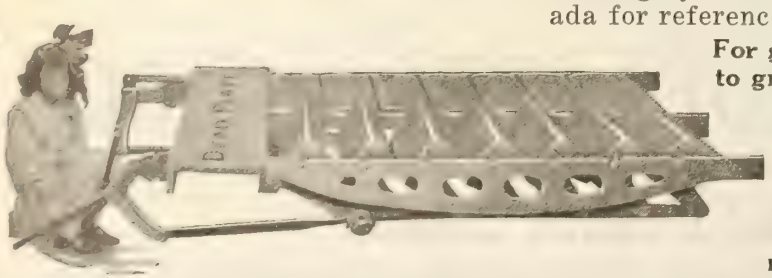
Nonpareil Grates Will Help You Meet it

Coal prices still advance. The demand is greater than the supply. The economical way to meet it is to let Nonpareil Grates reduce your coal bill 10 per cent.

A test will convince you—Nonpareil Shaking and Dumping Grates may be put under any kind of a boiler for a test period of thirty days. Should they fail to save 10 per cent. in fuel bill by better combustion, or prove unsatisfactory in any way, they may be removed and shipped back to us—we pay the freight. **Remember, Nonpareil Grates burn any fuel with heat in it.**

Firebrick Work

You know you are safe when "Safety First" Sexton tackles your firebrick work. Sexton has a reputation for building in boilers and doing general repairs, quickly and thoroughly. Many of the larger plants throughout Canada for reference.



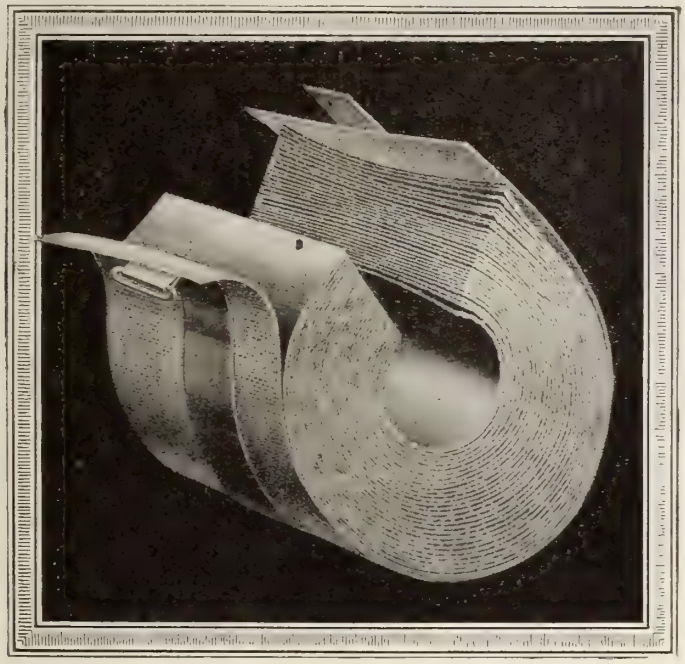
For grate bars of all kinds and repairs to grates of all kinds see Sexton.

THE W. R. SEXTON BOILER SETTING COMPANY

127 D'Arcy Street, Toronto

Established 1900 **Phone, College 682**

Asbesto-Sponge



SOMETHING NEW? Hardly! For instance, here's a case that can probably be equaled—maybe excelled—but only by another lot of Johns-Manville Asbesto-Sponge Felted Pipe Covering.

Back in the days when Cleveland was President; when Cuba was struggling to throw off the Spanish yoke; before automobiles were taken seriously by more than a few people and when aeroplanes were said to be "impossible," a certain firm put some Johns-Manville Asbesto-Sponge Felted Covering on its steam lines.

Twenty-two years later that Asbesto-Sponge Felted Covering was still giving the best of insulation service, but the piping had to be dismantled because of change in the layout.

—And after 22 years of hard service this Johns-Manville Asbesto-Sponge Felted Insulation had retained its original properties—and its insulation value was unimpaired.

So when we say Johns-Manville Asbesto-Sponge Felted is the best commercial insulation known, we're not talking about something new. We're telling you about a material of known value which has withstood the hard test of years of efficient service.

In our booklet there are more facts of value. Send for it.

Canadian Johns-Manville Company
Limited

Montreal Toronto Vancouver
Winnipeg Hamilton London Ottawa

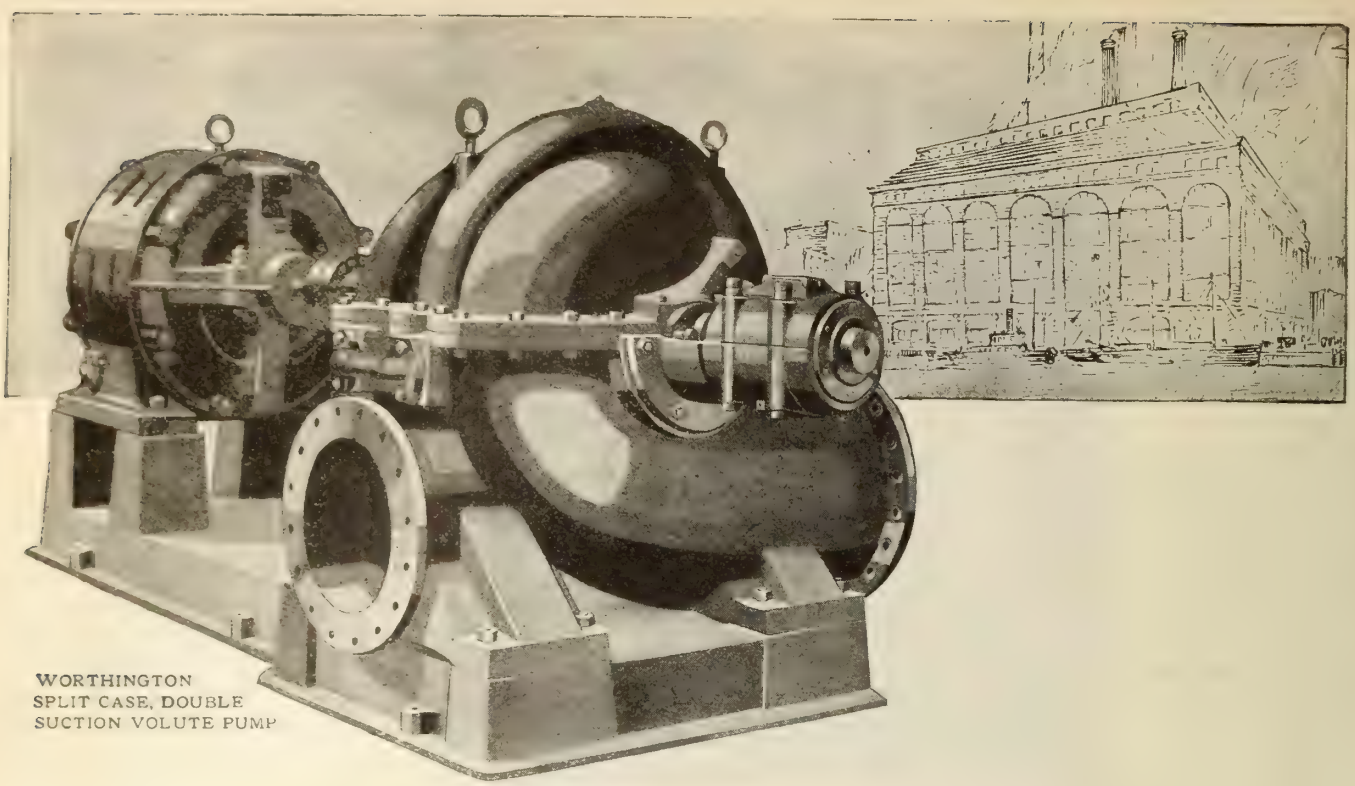
JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boilers and walls leak proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation



WORTHINGTON
SPLIT CASE, DOUBLE
SUCTION VOLUTE PUMP

Worthington Centrifugal Pumping Service

THE increased use of centrifugal pumps for general and special pumping service too, has brought about a development of the centrifugal type which in Worthington Double Suction Volute Pump has attained the highest point of refinement and utility.

Worthington has incorporated in this Volute Pump, improvements and special design features which may take shape in special impeller design to meet unusual conditions; throat construction at outlet of impeller, or a combination of several special Worthington features may be used as dictated by service requirements.

So whether your pumping needs are usual or very special, protect yourself against misfits by using Worthington engineering corps. The service is tendered freely, and is sponsored by the 80 years old Worthington organization.

Other Worthington Products

Steam, Power, Centrifugal and Water Works Pumps, Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: **115 Broadway, New York City**
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Epping-Carpenter, *Pittsburgh, Pa.*
Laidlaw Works, *Cincinnati, Ohio.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.

UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:—

Connell Water Tube
(Patented U.S. and Canada)
Return Tubular.
Locomotive.
Upright.

We specialize in the making of—

Smokestacks.
Tanks of all types.
Plate work of any description.
Grey Iron Castings.

E. Leonard & Sons Ltd.

Head Office & Works
London - Canada

Established 1834

LEONARD

Let Riley Stokers Reduce Your Costs

Riley Stokers are always on the job—you can rely on them to be at work every day. They are tireless—working all hours of the day and night—without complaint.

Industrial plants can cut their operating costs to a minimum by using Riley Underfeed Stokers. Consider the following facts :—

EFFICIENCY—Boiler tests on Riley Stokers have shown over-all efficiencies of 80% and higher.

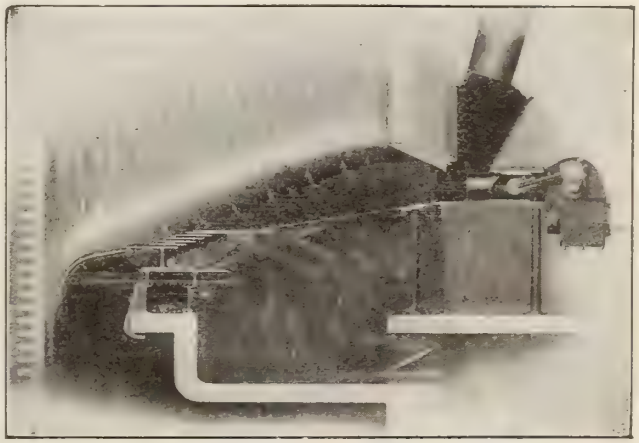
LABOR SAVING—One or two men can replace ten or twelve required for hand firing. Continuous, automatic discharge of ashes means elimination of drudgery in fire cleaning. Labor for ash handling in a well-laid-out plant is negligible.

COMPLETE COMBUSTION — The underfeed method and moving grates intimately mix the proper amount of air and coal, giving perfect combustion.

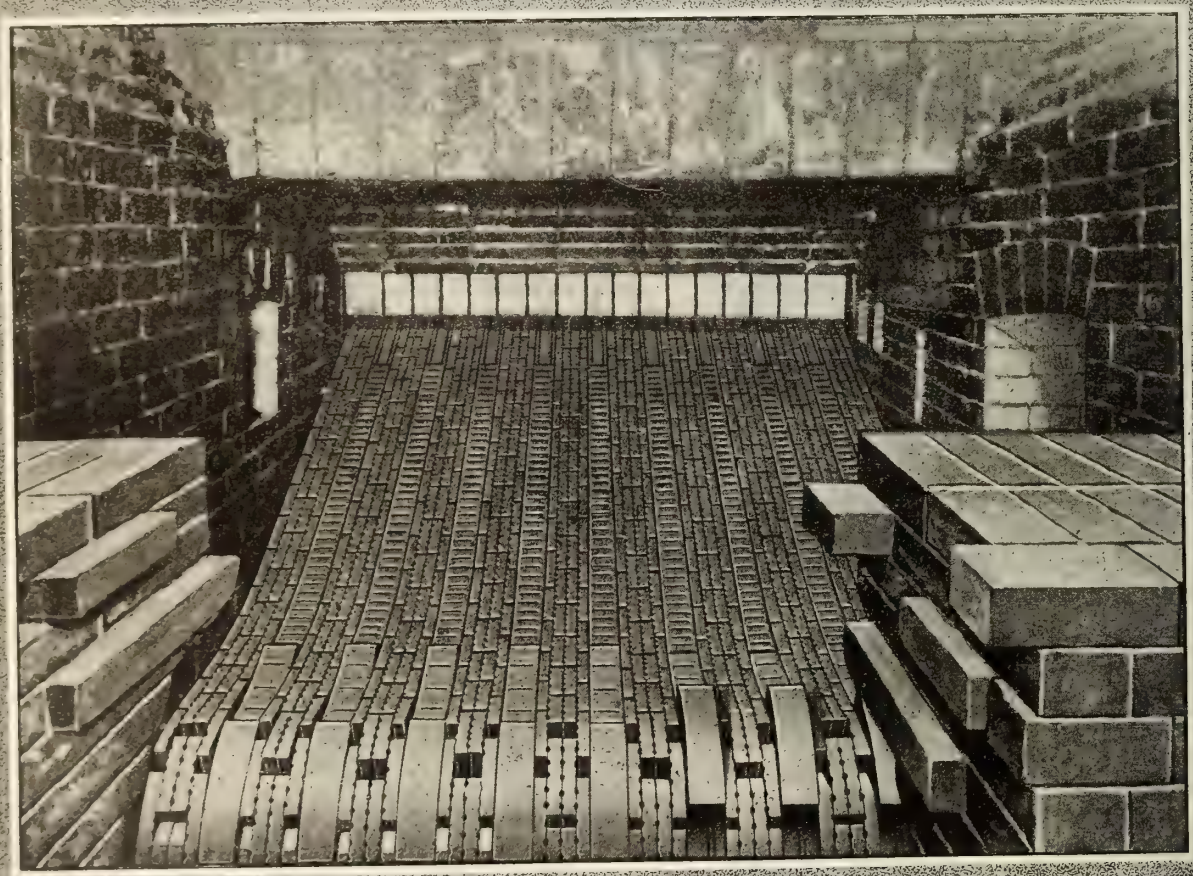
Catalog HR-7 sent on request.

For information on the Murphy Automatic Furnace for small plants, see last month's advertisement, or send for Murphy's catalog HM-7.

Sanford Riley Stoker Co.
Worcester, Mass.



THE
STOWE STOKER
Employing Mechanical Draft



LACLEDE
A BUSINESS INSTITUTION

Forced-Draft, Conveyor Feed

—*The Scientifically-Correct Stoker Principle*

The engineering profession in general has always admitted the fundamental superiority of progressive feeding, or more properly, the *conveyor* feeding principle. What shortcomings this principle may have had are now entirely overcome by the application of forced draft.

In this engineering triumph—*the forced-draft, conveyor-feed* stoker—capacities of 300% are an every-day occurrence. Economies after deducting for auxiliaries slightly *excel* those of any other forced-draft type. Flexibility sufficient for all practical purposes is obtainable. Coking coal may be burned successfully.

With these fundamental facts demonstrated, it it obvious that such things as the ease in handling, absolutely automatic operation, absence of clinker and perfection of ash disposal put this type of stoker unquestionably in the foreground.

THE STOWE STOKER is destined to dominate this field because:

(1) A single Stowe Stoker can be used for units up to 1500 H. P., thus doing away with the center fire wall.

(2) Graduated air spaces are substituted for the complicated arrangement of various air pressure compartments.

(3) Drippage, instead of clogging air passages, falls into a pit provided for that purpose.

(4) It is the *only* conveyor feed built on a decided incline and therefore excels in strong ignition temperatures.

(5) It is the *only* conveyor feed that holds the nearly spent fuel back on the grate until every bit of combustible is consumed.

(6) There are no air ducts in the firing aisle.

In selecting your forced-draft, conveyor-feed stoker, keep in mind these outstanding advantages of the Stowe Stoker.

Branch Offices:

CHICAGO, 1366 Peoples Gas Bldg. PITTSBURGH, 901 Oliver Bldg.
NEW YORK, 504, Fifty E. 42nd St.

Agents:

PHILADELPHIA, PA.
A. C. Warner Co.,
Bulletin Bldg.

KANSAS CITY, MO.
Thermal Efficiency Co.,
1210 Scarritt Bldg.

CHARLOTTE, N. C.
J. R. Purser,
406 Com. Bank Bldg.

DENVER, COLO.
Schwarz Eng. Co.,
310 Mack Bldg.

WINNIPEG, CAN.
Wm. A. Goold,
701 Merch. Bk. Bldg.,

MONTREAL, CAN.
John C. Russell,
109 Place D'Youville

D131

CHRISTY

FOUNDED 1844 ST. LOUIS

LINDE

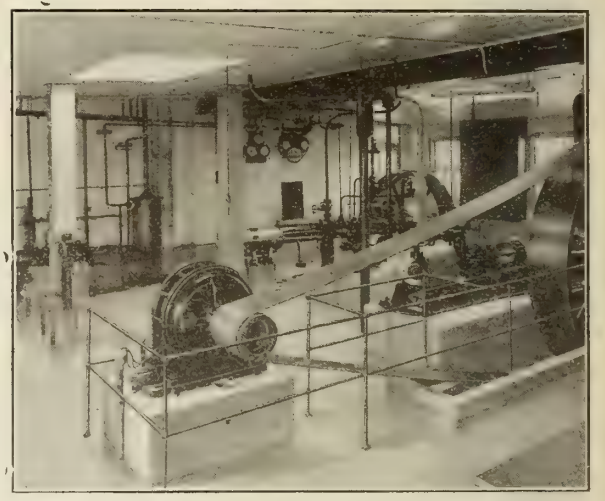
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

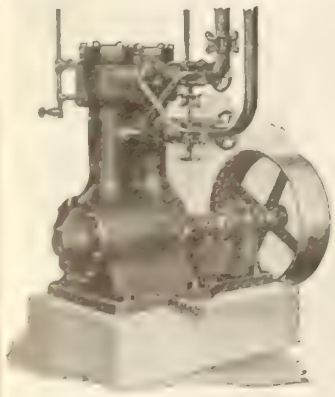


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

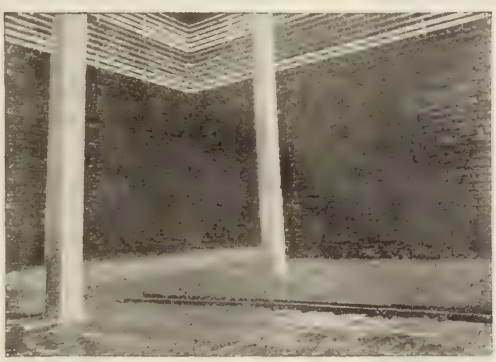
There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Balancing an Unbalanced Business

Because of the wide variation in the demand for ice, a great many manufacturers conclude that they must run their plants under a heavy overload during the warm months, and then let them lie practically idle during the slack season. As a result, these plants seldom produce more than 50% of their annual capacity, and naturally the large overhead expense adds materially to the cost of production.

Take the case of the City Ice Company, Lexington, Ky., for instance. In 1911, when their plant was operated in this manner, the output was only 43.9% of its yearly capacity, the company was unable to handle the summer demand, and the manufacturing cost averaged $2.50 per ton. In 1914, however, they provided a 5,000-ton ice storage completely insulated with Nonpareil Corkboard Insulation. By filling it during the off season and disposing of the accumulated ice during hot weather, the plant was able to operate under a nearly constant load the year round. And during the first twelve months the storage house was in use, the company operated at 91.3% of its yearly capacity, while the manufacturing cost was reduced to less than 45c per ton.



The walls of the ice storage of the Peoples' Ice Company, Wichita Falls, Texas, are insulated with Nonpareil Corkboard Insulation, mastic finish.

If your manufacturing costs are high, and if you can't meet the summer demand, an ice storage is probably what you need. It would be a good idea to make your plans now so that you can have your storage in time for next year's business.

Armstrong Cork & Insulation Company, 504 McGill Building, Montreal, Quebec, Canada

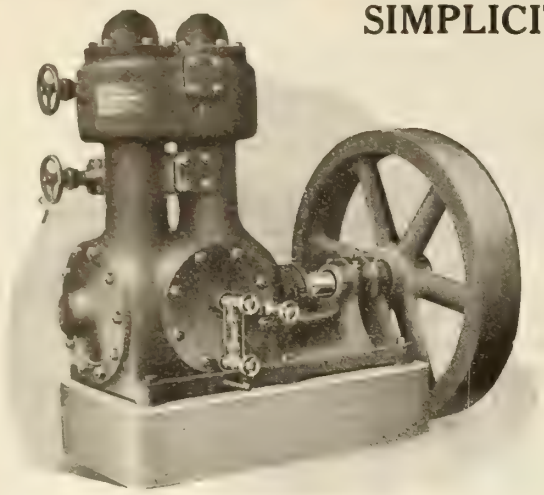
Also manufacturers of Nonpareil Cork Covering for brine, ammonia and ice water lines; Nonpareil Insulating Brick for boiler settings; Nonpareil High Pressure Covering for steam lines and Circle A Cork Brick for cold storage room floors.

Nonpareil Corkboard Insulation

For Ice Storages and Other Cold Storage Rooms

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permits them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

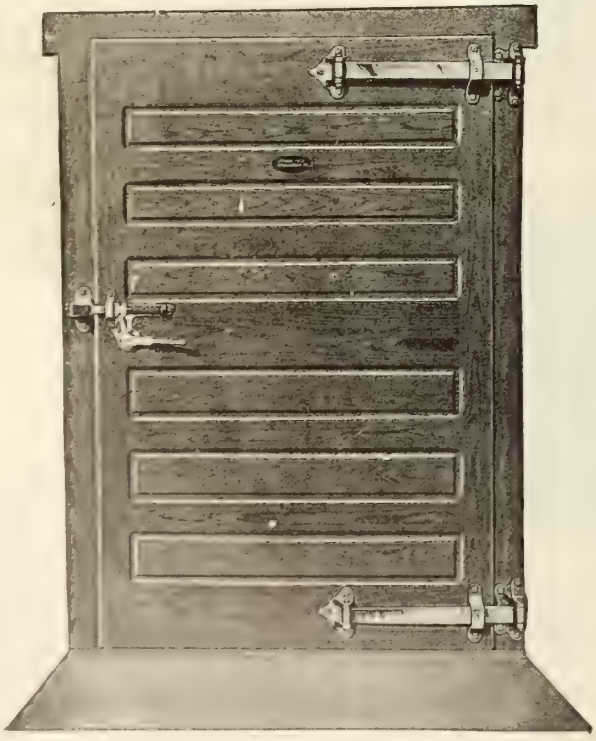
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

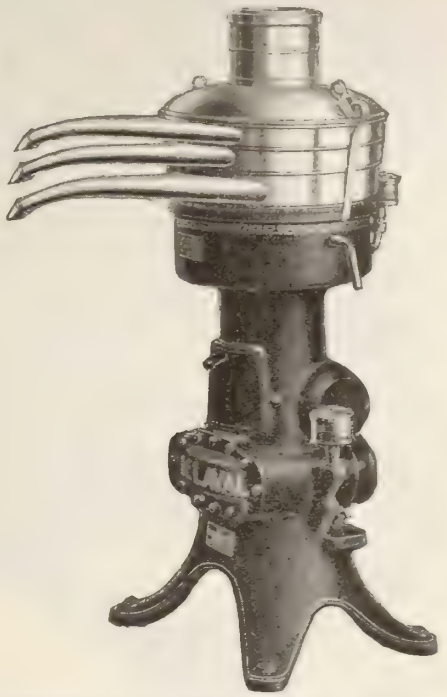
Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

The DE LAVAL
Centrifugal
Oil Purifier

The De Laval Centrifugal Oil Purifier is a new and modern means of recovering oil which, through use, has become unfit and dangerous to use.

The Method is simple, continuous and economical in operation and restores the oils to their original usefulness.

The Oil Purifiers are built in three sizes, each size in either electric, belt or direct steam turbine drive. They are used for purifying many kinds of oils in various industries.



De Laval Oil Purifier—Turbine Driven

Lubricating Oil

The De Laval Method removes water, dust, grit and metal particles from used lubricating oil. The absence of these impurities makes the wearing parts last longer, reduces loss of power, saves the machinery, and eliminates the dangers of a clogged oil system.

Cutting Oils

A résumé of the results obtained in several machine shops using the De Laval Method of reclaiming cutting oils shows:

A net saving per year of 20 to 50 per cent in oil consumption, better finish on work, increased production of machines, 15 to 60 per cent longer life of cutting edges of tools, and greatly reduces the dangers of septic poisoning.

In reclaiming oil from soda-wash it saves oil and soda-wash, which previously were wasted.

Hardening Oils

The De Laval Method eliminates carbon and scale from drawing oil, thereby insuring more even and more effective hardening. It also reclaims the oil which heretofore was thrown away with the impurities.

The De Laval Method does the same for quenching oil and eliminates the clogging of the oil system, with its accompanying danger and delay.

Fuel Oils

The De Laval Method removes grit, dirt, carbon and water from fuel oils used in Diesel type engines. In this way the delay and danger caused by grit in pumps, valves and other working parts are practically eliminated.

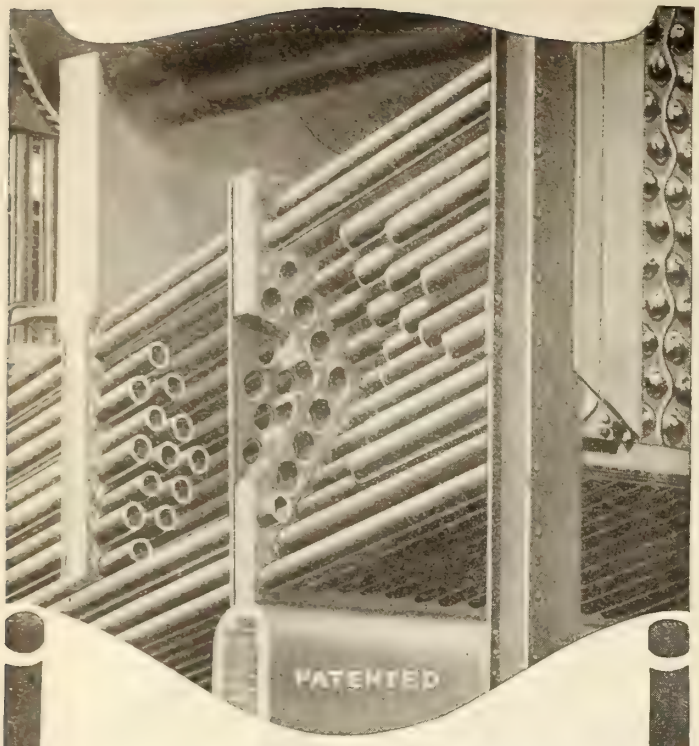
Write to nearest De Laval office for Oil Purification Bulletin No. 100, which describes the benefits and savings in detail

A complete experimental department is maintained for working out the problems of our customers by means of centrifugal processes

THE DE LAVAL SEPARATOR COMPANY

NEW YORK CHICAGO

TURBINE EQUIPMENT CO.
Toronto, Ont.
THE DE LAVAL CO., LIMITED
Peterboro, Ont.



GAS TIGHT BAFFLES

Vertical—Horizontal—Inclined. Any shape, size, slope or angle. Monolithic and Permanent.

The one-piece idea is the logical solution of the baffle problem.

Perfect fitting, gas tight baffles of any size, shape or angle are easily moulded into place with.

BETSON'S PLASTIC FIRE BRICK

In the construction of baffles of Betson's Plastic Fire Brick, the material is packed solidly between the tubes, and, therefore, conforms exactly to them. These baffles always fit tightly, when the boiler is steaming, because the material sets when the tubes are hot. When the boiler is cold the tubes contract and draw away, making tube renewals easy without disturbing the baffles.

Betson Baffles may readily be placed at the proper angles for meeting the new idea of gradually reduced Gas passes.

Send for instructive pamphlet. You should also have our catalog on complete furnace linings. Quotations given and questions cheerfully answered.

Betson Plastic Fire Brick Co., Inc.
P.O. Box 386-6 - - Rome, N.Y.

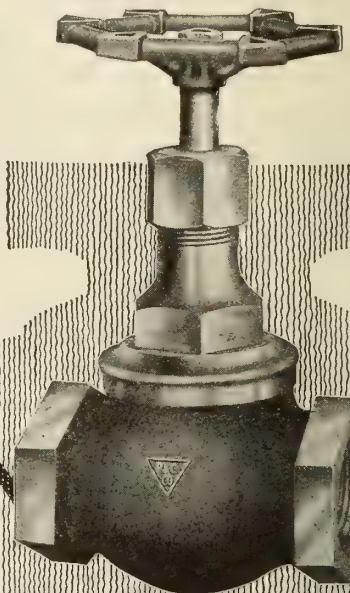
Warehouses in Principal Cities

Canadian Distributor :
International Chemical Co., 44-6 Lombard St.,
TORONTO, Ont., Canada

Why Pay 90% More for Your Valves ?

Every time you replace a worn valve with a new one, you are paying 90% *more* for that new valve than it would cost to renew a Pratt & Cady Renewable Globe or Gate Valve.

That may mean only a dollar or two per valve, but figure the total cost per year!



PRATT & CADY RENEWABLE VALVES

can be made as good as new, when worn, at about 10% of the original cost of the valve.

This takes but a few minutes. The valve doesn't even have to be removed from pipe line.

Due to this renewable feature and their rugged construction, a P & C Renewable will outwear a great many ordinary valves.

No matter for what purpose you require a valve, there's a P & C made specially to meet the condition. We should like to send you our booklet.

PRATT & CADY CO., INC.

Manufacturers of Valves, Asbestos Packed Cocks, Feed Water Heaters, Hot Water Generators, Hot Water Service Heaters and Power Pumps.

Boston, Chicago, Cleveland, Detroit, Hartford, Minneapolis, Philadelphia, Pittsburgh, San Francisco, New York

Representatives in All Large Cities

P&C CO

THE GARLOCK TRADE-MARK AND THE PRODUCT IT REPRESENTS

need no introduction. Wherever steam power is used, the name "GARLOCK" stands for reliability. Through the maintenance of our basic idea—standardization of raw product, and a standard of packing quality—the Garlock trade-mark is known and appreciated throughout the world.

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONT.

—Branches—

Montreal, Que.
Toronto, Ont.
Winnipeg, Man.
Calgary, Alta.
St. John, N. B.
Vancouver, B.C.

REES RoTURBo

Rotary Jet Condensers and Vacuum PUMPS

Sole Canadian Manufacturers

The REES-RoTURBo products are widely used in Great Britain and United States and are recognized as the very latest development in this class of apparatus, which include REES-RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Vacuum Air Pumps.

The Rotary Jet Condenser is used in connection with steam turbines and reciprocating engines. It is particularly adaptable to sugar and salt boiling plants, etc. The Rotary High Vacuum Air Pump is identical in principle with the Jet Condenser and possesses similar advantages. **Made in Canada by the G. & McC. Co. only.**

The engineering profession of Canada is well acquainted with the **quality** in construction that typifies all G. & McC. Co. products —this **quality** is thoroughly maintained in REES-RoTURBo Rotary Jet Condensers and Vacuum Pumps.

Catalogues Containing Complete Description will be Mailed on Request

The Goldie & McCulloch Co., Limited

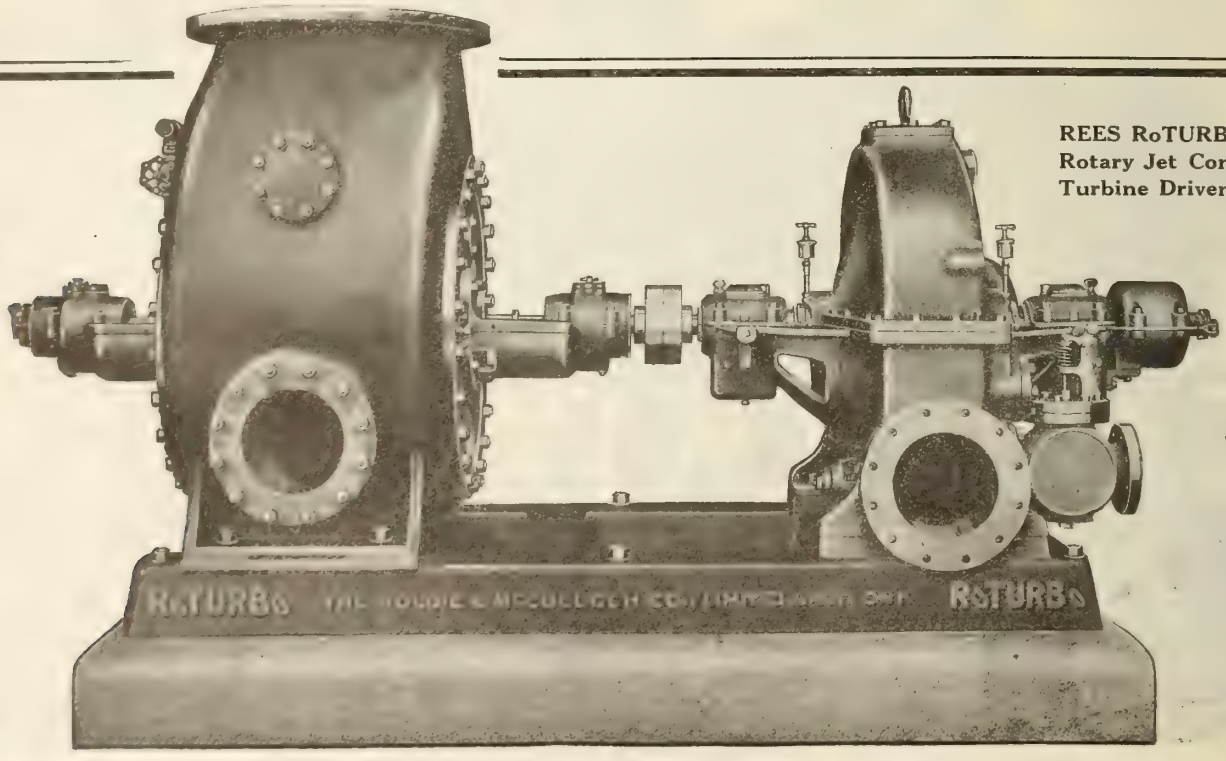
Head Office and Works, GALT, Ontario, Canada

Toronto Office
Suite 1101-2
Bank of Hamilton Bldg.

Western Branch
248 McDermott Ave.,
Winnipeg, Man.

Quebec Agents
Ross & Grieg,
400 St. James St., Montreal.

British Columbia
Robt. Hamilton & Co.,
Bank of Ottawa Bldg.
Vancouver, B.C.



REES RoTURBo
Rotary Jet Condenser
Turbine Driven

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Power Plant Features of the Canadian Ford Co.

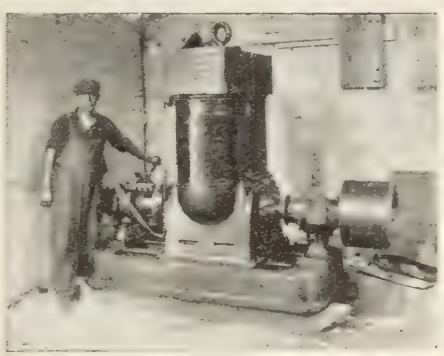
The Power Plant of the Ford Motor Company of Canada Is Interesting on Account of Its Size and Many Novel Features Incorporated in Its Design

By W. F. SUTHERLAND

THE story of the Ford car has often been told, and the manner in which the vision of Henry Ford became a reality is well-known to everyone. The Ford shops and Ford methods, too, have become well-known, and originality and engineering skill have made them unique in many respects. Particularly is this true in the generation of the power necessary for the plants of both the Ford Motor Company of Detroit and of the Ford Motor Company of Canada, Ltd., at Ford, Ont.

This article deals with some of the many interesting features of the latter plant, and before entering upon a description of the engineering features of it, it may be well to say that the Ford Motor Company of Canada, Ltd., is a strictly Canadian organization throughout, and in addition to supplying the domestic demand it exports to practically every one of the British Dominions and possessions. The car made by the Canadian company at Ford City is not merely an assembled product, and "made in Canada" in this case means not merely an aggregation of small parts assembled here, but actually manufactured. Less than $20 worth of imported parts are used in its fabrication. From the raw material to the finished product every step in the making of the car is done in Canada, thus necessitating the employment of four thousand men.

The original power plant first used at Ford City was on quite a modest scale as will be seen from one of the illustrations. A 75 horsepower Edison bipolar machine, of the type familiar in the earlier days of the electrical industry, furnished the power by which



ORIGINAL POWER PLANT.

the shops were run. From this modest beginning to the present plant in the short space of fourteen years is quite a step, and the advances made in engineering practice incorporated in the present plant are on a comparative scale to the horse-power generated formerly and today. Many of the features of design seen in the present power plant are original with Ford engineers, and throughout the economical production of power has been the chief desideratum.

The present plant of the Canadian company may be said to consist of two sections, an older one in which moderate size units were installed and the latter one containing the 3,000 kw. "Gasteam" unit only placed in complete operation during the latter part of 1919. Several factors held sway in determining the type of prime mover installed. The superior thermal efficiency of the gas engine, the need of gas for shop purposes, the reliability of the steam engine, and the necessity for some means of shop heating were all determining factors which led to the selection of a combination steam and gas unit. A very high overall efficiency also resulted from this type of engine since each prime mover supplemented the other.

With both gas and steam units in operation the power plant includes boiler room and producer gas plant, and it may be well to treat these first, passing in turn to the engine room and other plant features.

The Boiler Room

Six Badenhausen boilers are installed, four of 380 h.p. and two of 500 h.p. The smaller boilers are equipped with five retort Taylor stokers, and the larger with seven retort stokers of similar make. The stokers are driven through Link Belt Co. silent chain drive by variable speed reliance motor or in emergeny by a 7 x 7 inch Troy vertical steam engine. The 500 h.p. units are provided with superheafers designed to give 200° superheat. The 380 h.p. boilers are not provided with super-heaters, but like the 500 h.p. boilers have some superheating surface integral with the boilers which gives about 20 degrees to 30 degrees of superheat. The Taylor stokers on both types of settings are fitted with extension grate and dump plates but without clinker grinders. The boilers and stokers are designed for 75 per cent. combined effiiency.

The draft pressure required to burn 55.7 lbs. of coal per sq. ft. per hour on the grates is in the neighborhood of 1½ to 2 inches static pressure at the tuyeres. The forced draft fans are of the Buffalo turbo-conoidal double inlet type. Two

are installed and each have a capacity of 50,000 cu. ft. per min. at 2 in. static pressure. One of them is driven by a 50 h.p. motor and the other by a 75 h.p. steam turbine.

Diamond soot blowers are installed. The blow-off piping is fitted with a Johnson gate valve and a Simplex blow-off valve to each boiler. The boilers were formerly equipped for the burning of natural gas but on the failure of the supply this source of heat is no longer used.

The ashes are removed at the rear of the boiler settings by an American steam jet ash conveyor to an overheat tank. The waste gases are exhausted by means of a Weiderholdt concrete chimney finished with 1 inch tile outside and inside. The chimney is lined with fire-brick to ten feet above the breeching, and this lining has an inside diameter of 10 feet, while the chimney at the base is 14 ft. 5¼ in. outside diameter by 12 ft. 9¼ in. inside. It is 165 feet high.

FIRING AISLE SHOWING BOILER STOKERS AND PRODUCERS.

Coal Handling

Coal is delivered from railroad cars to a track hopper located in a coal tower exterior to the plant. An 18 in. apron conveyor carries it to the crusher from which it reaches the overhead bunker through a continuous elevator pick bucket delivering on to a belt conveyor provided with two automatic trippers. The capacity of the equipment is forty tons per hour. The conveyors were supplied by the Link-Belt Company, while the crusher of the hammer type was installed by the Williams Patent Crusher and Pulverizer Company.

The use of both producers and boilers necessitates the sizing of the coal since the producers work best with 1 in. to 3 inch. lump coal while the stokers use the finer fuel. The sorting into two sizes is automatically performed by a screen attached to the first tripper. The coarse coal can be discharged directly from the screen on the first tripper into the producer bunker while the fine is put back onto the belt and goes to the second tripper to be discharged into the boiler bunker at that point, or vice versa, the fine can be discharged by the first tripper into the boiler bunker and the coarse put back onto the belt and discharged by the second tripper into the producer bunker. It is thus possible to discharge either fine or coarse into any part of the bunkers, irrespective of which part of the bunker is being supplied by the other tripper.

Boiler Feed

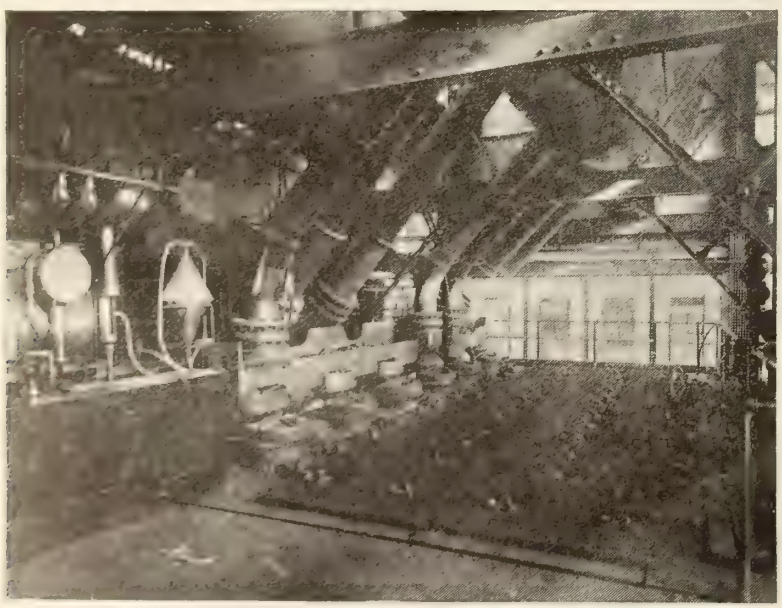
The main boiler feed line is located at the rear of the boilers and is fed from a Swartout open feed water heater of 3,000 h.p. capacity by means of either of two pumps. The first of these is a 3 in. four stage Rees Roturbo pump having a capacity of 250 gallons per minute at 250 lb. pressure. It is driven by a General Electric single-stage turbine of the Curtiss type, at 3,000 revs. per min. The other is an eight stage pump of the same make and is driven by a Westinghouse d.c. motor at a speed of 1,900 revs. per min. The turbine-driven pump is fitted with speed-limiting device and an automatic pressure control governor. The boilers are equipped with Cope's feed-water regulators.

The feed water heater receives all the exhaust steam from the various plant auxiliaries and all oil free condensate and such gas engine cooling water as is not required for hot factory service. Feed water is treated to precipitate all scale forming solids in the heater.

Factory Heating

The factory is heated by a force circulating hot water system, the water being circulated through the engine condensers. Live steam is used to make up the small difference between what is obtainable from the condenser in use and the existing load. The outgoing temperature is maintained at the proper point to supply the required amount of heat, dependent upon the outside temperature.

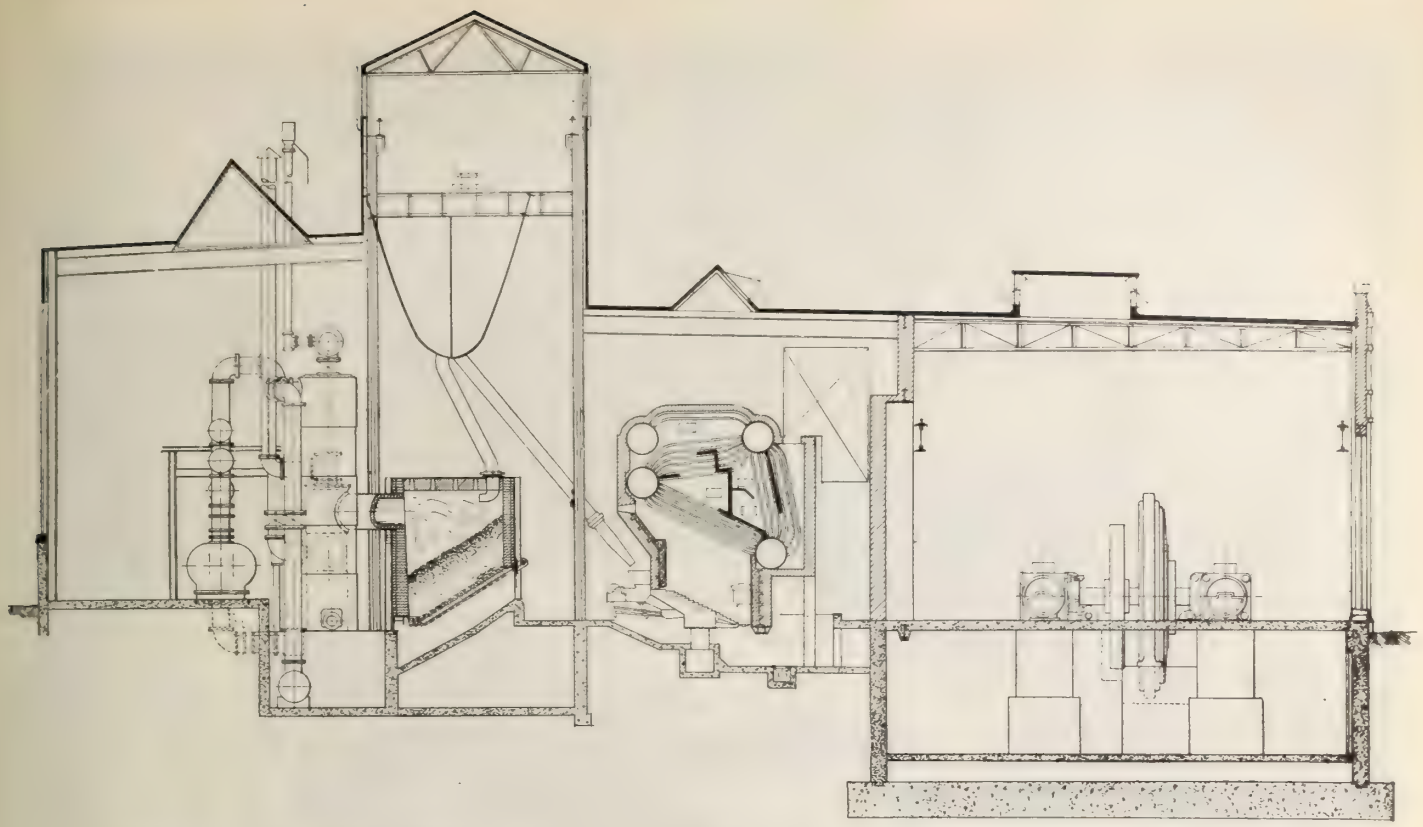
For zero weather it is necessary to maintain an outgoing water temperature of 190 degrees fahr. while delivering 1,000 g.p.m. The return water temperature under these conditions will be about 160 deegrees fahr. Two circulating pumps are provided of 8 inch. size, either one of whom will supply the above requirements, the other being a reserve unit. One pump is driven by a 15 h.p. General Electric turbine of 1,440 r.p.m., the other by a Canadian Westinghouse motor. The condensate from the live steam heater flows into a receiver, from which it is pumped by a Burnham pump direct to the feed-water heater.



TOP OF GAS PRODUCERS SHOWING COAL DISTRIBUTORS AND GAS ANALYSIS APPARATUS.

Gas Producer Plant

At one time the natural gas fields of Western Ontario were capable of supply-



SECTIONAL ELEVATION THROUGH POWER-PLANT SHOWING PRODUCER PLANT, BOILERS AND GASTEAM UNIT.

ing a very cheap fuel for industrial and heating purposes. With their approaching exhaustion this condition has changed and industrial plants are no longer able to use natural gas. At this particular plant natural gas was used, not only under the boilers but also in the gas engines. Since this fuel is no longer available gas producers have been installed, and in their construction and operation much of interest is seen.

Three Smith suction gas producers are installed at this plant, being located immediately opposite the boilers and fed from their own portion of the common bunker. Each producer is rated to gasify 50 tons of coal per day of twenty-four hours, and is built up of six sections. An inclined grate is used which has an inclination of 35 degrees from the horizontal. Each producer has 270 sq. ft. of grate surface and at the bottom of the grates heavy clinker bars are provided for the crushing and passing through to the ashpit all clinker that settles through the fuel bed to the grate.

Coal coming from the bunkers above through chutes is automatically fed into the producer by means of a mechanical stoker designed to admit the charging of coal without admitting air. This mechanism may be seen in one of the illustrations.

The gas leaves the producer at about 1,110 deg. fahr. and is cooled and washed in a primary cooling tower by means of water sprays, the water being supplied at a pressure of 20 pounds.

The gases are drawn through the primary coolers and from the producers by means of Connelsville gas exhausters, one to each producer. Each exhauster has a rated displacement of 6,000 cub. ft. of gas per min. and is driven by a twin direct connected 11 x 24 in. high-speed Corliss engines of Hooven Owens Rentschle make. These exhausters boost the pressure to about 3 pounds. The gas is then forced through Smith tar extracters which consist of sun glass wool diaphragms suitably housed. The tar-laden gas is driven at high velocity through these spun glass wool diaphragms (about 1½ pound of glass wool to each extractor) and an agglomeration of tar particles takes place until they are of sufficient size to drop out of the gas by gravity. The life of the sun glass wool is from two to three months, depending on the quality of the wool used and the care taken in packing it in the diaphragm. The tar flows from the tar extractors to a tank 36 in. in diameter located in the basement. After leaving the tar extractors the gas then passes through a secondary cooler in which it is cooled as low as the temperature of the river water will permit, this is done to remove as much moisture as possible.

The water from the primary cooler is sent to a tar settling tank where the tar settles out and is piped to the main low-pressure gas header. The tar which separates out in the tar extractors likewise is piped to this header. From here the tar is drained into a small tank at a lower level, and when this is full, steam is admitted and the contents elevated to another tank at a higher level than the tops of the gas producers. From this point the tar flows to the atomizers in the producers by gravity. The sprayer, by means of which the tar is atomized and distributed over the fuel bed is made by placing a ⅜ steam pipe inside a 1 in. tar pipe. The ends are reduced in area and are approximately flush with bottom of the top lining of the producer.

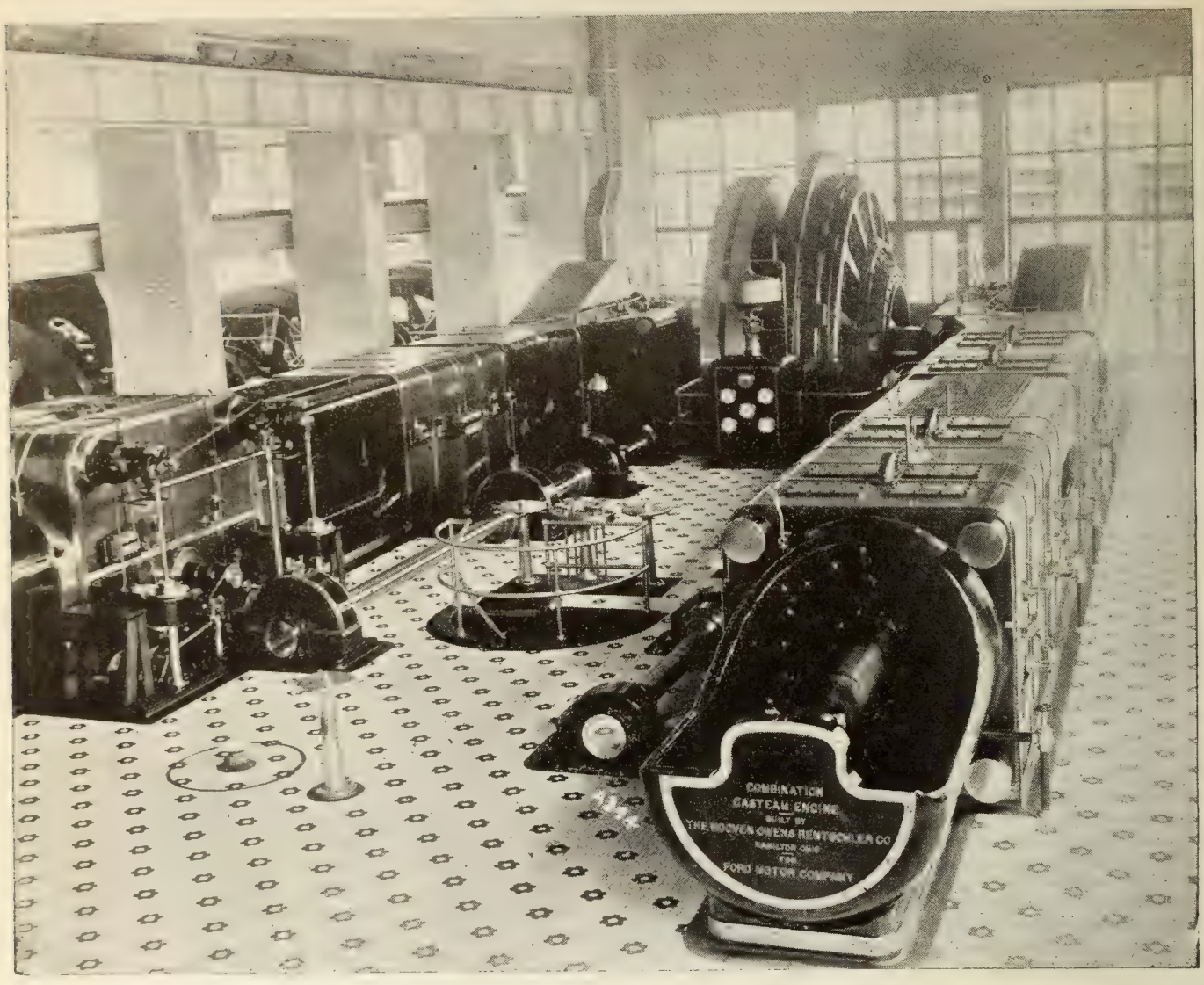
The successful disposal of the tar is no mean accomplishment and is a problem which has bothered many gas plant operators. No little credit is due the engineers of the Ford Motor Company, and Mr. H. F. Smith, of the Smith Gas Engineering Company for the successful working out of the system at present in use.

The spraying or vaporization of the tar in the producer has an appreciable effect on the heat value of the gas, which shows a gain of anywhere from 10 to 15 B.t.u. per foot. Due to a slight increase in the percentage of methane.

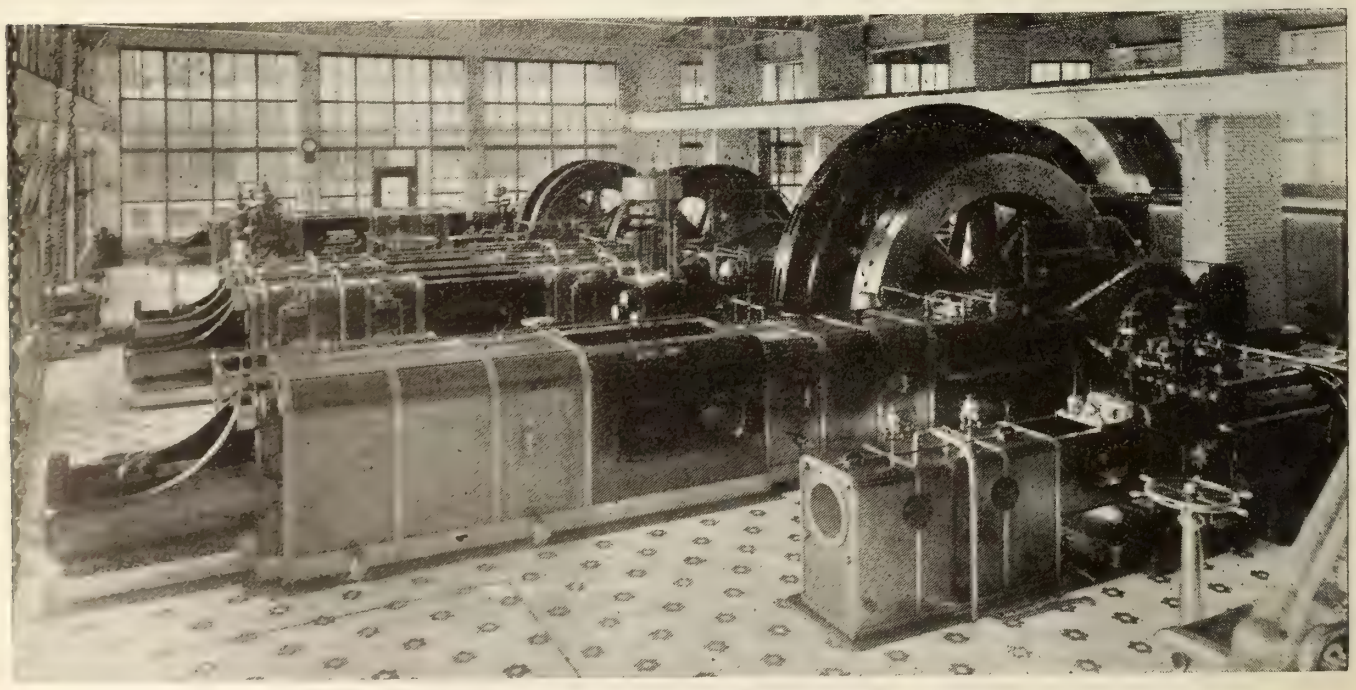
A low-pressure steam line is carried inside the main tar header and this serves to keep the temperature of the tar at about 160 deg. Fahr., so that it flows very nicely through sight feed flows.

The operation of a producer plant is an art in itself. Three firemen are required for each producer, and by means of ⅞ steel bars from 6 to 19 feet long they keep the fuel-bed compact and in good condition. In particular they watch for holes and other unevenness which may develop in the bed to the detriment of the gas being made. The depth of fuel bed averages about 5 feet on high side of the grate and 7 feet at the other end.

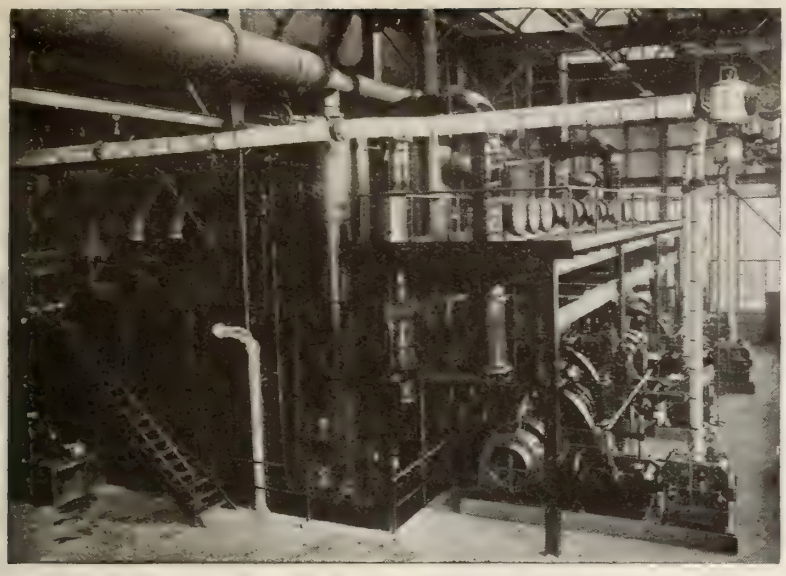
The exhaust steam from the blower engines is used to saturate the air blast to the producers and an intermittent acting thermostatic valve is used to automatically control the steam supply and maintain a blast temperature of



GENERAL VIEW OF LARGE "GASTEAM" ENGINE AND 3,000 K.W. DIRECT CURRENT GENERATOR.



EARLIER PORTION OF PLANT SHOWING GAS ENGINES AND SMALLER GAS-STEAM UNIT.



GAS PRODUCER EQUIPMENT WITH BLOWERS AND ENGINES.

between 140 deg. and 150 deg. fahr. More than half of the exhaust steam from the source is thus utilized. The balance goes to feed water heating.

With a temperature of blast below 140 deg., clinker troubles are apt to arise, and with a greater temperature than 150 deg. the percentage of carbon dioxide increases to the detriment of the quality of the gas.

A gas testing cabinet forms part of the plant and is shown in an illustration herewith. The complete unit was supplied by the Smith Gas Engineering Company, and by its use a very accurate control can be had of the quality of gas.

Large Gasteam Unit

The large gasteam engine installed in the Canadian power plant is similar to those in the plant of the American Company at Highland Park, Michigan. The unit consists of a horizontal tandem compound steam engine together with a two-cylinder tandem gas engine, both driving through a common shaft a 3,000 kw. direct-current generator at 80 revs. per mm. The generator delivers direct current at 250 volts and at full load rating has a capacity of 12,000 amperes. It is compound wound.

The steam side as has been mentioned is tandem compound with 30 in. h.p., 60 in. l.p. cylinders, and 72 in. stroke.

The gas engine unit works on the four-cycle principle, employs make and break ignition, and has two double-acting cylinders, each of 42 in. diameter by 72 in. stroke; the valves are 12 in. in diameter and the piston rod 13 in., the latter made hollow for water cooling.

The high pressure steam cylinder is equipped with poppet valves in order to permit of the use of superheated steam at a high temperature, while the low pressure cylinder is equipped with Corliss valves. The exhaust steam leaving the h.p. cylinder passes through a reheater, through which a major portion of the exhaust gases from the gas engine are circulated. A small portion of these gases is circulated through the jackets of both the high pressure cylinder. A surface condenser of 4,900 sq. ft. area and built by the Wheeler Condenser and Engineering Company, is installed and is served by an 18 x 12 in. motor-driven Edwards wet air pump, together with the usual motor-driven circulating pump, which draws its supply from the river. The circulating water at the present time is returned to the river. It may at some future date be utilized for heating utilities when the heating load reaches such proportions.

An interesting feature in connection with the design of the gas engine side of the unit is the mechanism for operating the valves, which, instead of operating these by means of eccentrics, they are worked off a cam shaft.

The make and break mechanism for ignition is electrically operated from a central station. Each end of each cylinder is provided with four ignitors for the more uniform and rapid ignition of the gas.

Small Units

In the older portion of the power house are two gas engine units. Each of these drive a 500 kva. Crocker-Wheeler generator which furnish three-phase alternating current at 480 volts and 60 cycles. The engines are each two-cylinder tandem, the cylinders being 24 in. dia. by 36 in. stroke. Each engine is also direct connected to a single stage 13 in. by 14 in. air compressor.

In addition to the above units there is also another gasteam unit smaller than the large one described above. This latter unit drives a Crocker-Wheeler generator of 1,125 kva. and furnishes 3-phase energy at 480 volts and 60 cycles. This engine is in many respects similar to the large one. The two gas cylinders arranged in tandem are 24 in. diameter and have 36 in. stroke. The high pressure steam cylinder is 18 in. dia., the low pressure arranged tandem is 34 in. dia. and the stroke is 36 in., the same as that of the gas side. The speed is 120 revs. per min.

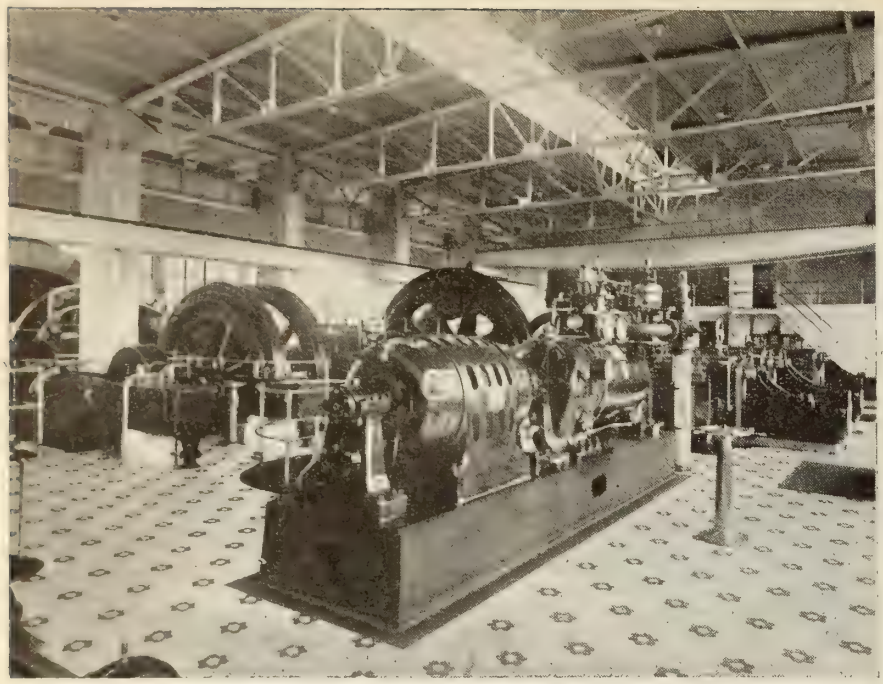
For the furnishing of compressed air to the shop there is an addition to the above gas engine driven units, a cross-compound Corliss steam-driven air compressor. This machine has 12 in. and 26 by 24 in. steam cylinders with 13 and 22 in x 24 in. compressor cylinders. The first mentioned air compressors being direct connected to an A.C. generating unit operate at constant speed of 150 r.p.m. The speed of this latter unit is controlled by an air cylinder attached to the speed limiting governor.

All of the gas-steam engines, gas engines and the air compressor were furnished by the Hooven, Owens, Rentschler Company.

The smaller gas-steam unit and the air compressor are served by a surface condenser made by the Wheeler Condenser and Engineering Company. This condenser is fitted with a 12 x 10 in. Edwards Triplex air pump.

For night duties and Sunday service a steam turbo-generator set has been installed. A Terry steam turbine is directly connected to a 150-kw., 250-volt d.c. generator, and is also connected to 3-phase motor, 3-phase 60 cycle of the synchronous type.

3,000 K.W. GENERATOR AND FLYWHEEL OF GASTEAM ENGINE.



WESTINGHOUSE-PARSONS TURBO-GENERATOR UNIT.

The above set is for auxiliary purposes while for general use a second set is installed. This unit is a Westinghouse-Parsons turbo-generator set, having a capacity of 375 k.v.a. and delivering three-phase current at 480 volts and 60 cycles. The speed of the unit is 3,600 revs. per min. A Westinghouse surface condenser of 800 sq. ft. area serves this unit.

Motor-Generator Sets

It will be noticed that two systems are in use alternating and direct current both being supplied. In order to make the distribution more flexible and to permit of the transference of load from one system to the other, motor generator sets are installed. The first of these consist of a 1,020 kva. 60 cycle synchronous motor direct connected to a 900 kva. 250 volt d.c. generator. This set is so arranged as to permit of the supplying of either a.c. or d.c. power which ever is required. Another motor-generator set is also installed, and this set performs a slightly different function. A 900 kva. synchronous motor is directly coupled to a 250 kw. 250-volt d.c. generator. It will be noticed that there is a considerable difference in the sizes of motor and generator, and while the generator is over-motored, the motor is used for power-factor correction and the d.c. generator is of service at night for auxiliary service. A power factor of 92 to 95 per cent. is maintained on the alternating current load.

Control and Ignition

A 125-volt exide storage battery is used for switch control, auxiliary lighting, and is also used during the day for ignition on the gas engines.

Electrical Features of Design

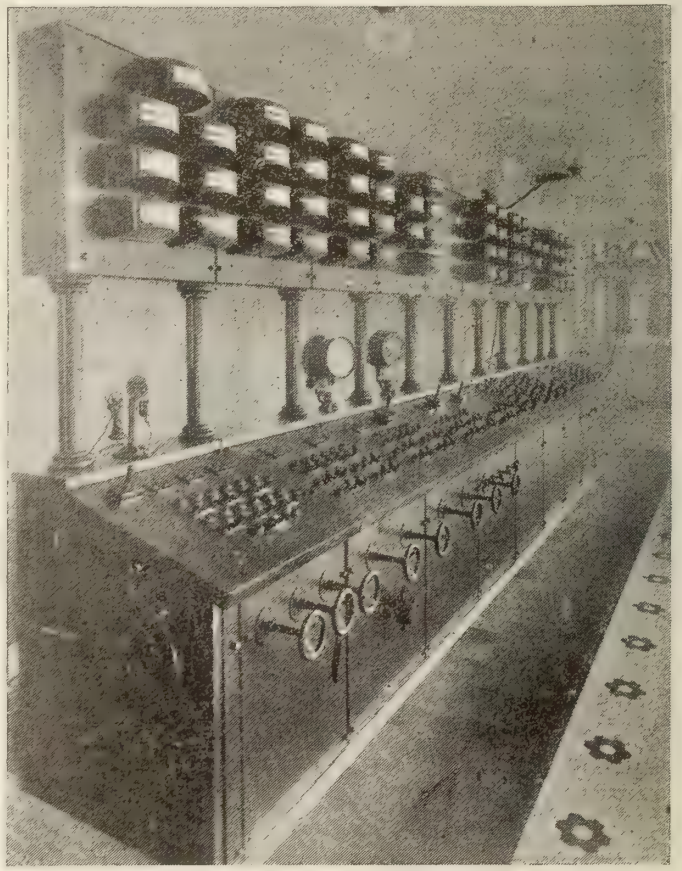
With generators of 3,000 kw. capacity and delivering current at 250 volts, the copper work and switching equipment would naturally be of some size. This is the case and leads from the main d.c. generator are of large proportions. Twelve bars of 6 by ¼ in. copper are required for the two main leads, while for the equalizer between units a six bar bus of the same size copper is used.

The generator leads are carried underneath the main floor to a wall and up and out through the roof across which they are carried to the d.c. generator switch structure. This is located on the second floor and here the main circuit-breakers for the generators are installed. The 3,000 kw. set is provided with a 15,000 amp. two-pole circuit breaker with equalizer attachment. The 250-kw. set has a 1,600 amp. breaker, 3-pole for main leads and equalizer. The 900 kw. set has a similar circuit-breaker of 5,000 amp. capacity. The feeder board from which all feeders are taken to the various departments in the shop is located immediately below the generator panels and is provided with circuit-breakers of a similar type. All these breakers are of the "I. T. E." type, made by the Cutter Company, Philadelphia.

The alternating current distribution is taken care of by an oil switch structure in a special switch room located to one side of the engine-room basement. These switches, together with the circuit-breakers, are all remote controlled from a bench board located in a gallery overlooking the engine room. This bench board is shown in one of our illustrations and has a capacity of 32 feeders in addition to the machine controls.

General Details

Throughout the entire power plant one is impressed with the effort which has been made to render it attractive to the eye. Tile floors, tile walls, and the very large glass area combine to make an engine-room at once attractive and well lighted.



BENCH-BOARD FOR CONTROL OF GENERATORS AND PLANT FEEDERS.

A Description of a New Large Gas Engine

This Engine, of 1,000 Horse Power, Embodies Some New Features of Design, Which Allow of a Considerable Saving in Space—It Has Four Cylinders on One Crank

Courtesy of "The Engineer"

THE large variety of gas engines employed a decade ago for the development of anything over small power has, within recent times, been narrowed down to two distinctive types—the slow-speed tandem horizontal design and the high-speed vertical class; but a new form of engine embodying the best features of both classes is now working in the Midlands, and its operation, so far, has been so satisfactory that it promises to become a serious competitor with its two established rivals.

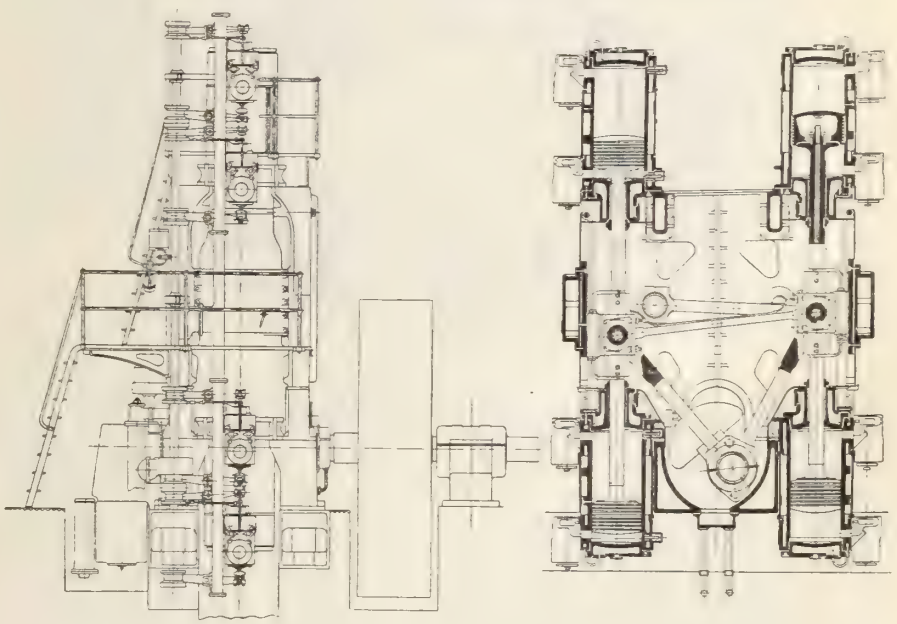
The engine in question has been the subject of a large amount of study on the part of the designer—Mr. J. H. Hamilton, of the Premier Gas Engine Company.

The consideration which chiefly guided Mr. Hamilton in designing the new engine was an appreciation of the fact that the purchasers of large gas engines, who are generally blast-furnace or steel works proprietors, have a distinct bias in favor of comparatively slow-running machinery. It may be that they are more tenacious of that love for visible reciprocating parts, than are other classes of engineers, or it may be that the rough usage of a steel works is more readily resisted by the low-speed engine; but whatever may be the cause, there is no doubt that the iron-masters of this country prefer slow-speed gas engines to the more recent high-speed vertical type. And this despite the fact that the latter engine occupies far less floor space—a very valuable characteristic in crowded ironworks. Another consideration influencing the design is the reduction of manufacturing costs to the lowest possible limit.

The result of taking all these factors into consideration is the adoption of a vertical arrangement, the four-stroke cycle, a speed of 125 revs. per minute, and a single crank for every four cylinders. The last mentioned feature is one of the greatest innovations in the engine, and helps very largely in the reduction of its cost as compared with other four-cylinder vertical engines, for, with the usual arrangement the crank shaft is the controlling factor in the price of the engine.

Referring to the sectional line drawings above, it will be seen that the cylinders are grouped in pairs. on opposite sides of the crank shaft, with a triangular connecting-rod, after the fashion of the old Musgrave steam engine, transmitting the motion of the two sets of piston rods to the single crank. The upper ends of the two branches of the connecting rod have gudgeon pins working in short transverse slides in the cross heads, while the right hand pin also takes the ends of the radius rods that transmit the side thrust of the connecting rods to anchor pins in the main frame. In this way, it will be seen the principal forces which, with the normal arrangement of crank and crosshead produce a considerable amount of friction on the slides, are taken by the linkage, and the only side thrust which is put upon the cross-heads is that produced by the friction of the gudgeon pin slides as they make the small movement (about one inch) accounted for by the circular movement of the end of the radius rod.

The arrangement possesses the advantage of reducing to a minimum the frictional losses involved in the conversion of the reciprocating motion of the piston to the rotation of the crank, and also gives a very even turning movement. The effect of the triangular connecting rod in this direction is, in fact, practically equivalent to setting the cylinder axes at an angle of 60 degs., like the familiar motor cycle engine.



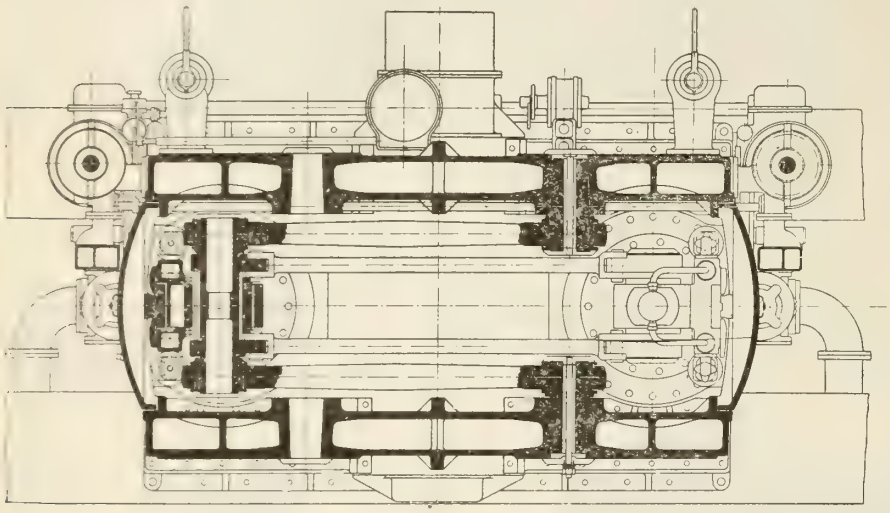
Some indication of the fact that the stresses are confined within a comparatively small part of the engine may be obtained by a visit to the upper platform. Even when the engine is working at a considerable overload, the movement at this height—some 20 ft. above the foundation—is barely perceptible, and no relative motion between the two top cylinders can be detected.

One of the peculiar detail features of the engine is the big end of the connecting-rod. It is, of course, desirable that the two lines of cylinders should be as near together as possible, not only to save space, but also to reduce the rocking stresses on the bed-plate. For this, and several other reasons, a marine type of big end is not suitable and the bearing is formed by forging claw-like extensions on each of the connecting-rods. These claws interlace much after the fashion of a man's fingers when the hands are clasped, as in prayer. The result is that the crank pin is completely embraced by the ends of the two rods, and yet either rod can be swung clear of the pin if necessary. The two parts are connected by a couple of pins, plainly shown in the cross section, which are in shear, and thus far less liable to failure than are the bolts of the usual type of big end, which are in tension. The brasses are made in four parts, with tapered exterior faces fitting into conical seatings in the big end and a gland-like arrangement is used to adjust them to the pin. There is clearance inside the crank webs for the removal of the brasses without separating the two halves of the big end.

Another detail which indicates the thoroughness with which the design of the engine has been thought out is the arrangement of the gudgeon pins. They are secured by means of cotter pins and set screws, and, as a final precaution against their working out endways, cover plates are bolted over each end.

The line drawing shows the arrangement of the links at the level of the crossheads, and the bearings of the various rods on the pins, in plan.. The radius rods are the two outside members of the group, while the pair of rods within them forms the upper side of the connecting-rod triangle. The gudgeon pins are fixed in the eyes at the ends of the two connecting rods, and have bearings for the radius rods and the cross-head slipper. The eyes of the connect-

ing-rod are provided with cotters to fix the gudgeon pin and to ensure that there is no backlash at the joints. The anchor pins of the radius rods are drilled, and copper lubricating pipes, strapped on to the sides of the rods, lead from them to the pins and slides. The oil is supplied by a double-barrel oscillating pump driven direct off the crank shaft, which sucks from a sump in the bottom of the crank case. The lubrication of the crank pin is provided for by holes drilled in the crank webs. An entirely separate system is, of course, provided to distribute the heavy oil required for lubricating the main pistons. The lubricators for this purpose have sight feeds which deliver into pump barrels, one for each supply pipe. The plungers of these pumps are lifted by a slow-moving cam and forced forward abruptly by strong springs. The lubricators are in conspicuous positions on the platform round



the engine, and a glance on the part of the attendant will assure him that any lubricator is working satisfactorily.

A feature of the engine which is no doubt largely responsible for its sweet running, is the very thorough way in which it is water-cooled. The cylinder castings are of comparatively simple form, as the valve boxes are separate castings bolted on, and the water jackets can thus be carried well round the cylinders, while the two covers are, of course, cored out for water circulation. The middle part of the jacket is formed by bolting round the cylinder cast iron "mantles," as shown above. These mantles can easily be removed when it is necessary to clean out the jackets. The pistons also are water-cooled, and in this respect the new engine possesses an advantage when compared with the high-speed type of vertical engine. The water for this purpose is carried through a telescopic joint arrangement alongside each pair of piston-rods, and is distributed from a box bolted to the side of the crosshead, which is indicated on the drawings on these pages. The exhaust valves are also fitted up for water cooling, but the makers inform us that after trying one or two types of valve they have found one with which water cooling is unnecessary. The supply of water to the valves had been cut off when we saw the engine running at Wolverhampton.

There is a separate valve box for each end of each cylinder, and each box contains three valves. The exhaust valves are below, with their spindles appearing through the bottom cover of the box, while the air and gas valves are worked by one spindle coming through the top. Between the two sets of valves there is the port communicating with the cylinder. The valves are operated by horizontal rocking levers and grooved cams on two vertical shafts running up the sides of the engine. These shafts, in turn, are driven, through bevel gearing, by a horizontal shaft running across the base of the engine and driven through a two to one skew cut reduction gearing. There is a slight tendency, on account of the effort necessary to operate the valves, for the cam shaft to rise in its bearings, and thus, although it may appear to be a rather massive shaft to stand vertically, it runs quite satisfactorily in a plain footstep bearing.

The valves are operated positively by the rocking levers, and the fact that they are properly bedded on their seats, when closed, is ensured by making the stroke of the lever too long by about 1-16 in. This extra stroke is taken up by the compression of springs arranged in the connection between the lever and spindle. This arrangement possesses a great advantage over the usual practice of employing heavy springs to perform the whole operation of closing the valves, as, in the event of the small tightening springs failing, the valve would still continue to work with, possibly, a small leakage. On the other hand, if the spring of the usual spring-closed valve breaks the valve generally stops wide open.

The supplies of gas and air are brought to the vales by two rectangular trunks. The trunk has a longitudinal diaphragm to separate the gas and air right up to the point where they mix in the valve boxes. At the lower, or inlet, end of the trunk there is a butterfly valve, connected with the governor, to regulate the amount of gas and thus proportion the mixture to the load on the engine.

Ignition is effected by duplicate make-and-break spark gaps, arranged in the valve boxes, working with current at about 10 volts. The rockers of the spark gaps are operated by tappets on the main valve cams, and a simple system of links. The effective manner in which the sparks ignite the charge may be judged from the fact that when running light we had the engine throttled down until it was going at only 44 revolutions per minute, and it still ran quite steadily.

As regards the general arrangement of the engine, the principal working parts are boxed in by the side frames, which take all the internal stresses of the engine. They are admirably adapted for this purpose, as they practically form a complete rectangular box with a cylinder at each corner, as may be seen from the section below. There are port holes, closed by sliding doors, at the sides, and above there is a good wide opening for access. It is noticeable, on looking through any of these openings when the engine is running, that there is none of the oily smoke in the crank case often associated with vertical gas engines, while the working parts are so cool that they can be handled comfortably. Inside the framing there is plenty of room, and we should imagine that fitters would have no hesitation about dropping down into it and getting to work, if necessary, immediately the engine was stopped.

Started is effected by admitting compressed air to one pair of cylinders through a valve actuated off the lay shaft. We saw the engine started with air at a pressure of 180 lb. per square inch. In about three revolutions it was up to full speed, and took up the full loda as quickly as the switchboard attendant could apply it.

The weight of the engine is distributed over the foundations by two cast box girders about 2 ft. 6 in. deep, and between them there is a small excavation for the withdrawal of the lower pistons. As the engine is erected in the Hickman power station, it has the original fly-wheel used on the test bed, supported by an outboard bearing, and a flexible coupling is used to connect it with the electric generator which it drives; but, obviously, future sets intended for electric plants would have the fly-wheel incorporated in the generator, which would then come inside the outboard bearing.

The cylinders of the engine in question are 24¾ in. in diameter. The stroke is 30 in., which, at the normal speed of 125 revolutions per minute, gives a piston speed of 625 ft. per minute. The mean eective pressure in the cylinder is 66 lb. per square inch. Working on blast-furnace gas this engine develops 900 horse-power, or 1,000 horse-power with producer gas. The overall dimensions of the engine, including a generator alongside the fly-wheel, are 18 ft. by 25 ft. b y about 20 ft. high above the floor level. A unit of approximately the same capacity, but of the double-acting tandem horizontal type, would measure 27 ft. broad by 60 ft. long. It will thus

be seen that an economy amounting to about 70 per cent. in floor space alone can be effected by adopting the new engine. This feature is brought home to the visitor to the Hickman works very forcibly. The power plant there comprises about a dozen horizontal engines, made by the Premier Company, of which the last three are of 1,000 horse-power each. The vertical engine, standing next, although it has an imposing appearance, on account of its height, is quite insignificant as regards the room it occupies.

So far the engine has run about six months in regular service, and the power plant engineer of the owners told us that it had given no trouble whatever. As soon as it is possible to provide the requisite load it is intended to run the engine continuously for four months. From the reports which we had of the performances of the other Premier engines in the station there is no reason to doubt that the new set will accomplish the task.

The Premier Company is now engaged on the designs for some larger engines of the same type, which are to have cylinders 39 in. in diameter and to develop 3,000 horse-power per four cylinders. In one preliminary design there are eight cylinders, with an electric generator arranged between the two groups of four.

SAVING IN BELT TRANSMISSION

At a foremen's meeting the other evening, one of the questions discussed was, "Why do we lose so much time in getting the full product from a machine with a new belt?"

One man asked: "Has it anything to do with the way the belt hugs the pulley?" The reply came quickly from two or three: "The trouble is the belt was not properly stretched before it was put in place."

The next man who rose, said: "All my belts jump when the belt hooks go over either the receiving or driving pulley."

Finally the manager said: "Well, let us take this up as we did the other power problems. We will have the engineering department take full charge of all the belts that are put on new in two or three rooms, for the next two weeks, and then hear their report."

When the tests were made, and the report read, the following facts were brought out:

First: All the belts, even those as narrow as 1¼ inch, showed the least trouble when stretched on the floor in the roll before being measured for the length required. This was done by securing the ends of the belt by nails at one end, the other being put in the regular clamps and drawn up a little every day before cutting to length.

Second: All the belts of whatever width that were used showed a loss in power when they were put together, either with lacing, or any other style of belt hook. Those that were cemented, with no extra thickness at the joint, showed regular transmission, no lost motion on machine or shaft, and the production very soon, after the new belt was put on the machine, came up to full product.

The tests showed such favorable results that the following rules were adopted after the points had been thoroughly discussed:

Rule 1.—All belts shall be given out only in lengths required for applying to the drive, and only after same have been subjected to a regular process of stretching, the roll being secured to the floor at one end, and the clamps applied to the other, the amount taken up being determined by tests on the exact width of the belt being kept, one inch not being reduced by the pull to three-quarters, and so forth.

Rule 2.—Any roll of belting, so stretched, that shows uneven width shall be laid to one side, and shown to the purchasing agent, to be taken up with the firm that supplied the belting.

Rule 3.—The putting on of the belts, after the order is received from the foreman of the department, shall be turned over to the belt man, who will apply the same.

Rule 4.—All the rooms will have, as standard the amount of belting used in the last twelve months, and will be credited with all the saving made by the above rules for the next two months. This to be divided at the end of each two months' period, giving 75 per cent. as the bonus to the wages in the room, and the balance as saving on the corporation overhead account.—*Belts.*

THE SMALLEST WIRELESS RECEIVER

A late British wireless invention is a portable wireless telegraph receiver. The whole apparatus—receiving coil, tuning condenser, two valve detectors, accumulator dry battery, transformers and reaction soil—goes into a box which is only fourteen inches long, thirteen inches broad, and five inches deep. The cover of the box lifts off its hinges and forms a base with a pivot on which the receiver can be rotated so as to get the strongest signals according to the direction in which the waves are coming. A compass card on the cover enables the receiver to be set in the correct position for receiving from certain stations. With this little appliance, which weighs only 20 lbs., signals can be read in Great Britain from the largest stations in France and Germany as well as in England, without any additional wires. The signals, which are read in a telephone, are clearly audible in a reasonably quiet room.

INSURANCE POLICY FOR EMPLOYEES

An insurance policy for the sum of five hundred dollars is now given entirely without cost to every employee of the American Westinghouse Electric and Manufacturing Company who has been in the service of the company for a period of six months or more. Furthermore all employees who have been in the company's service for six months or longer and who deposit a sum each pay-day in the Employees' Saving Fund equal to 2 per cent. or more of their earnings, will not only receive 4½ per cent. interest compounded semi-annually on such deposits, but, in addition, will automatically have their insurance increased to amounts up to 2,000 dollars, depending on the length of time they have been with the company. For example, a man who has been in the service of the company for at least fifteen years, and has regularly deposited in the Employees' Saving Fund 2 per cent. or more of his salary, on which he regularly receives 4½ per cent. compound interest, is presented with an insurance policy in one of the established companies for the sum of 2,000 dollars at no cost whatever to him.

STANDARDIZATION OF SHAFTING

The American Engineering Standards Committee has invited the American Society of Mechanical Engineers to act as sponsor for the standardization of shafting. The Society has already done a considerable amount of work on a set of standard diameters for transmission and machinery shafting. It is proposed that the work, which will be carried out by a sectional committee working under the rules of procedure of the A. E. S. C., shall be broadened to include the standardization of the method of determining what diameters of transmission shafting should be used for given loads, the dimensions of shafting keys and keyways, and the setting of dimensional tolerances.

STANDARDIZATION OF PIPE FLANGES AND FITTINGS

The American Society of Mechanical Engineers has been requested by the American Engineering Standards Committee to assume sponsorship in the standardization of pipe flanges and fittings. In 1914, the Society issued a report covering a schedule of pipe flanges and fittings, for diameters from 1 in. to 100 ins. for 125 lbs. pressure, and also a schedule for extra heavy pipe, covering a range from 1 in. to 48 in. diameter, and for 250 lbs. pressure. In 1918, a supplementary report was published for working pressures of 50, 800, 1,200, and 3,000 lbs.

While the work has not been active during the last year, it is now proposed that it be continued, the Society being formally recognized as sponsor, under the rules of procedure of the A. E. S. C.

Making New Line.—"The Wilt Twist Drill Company of Canada, Limited, Walkerville, Ontario, are now manufacturing a complete line of specially designed Ford reamers, catalogues of which are now ready for distribution and will be furnished on request."

The Thirty-First Convention is Now History

The Woodstock Lodge of the C.A.S.E., the Mayor and Aldermen of the City, and the Citizens at Large, All Contributed to the Success of the Occasion

By T. H. FENNER

THOSE who had the good fortune to attend the thirty-first convention of the C. A. S. E. at Woodstock, came away from that hospitable city with no doubts about its success. Pleased expressions on the faces of delegates, exhibitors and visitors were so prevalent that on the second day Old Sol could not keep away from the party any longer. He accordingly resumed the job that he had temporarily vacated and got busy drying up the picnic grounds. This was successfully completed in good time for the sporting events to be pulled off, which we will have much pleasure in describing later.

The Machinery Exhibit

The advance guard of the Exhibitors' Association were on the ground on Monday the 21st, and proceeded with the decorating of the booths, and the unpacking of their exhibits. The building allotted to them was the city market place, and it was admirably suited for the purpose. The spacious counters, chopping blocks, etc., made excellent show stands, and when the exhibitors had done their worst with the pink, blue, green, orange, and black crinkled paper, the market was transformed, and Woolworth's staff at their last gasp. Some of the decorations displayed distinct cubist leanings, and it was only through the active intervention of the Ladies Auxiliary of the G.W.V.A. that worse horrors were not perpetrated. Purple and green seemed to be the favorite, but here and there delicate clusters of pink and orange might be seen mingled with violet and yellow. However, leaving the artistic endeavors to one side, the standard of the exhibits themselves was distinctly high. The various firms sent a large and varied assortment of their products, and these were displayed, and their various points explained in minute detail by the indefatigable representatives. We understand that in some cases their trouble was rewarded by the receipt of orders which were well worth while. This is very satisfactory, but even those not fortunate enough to book orders on the spot no doubt laid the foundation for much future business. The following engineering specialty and supply houses were represented:

Mason Regulator and Engineering Co., Toronto and Montreal, showing the Reilly heater, Bundy steam traps, Mason reducing valves, steam gauges, etc. Mr. S. Balmfirth was in charge.

C. B. Turner, Toronto. Mr. Turner, looking hale and hearty in spite of his recent illness, was on hand with samples of sediment removed from feed water by his patent process, as well as high temperature fire clays, etc. There were many visitors to "Dad" Turner's corner.

Dearborn Chemical Co., represented by Mr. Hunter, had interesting literature descriptive of their treatment of boiler feed waters, and the various chemicals employed.

James Morrison Brass Manufacturing Co., Toronto, had a very complete line of their products on exhibition, while Mr. Betton was on hand to explain their leading points. All kinds of valves were exhibited and a handsome gauge board, mounted with steam, vacuum and compound gauges had a prominent place. The cross-section reducing valves and injectors came in for much attention from the visiting engineers.

The Dart Union Co. had a tastefully decorated booth, presided over by Lieut. L. Archibald, who evidently wished to be reminded of his flying days. His booth was frescoed round with miniature Zeppelins, from which depended brightly-colored darts, with the well-known union featured at the end.

The Morehead Bickle Co., Woodstock, had on exhibition a working model of their Morehead trap. This had a section of the metal cut away and replaced by a sheet of mica, through which the water could be seen mounting to the level, at which the trap dumped and cleared itself. Mr. Bickle was on hand to explain its features.

Thomas Gordon Co., Hamilton, sales agents for the Philadelphia Rubber Co., showed their various lines of packing, etc., to an interested audience.

Allen General Supplies, Toronto, had a booth from which literature dealing with their lines was distributed. These included Venturi meters, Coppus blowers and Cope's feed-water control.

The Goldie and McCulloch Co., Galt, represented by Mr. Earl Hetherington, occupied space at the entrance to the exhibition hall, where information on their high-grade engines, boilers and power plant specialties was freely available.

Darling Bros., Montreal, heating specialists, showed their radiator traps, etc., while Mr. Curzon, Montreal office, and Mr. Worthington, of the Toronto office were present to explain the principles of their equipment.

Jenkins' Valve Co., Montreal, had an exhibition of their well-known steam and water valves, of the gate and globe variety. Mr. J. S. Mock had charge of the exhibit.

France Packing Co., Philadelphia, ably represented by Mr. "Bob" Jones, showed their metallic piston and valve rod packing.

Geo. W. Cole Co., Toronto, had a couple of their steam traps on the stand, and were represented by Mr. Grant Cole and Mr. W. H. Auger.

The Valve Engineering Co., Toronto, showed their lines of packing metallic hose, etc.

C. A. Dunham Co., Ltd., Toronto, heating specialists, showed the Dunham radiator trap of the diaphragm type, and were represented by Mr. Peterkin.

The Garlock Packing Co., Galt, showed their well-known lines of engine and pump packing, pointing material, etc.

Republic Flow Meters of Canada, Ltd., had a working model of their electrically-operated flow meter erected in the hall, which was a subject of much interest.

W. R. Sexton, Toronto, showed a set of "Nonpareil" shaking and dumping grate bars, and Mr. Sexton was present in person to demonstrate the merits of these bars.

Power House was on hand to meet its many friends, and was represented by Mr. T. H. Fenner, editor, and Mr. Tressider, advertising manager.

Power, New York, was ably represented by the ever popular Jack Armor, who passed up an engagement in Montreal in order to meet his friends of the C. A. S. E.

Canadian Manufacturer was effectually displayed, and represented by Mr. Gordon C. Keith, Editor.

The Business Sessions

The business sessions of the convention were started promptly at 10.30 a.m., June 22, by the president, Mr. George Moll. Mr. Moll rounded the delegates up and got everything started on time, and carried through with alacrity. A number of questions of interest to the members were brought up, among them being a proposed amendment to the licensing laws. This would have the effect of more strictly defining the word emergency in the Graded Certificate Act, and keeping its interpretation more in line with the spirit of the Act.

Some slight changes were introduced into the preamble of the constitution of the C. A. S. E., and these will be made known to the members of the respective lodges in due course. The subject of closer affiliation with the North-Western Association of Mechanical and Electrical Engineers of Edmonton was also discussed, and it was decided to proceed along these lines.

The sessions were continued daily until the closing day, at which the officers of the Grand Lodge were chosen for the ensuing year. These are as follows:

Past President, George Moll, London.
President, R. C. Leitch, Toronto.
First Vice-President, Fred Harper, Kingston.
Secretary Treasurer, R. J. Ellis, Hamilton.
Conductor, W. Fyfe, Montreal.
Doorkeeper, R. E. Rodney, Ottawa.

John Hale, the retiring secretary-treasurer, becomes an honorary member.

On Tuesday evening a combined educational session and a smoking concert was held in the City Hall, which had been kindly lent by the Mayor and Aldermen of Woodstock for the use of the convention. The Woodstock Lodge provided the necessary smoking material, and the genial Geo. Moll filled the chair, both physically and officially.

Proceedings were opened by the reading of a paper entitled, "A Few Parallel Lines," by Mr. W. H. Auger, which dealt rather cleverly with circulating systems of various kinds.

A very able paper on "Combustion Engineering" was read by Hartley B. Gardner, of Toronto and Boston, and a copy of this will be sent to all members. The reading of the paper was followed by a short speech by Mr. A. M. Wickens, who made several apposite comments on the subject.

The serious part of the session being disposed of, Mr. Geo. Moll upheaved his six feet odd of good humor and comradeship, and called on Mr. "Bob" Jones to lead in a little community singing. Mr. Howard Fletcher proceeded to the piano and the assembled delegates responded right lustily. Following this, Mr. Jack Armor took the stage and rendered his famous monologue. Many of his stories proved just as popular to the audience as they were a year ago. "Jack's" place in the favor of the C. A. S. E. members is so secure that he could probably get an encore by reciting a section of the O. T. A.

While the mere men were thus being instructed and amused, the ladies were entertained at the moving picture theatre, so that nobody was neglected. Everyone retired to their homes and hotels feeling that the day had been well spent and looking forward eagerly to the morrow.

The Big Day

Wednesday, the day scheduled for the picnic, dawned dull and rainy, and when exhibitors and delegates met in the exhibition hall much doubt was expressed as to the chances for the picnic. The delegates went to the City Hall at 10.30 to resume their session, and the exhibitors spent the morning at the exhibition showing their specialties to interested visitors. It was felt for a time that the afternoon sports would have to be postponed, but shortly before noon the clouds cleared away and the sun came out with such vigor that before the time set for the sports the ground was dried up and in great shape.

The picnic and sports were held in the beautiful South Side Park, and the automobile owners of the town lent their cars freely to the visitors, taking them down to the park. Not only this, but a drive round the outskirts was included. Everybody turned out, and the city lent their brand new fire truck, which accommodated quite a crowd. In fact there was nothing the city could do to make things go that was not done.

The sports were under the direction of Mr. E. B. Curzon and Geo. E. Moll. Mr. Moll's dulcet voice came in splendidly on this occasion, as the announcements made by him could be heard distinctly in Brantford.

The first event was a sprint of 100 yards, won easily by Douglas Shearer, and W. H. Worthington second. The time was not given out publicly, but we heard the winner claiming it at 9 3-5. This would seem to be a pretty good gait.

The second event, a 50 yards dash, for the wives of engineers, resulted in a win for Mrs. McCalley, Mrs. Leitch being second. The result was rather surprising, neither of the ladies being of the greyhound type.

The wheelbarrow race resulted in a win for Messrs. Thompson and Worthington, the runners-up being Messrs. Cook and Sexton.

The ladies' clothes-pin race proved full of amusement to participants and spectators. The pins had to be plucked off a line by the teeth, carried to a hat and dropped in without the aid of the hands. The men holding the rope, contrived to keep the pins from being too steady, and the frenzied endeavours of the ladies to get a firm grasp with their teeth were well worth watching. Mrs. Leggodel proved the best, and Mrs. Darville came a good second.

The donkey race for men was a humdinger. The writer thought it an appropriate race for himself to enter, and therefore picked out a partner who looked as though he could bring home the bacon. At the time of entering, the fact that the rider becomes the ridden half way through, was not clear to deponent. The first half of the race, when your editor was riding was fine, but at the half-way mark his judgment in picking a steed came back on him. Said steed, one Peterkin, was rangy of limb, and about 250 pounds on the hoof, and was fine for carrying purposes, but not for being carried. Therefore it was no surprise to the team, when, in an endeavor to make a little spurt, rider and steed collapsed with a loud crash. If it had not been for that we might have won. As it was the winners proved to be Messrs. Watson and Gordon, closely followed by Fyfe and Galloway. The next time the writer goes in for a race of this kind he is going to have two partners, one to carry and the other to ride.

A soap race for married ladies was won by Mrs. G. M. Wilkinson, Mrs. M. O. Fox being second.

Peanut race for unmarried ladies was won by Miss G. DeBrool, Miss Mary Smith being second.

In the men's smoking race, Mr. Pike was first, and the versatile Mr. Worthington second.

The little boys' race was won by Fred Abbott, second being Joseph Kean.

Aquatic Events

Following the running off of the various races, a move was made to the lake side to view the rowing and paddling events. The first of these was a skiff race, there being three entries. The interest in this was somewhat diverted by the fact that each contestant chose a course of his own, which made it something like a three-ringed circus to watch. Mr. Berry caught the judge's eye, and was declared winner.

The great event was undoubtedly the canoe race. There were such glorious possibilities, though much anxiety was displayed by the spectators. This was due to the fact that the course lay around an island, and it was feared that the canoes would upset behind this island, thus robbing the spectators of part of the show. However, much to the regret of all present, no one capsized. When the start was made there were so many bumps and collisions that hopes for a general upset ran high, but these subsided as the contestants gradually cleared away and disappeared round the island. They soon came in view again and spread out over all the water available, the first crew to cross the line being James Noble and S. Shearer, closely followed by L. M. Archibald and Berry. There was considerable noise for a few minutes caused by the unsuccessful competitors explaining the various accidents that happened them. However, order was soon restored, and the victors were toasted in a foaming beaker of "near-beer."

A so-called football match between engineers and supply men wound up the day, the score in this game being 0-0. Some of the players thought different, but the referee being George Moll, nobody had the necessary nerve to argue it out.

A Great Evening

The evening's entertainment in the City Hall was presided over by Mayor A. J. Gahagan, who received quite an ovation when he rose to open the proceedings, the audience singing, "He's a Jolly Good Fellow," and giving three cheers and a tiger. Mr. Gahagan spoke briefly, saying how glad the city was to welcome the convention, and the pleasure it gave the officers and citizens of the city to entertain their visitors. Mr. Moll, in replying, gave expression to the appreciation felt by delegates and exhibitors, of the open-handed hospitality extended by the city. The convention had never before had such excellent quarters and facilities extended to them. Mr. Moll also expressed appreciation on behalf of the delegates to the officers and members of the Woodstock Lodge, who had given so much of their time to ensure the success of the convention.

The programme which followed was excellent in quality and varied in character. Although the programme declared no encores, several of the artists were obliged to respond to recalls. Notable among the numbers was the rendering of "Mother Machree," and "Darling, I Am Growing Old," by Mr. Bob Jones, whose well-manipulated tenor voice showed to great advantage. Two pretty Irish songs by Miss Edna Fowles, and Highland dances in costume by Miss Campbell, also drew encores. Mr. Earl Hethrington's tenor was well displayed and received appreciative applause. The programme wound up with a speech by

Jack Armor, which made the hit of the evening.

The prize drawing then took place following which a most enjoyable dance was held. Miss Watson's orchestra supplied the music and there were many pretty partners to choose from. This event was, to many, the crowning success of the convention.

The Last Day

Thursday, after the previous day's excitement, was calm, and strictly devoted to business. The C. A. S. E. delegates elected their Grand Lodge officers, and installed them during the afternoon. Their names are given earlier in this report. The Exhibitors Association held their meeting, and the following officers were elected for the coming year:

C. B. Turner, Toronto, president.
Grant Cole, Toronto, vice-president.
Lloyd Archibald, Toronto, treasurer.
Robert Jones, Philadelphia, assistant secretary.
Earl Hethrington, Galt, chairman entertainment committee.
A. Betton, Toronto, chairman exhibits committee.
J. Thompson, Montreal, chairman reception committee.

A vote of thanks was tendered to Mr. Bickle, of the Morehead-Bickle Co., for his kindness to the exhibitors in lending motor trucks and other services.

A vote of thanks was also passed to the entertainment committee.

The 1921 convention will be held in Ottawa. The general consensus of opinion is that wherever future conventions are held they will have to "go some" to beat Woodstock.

Following are the officers of the Woodstock Lodge, to whom is due much of the credit for the success of the convention:

J. McCalby, past president.
R. Arnup, president.
J. Precious, vice-president.
J. Dixon, recording secretary.
N. Abbott, financial secretary.
W. Jameson, treasurer.
W. Davidson, conductor.
P. R. Thuell, doorkeeper.
J. Carney, J. Cross and A. Leggo, trustees.

STOKER MANUFACTURERS ASSOCIATION MEETING

At a recent meeting of the Stoker Manufacturers' Association held at Lakewood, New Jersey, the following officers and executive committee were appointed: Sanford Riley, president; M. Alpern, vice-president; A. G. Pratt, treasurer; S. A. Armstrong and H. A. Hatton, J. G. Worker, secretary.

This committee is to meet in New York at an early date to name the standing committees of the organization for the coming year. A vote of appreciation and a round of cheers was tendered to P. A. Poppenhusen, the retiring president.

When asked for a statement after the meeting in regard to his policies for the organization during the coming year the newly elected president, R. Sanford Riley, made the following statement:

"I have always believed that the stoker business is a good one, but it has not even yet taken its proper place in the business world. I have seen it develop from a very crude business, conducted on comparatively low plane, to a large business conducted on a much higher plane. We are getting an increasingly large percentage of able men in the business which makes it good, not only for those in the business but also for our customers. After all, we can profit only as we serve, and the service possible in our business is one of the greatest in any line of business.

"We are no longer the leading propagandist in the art of conserving fuel. The Government seems to have taken over the position and all we have to do now is to live up to the demands made of us.

"Our field is being enlarged every day by economic pressure, and my hope is that we, as an association, may conduct ourselves so as to be worthy of the field."

Mr. J. G. Worker was then asked what his views concerning the Stoker Manufacturers' Association and its usefulness in the trade and to the country generally were, upon which Mr. Worker said:

"As soon as real live business men get together in any sort of a meeting, and their personal efforts are directed towards a common cause, nothing but a definite constructive program can be expected. Just such a meeting was the beginning of the Stoker Manufacturers' Association. The fact that 99 per cent. of the stoker manufacturers of the United States are members of this association is significant. The function of a modern trade association are to furnish information and service to its members that they could not very well get outside and help to educate them, their members and their customers. Associations stimulate the members to improve the quality of their product and the service that they render and the tremendous influence for the industry as a whole is exerted by those associations that maintain a high standard and refuse admittance into the association of any concern who does not come up to the association standards. Whenever any real constructive measure is adopted by the association every one interested in stokers, including manufacturers, salesmen, and customers are helped. One of the things that the associations are doing and going to do is to have every real stoker manufacturer of the United States a member of the association, and emphasize by the character of the association the fact that the association stands for honest merchandising and for putting the stoker business on the highest level of business ethics."

Gates Refractories, Ltd., of Montreal, have recently obtained some good contracts for boiler installations and special firebrick.

INTERESTING BULLETINS

The Wellman-Seaver-Morgan Company, Cleveland, Ohio, have published a very thorough and attractive line of bulletins, covering some of their varied field of activities. The booklets show some interesting installations made by this company and are highly instructive. Following are the subjects which we have so far received:

Bulletin No. 41 deals with coal and ore handling machinery. The W-S-M. unloaders, travelling bridges with grab buckets, car dumpers, car haulages, transfer cars, boat loaders, bucket handling cranes, excavating buckets and weighing lorries are shown.

In Bulletin No. 42, special cranes are illustrated, pontoon cranes for marine work, dock cranes, shipbuilding cranes, cranes for concrete handling, and also some special purpose cranes.

The other bulletins received take up in detail the following subjects: No. 43 goes into the subject of hydraulic turbines; No. 44 shows hoisting and mining machinery; No. 45, steel works equipment; No. 46, coke oven machinery; No. 47, port and terminal equipment; No. 48, rubber machinery; No. 30, W.-S.-M. charging boxes; No. 26, tire running press; No. 18, the operation of a gas producer, and No. 19, superseding No. 13, illustrates their tire applying press.

Bulletin No. 22 gives the relations between power, shaft diameter, torsional stress, and speed of any shaft, and we hope in this latter case to present the charts for our readers' benefit.

All of these bulletins are prepared in splendid style, and we have been informed that they will be sent to anyone interested.

At the conclusion of a tour of inspection of Canadian shipyards Sir James McKenzie, managing director of Vickers Ltd., of England, stated: "I am surprised at the magnitude of these yards and also at the economic layout of the plants, and I have seen the most modern machinery in these plants that exists anywhere today, and for the first time in my life I am ready to admit that there is a great future for the shipbuilding industry of Canada. I have no hesitation in saying that the acquisition of the companies owning these plants is absolutely essential, in my opinion, to the existence of the British Empire Steel Corporation. It will only be following out the same lines as have been adopted by the United States Steel Corporation and our big steel interests in England, where they have control of their shipping and shipbuilding plants."

Molybdenum Steel.—Production rights for the new Arnold high-speed steel method have been acquired by J. D. Moffat, a director of the Sir Thomas Salter Pyne Company, of Sheffield. The company in question is making preparations for placing the new steel on the market at a lower price than tungsten steel.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

By W. F. SUTHERLAND

IN the last section a number of the characteristics of the electric circuit were discussed, and was shown that the flow of electrical energy through a wire had certain characteristics somewhat similar to the flow of water through a pipe. It was found that a property existed somewhat similar to the pressure which causes water to flow through a pipe; it was found that the rate of flow was measured likewise and finally it was also stated that a property, inherent in the wire, existed similar in its effects to the frictional resistance which exists in a water pipe and which retards flow through it.

This lesson will be devoted to the study of these three properties, pressure, rate of flow and resistance, and it will be found that a certain relation exists between the three characteristics of the electric circuit.

The unit of electrical pressure which is in common use for measuring potential or for purposes of calculation, is the "volt," as has already been seen. Similarly, the unit of current flow is called the ampere, and that of resistance is called the ohm.

All these units are more or less based on abstract considerations in their magnitude, and the physicist can go right back to the fundamental units of length mass and time, and can express the units of electrical measurement in these. For our purposes this is decidedly an unnecessary refinement, and we will be quite safe in saying that the units of electrical measurement are to-day fixed in much the same way as those of weight or length—by Government standards.

Starting with the unit of flow we have seen, in the last lesson, that it is the rate of flow which will allow a certain definite quantity of electricity to flow in one second. To cause this flow an electrical difference of potential or pressure must be created, for all circuits have more or less resistance. To this unit of electro-motive force or potential, is given the name of "volt."

To define the volt we must take into account the resistance of the circuit and can consider it measured in terms of the unit—the ohm. The definition of the volt can now follow, and it may be defined as follows. "The volt is the unit of electrical pressure or potential difference which causes a current of one ampere to flow through a resistance of one ohm. The ohm in turn is defined in terms of the resistance of a column of mercury of a very definite length, weight and cross-section.

Also when a current flows through a circuit having a resistance of one ohm and under, a pressure of one volt, the value of the current is said to be one ampere.

When an electro-motive force of one volt causes a current of one ampere to flow through a resistance, the resistance is said to have a value of one ohm.

The law which is implied in the above statements, and in that which follows, is called Ohm's law, and it holds universally true for direct current, although it is only applicable for one particular condition when alternating current circuits are considered.

All three of the above statements are mutually dependent and in effect are merely different ways of expressing the same thing. In algebraic notation they may be more simply expressed, for if we let

E=the electro-motive force in volts;
R=the resistance in ohms;
I=the current strength in amperes;

then

$$I=\frac{E}{R} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$E=IR \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$\text{and } R=\frac{E}{I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

For the benefit of those not conversant with equations to any extent, these may be expressed as follows:

Equation 1.—The current in amperes equals the volts across the apparatus or line divided by the resistance.

Equation 2.—The volts which will cause a current of so many amperes to flow through a resistance of so many ohms, will be given by the product of the number of amperes multiplied by the number of ohms in the resistance.

Equation 3.—The resistance in a circuit which has so many amperes flowing through it can be found by dividing the voltage by the number of amperes flowing through it.

An example or two will serve to show how this law may be applied to an electric circuit of a simple kind. In Fig. 7 is shown a complete generating and transmission system in miniature. A generator is shown, transmission lines are shown and a means for utilizing the energy is also installed at the end of the line remote from the generator. In the figure, the resistance of all the separate parts is also indicated. It may here be remarked that the resistance of the generator must be figured in, since although it supplies the energy, the current must flow through it as well as the rest of the circuit.

If the generator is generating electrical energy at 110 volts pressure and we wish to obtain the number of amperes flowing through the circuit, this can be done as follows:

The total resistance is $6+5+5+7=23$ ohms, the voltage 110, and since

$I=\frac{E}{R}$, dividing 110 by 23 we obtain

4.77 amperes as the answer.

If we put an ammeter on the circuit and found 5 amperes flowing through the circuit and knew that the resistance was 23 ohms as before, it would be possible to find the voltage generated.

$E=IR$.

Multiplying the 5 amperes by the figure denoting resistance, we would obtain $5\times23=115$ volts.

Or, if the resistance were unknown but we could find the number of volts and the number of amperes, it could readily be found. Let us suppose a voltmeter registered 100 and 5 amperes were flowing through the circuit. Then since

$$R=\frac{E}{I}$$

dividing the voltage by 100, by the amperage, 5, we would obtain 20 ohms for the resistance.

In Fig. 7 and in the descriptive matter which dealt with it, a complete circuit was dealt with. It is also possible to use ohm's law when dealing with only part of a complete circuit, as shown between A and B, Fig. 8. A resistance is shown and it is desired to find the number of ohm's value it has. A voltmeter is connected in the circuit across the ends of the resistance and an ammeter is also inserted in the main current. If the generator or other source of energy is connected in the circuit, two readings will be obtained, the current strength and the voltage across the resistance. Ohm's law will give from these two quantities the value of

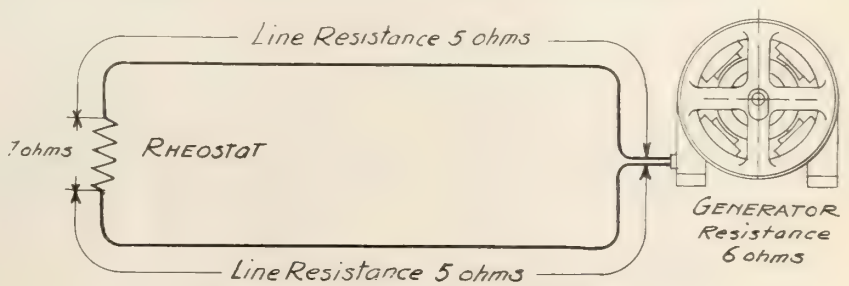


FIG. 7.—EXAMPLES OF A SIMPLE CIRCUIT.

the resistance directly, for $R = \frac{E}{I}$. For instance, should we find that the voltmeter indicated 10 volts, while the amperes were 5, the resistance would have a value of $10 \div 5 = 2$ ohms.

The connection shown in Fig. 8 gives a very convenient method of finding the value of resistances, and is very useful. It should be remarked, however, that the reading of the ammeter in the connection shown includes the very small current taken by the voltmeter, and this must be allowed for if fairly accurate results are desired.

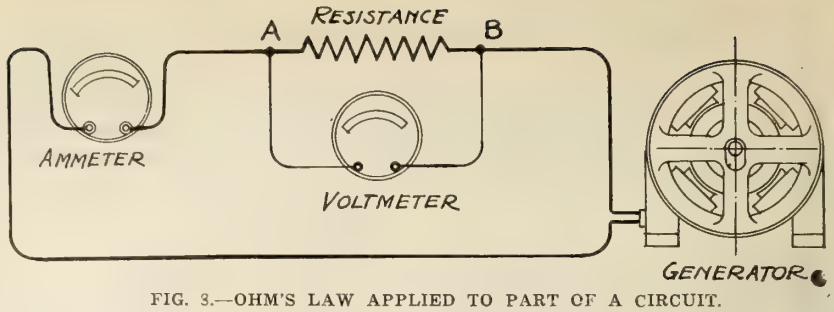


FIG. 3.—OHM'S LAW APPLIED TO PART OF A CIRCUIT.

Various Types of Electrical Circuits.

The complete path through which an electric current flows is called a circuit; this circuit may be a closed one, in which case the current has a complete path and flows with only whatever resistance may be present to impede its flow. Or a switch may be opened, and since a break has been created in the circuit no current will flow, in this case an open circuit is said to exist. Short circuit is a term given to an accidental connection between two parts of a circuit which cuts out a large amount of the total resistance and in consequence allows a large current to flow, frequently with disastrous effects.

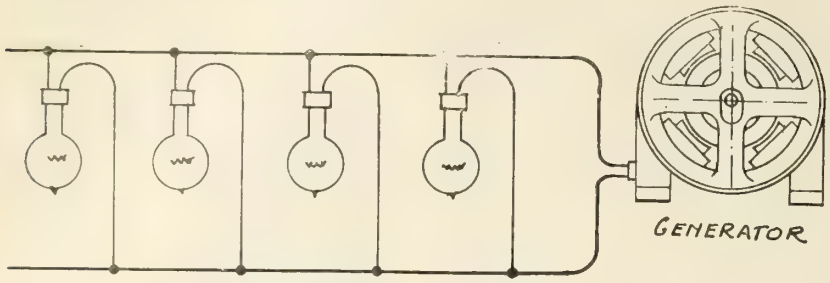


FIG 9.—EXAMPLE OF A SERIES CIRCUIT.

A circuit is said to be grounded when one of the conductors is connected to the ground in some manner, either by accident or design. Accidental grounds on machines or lines give rise to much trouble at times, when conditions are right for the flow of current through them instead of in the proper channels.

It is possible to dispense with one leg ground connection at each end of the line. When this is done the earth acts as one side of the line. The early telegraph and telephone systems were almost invariably built this way but complete metallic circuits are more in favor at the present time.

The rails are used in street railway work for the return conductor, and if well bonded together serve admirably for the purpose. If the bonding is poor however, serious trouble is likely to arise through stray currents leaving the rails and using water mains, etc., as conductors. In this case where the current leaves the mains, electrolysis occurs and the metal is rapidly eaten away.

Electrical circuits are of bewildering complexity at times, and to one unaccustomed to their tracing out, offer many difficulties. While this is true, the majority of circuits can be resolved into two kinds, or a combination of them, and a familiarity with these types enables one to readily understand the computations and design of circuits in general.

Figure 9 shows a generator feeding a load consisting of five lamps. By starting at the generator and following the connections through, it will be seen that the current must flow through first one lamp and then the next and so on, finally leaving the last one in the series and returning to the generator. A circuit of this type is called a series circuit since the current must flow through all the lamps in series. If we suppose the lamps to each have a resistance of 50 ohms, by multiplying this value by the number of lamps we would arrive at a value of 250 ohms for the total resistance. If now the generator was delivering current at a pressure of 500 volts, the current would be $500 \div 250 = 2$ amperes. Series circuits were quite frequent in the days of the old arc lamp, and while the current carried was very moderate, the voltage generated by the dynamo was often quite high, several thousand volts. A similar type of circuit is also in use to-day in smaller towns for tungsten lights. Here a current of say five amperes is used, and the voltage is automatically regulated to keep this value constant. Circuits of this type are often called constant current circuits.

Fig. 10 shows another arrangement of the generator and the five lamps. In this case the current leaving the generator splits into five parts, and each lamp takes a portion of it. If we had five amperes at the generator, and only one would flow through each lamp.

While in the case of figure 9 the voltage would have to be varied to keep the current strength constant for different numbers of lamps, in the case of Fig. 10 this no longer holds good. Let us suppose we have the five lamps in circuit and each one of them requires one ampere, the total current supplied by the generator would be $1 \times 5 = 5$ amperes. If one of the lamps were cut out, then only four amperes would have to be supplied, and at the same, or nearly the same voltage. This type of circuit is called the multiple circuit.

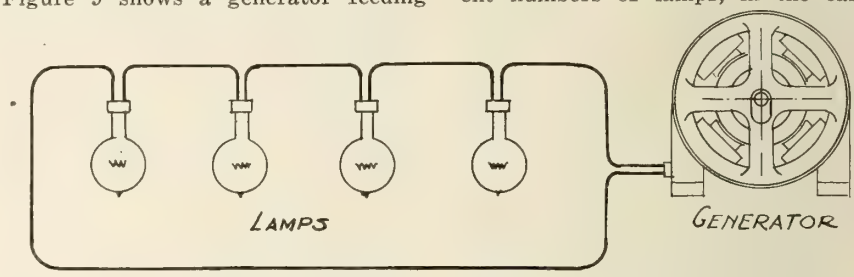


FIG 10.—EXAMPLE OF A MULTIPLE CIRCUIT.

A combination of the two types of circuits is possible, and is shown in Fig. 11. Four lamps and one motor are shown connected to the generator. Two lamps are connected together and their outside terminals are connected to the lines while the motor is connected in by itself on the lines. If the voltage generated is 220, it will be seen that while each group of two lamps has 220 volts

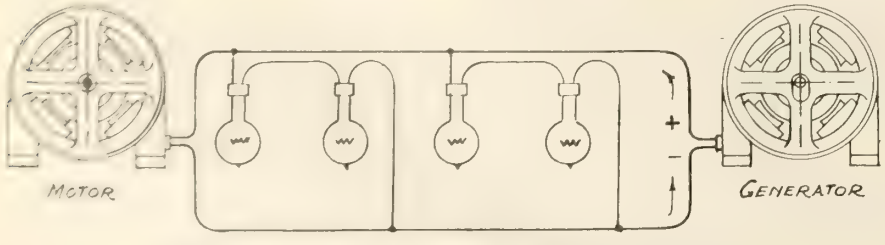


FIG. 11.—EXAMPLE OF A SERIES MULTIPLE CIRCUIT.

across the outside leads, each lamp will have only half of this, or 110 volts. The motor will have the full voltage or 220 volts, across its terminals. Each group of two lamps forms a series circuit, while the two groups of lamps and the motor form a multiple circuit. The combination is called a multiple-series or series-multiple circuit. The multiple circuit is also called the parallel circuit, and the two terms are used interchangeably, as are series-parallel and series-multiple.

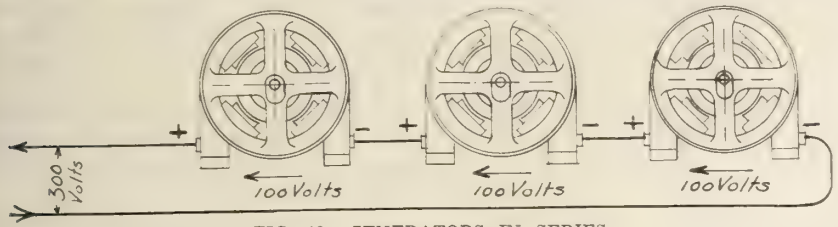


FIG. 12.—GENERATORS IN SERIES.

The Grouping of E. M. F.'s

The above examples have only dealt with the arrangement of lamps or other current consuming devices in series or parallel. It is possible, and is being done every day, to group generators or other means of creating electrical energy in a similar way. Fig. 12 shows three generators connected in series, and before discussing the results obtained from this grouping it may be well to take up the question of current flow. From various actions of the electric current on liquids through which it flows, and through its relation to electro-magnetism, it is surmised that the current flows in one direction or the other, and, while it is doubtful as to which direction it really takes it is assumed that the carbon pole of a battery is positive and the current flows from it and in at the zinc again. Polarity is indicated frequently by plus and minus signs, and the sign (+) means positive, while (—) is negative. The three generators shown in Fig. 12 all tend to make the current flow the same way as shown by the arrows underneath them. Each one of them is supposed to be generating current at 100 volts, and the combined result of their action is the build-

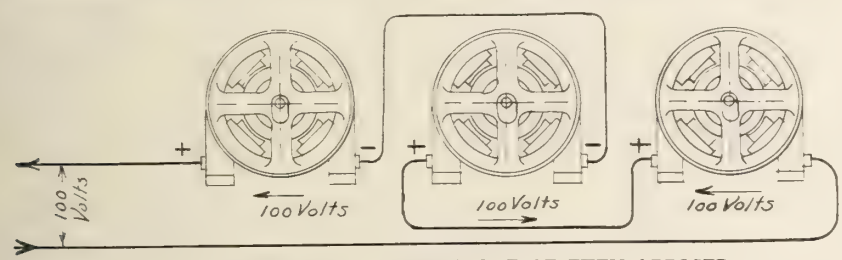


FIG. 13.—GENERATORS IN SERIES, ONE OF THEM OPPOSED.

to the remaining one, 100+100—100=100 =300 volts.

Fig. 13 shows the same arrangement except in that one of the generators has been reversed, and is now opposing the other two. In this case two of the generators neutralize each other and the voltage generated is only that due to the remaining one, or 100+100—100 =100.

In the case of a series connection such as above, it should be noted that the current strength does not change by the addition of more generators, but the voltage does.

A form of series connection which is of very common occurrence is shown in Fig. 14. A generator charging a storage battery has its positive terminal connected to the positive terminal of the battery, for while the battery is discharging current flows out of the positive terminal, when on charge conditions are just reversed and current is lead in at the same point.

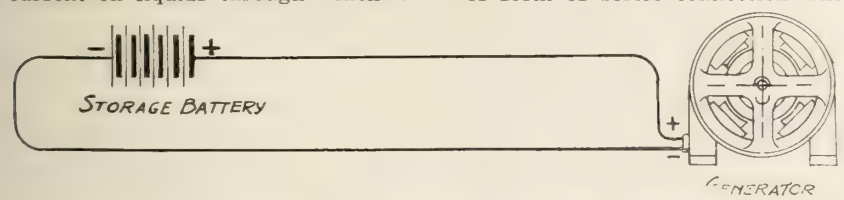


FIG. 14.—ELEMENTARY BATTERY CHARGING DIAGRAM.

Generators can be, and are quite frequently, arranged in multiple. Fig. 15 shows a connection of this type. If each of the two generators is furnishing 25 amperes at 110 volts, then the line current will be 25+25=50 amperes, while the voltage remains the same, namely 110 volts. If one of the generators had its leads reversed it would act as a motor and would supply no energy whatever.

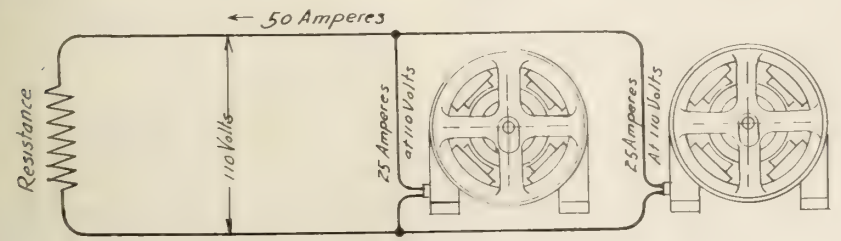


FIG 15.—GENERATORS IN MULTIPLE.

HANDY RULES FOR BELTING

Rules for finding length of crossed belts:—First, find the length of straight belt. Square each the diameter of the large pulley and distance between centres. Add together and extract equare root of sum. Subtract from this the distance between centres. Multiply the remainder by two and add to length of straight belt as previously found. The result will be the length of crossed belt.

As a belt depends entirely on its power of adhesion to the pulleys to perform its function, see to it that its power of adhesion is maintained at the maximum by not overloading, and by the consistent use of suitable belt dressing, sparingly but regularly applied. Do not allow the dressing to clog on the pulleys. As belt slip is such an insidious danger—it makes no noise—and may be going on unsuspected until irretrievable damage has been done to the belt. Begin the application of belt dressing immediately the belt is put into use.

Rules for Finding Length.

When it is not convenient to measure with the tape line the length required, the following rule will be found of service: Add the diameter of two pulleys together, divide the result by two, and multiply the quotient by 3 1-7; add the product to twice the distance between centres of the shaft and you have the length required, substantially. If one pulley is considerably larger than the other, a little extra allowance should be made, because the distance from the centre of the top of one to the centre of the top of the other is a little greater than the exact distance between the centres of the shafts.

To ascertain the number of feet in a roll of belting: Add diameter of roll in Multiply the result by the number of inches to diameter of hole in centre. coils in roll, and then by 132; the three left-hand figures being the number of feet in roll.—*Belts.*

According to Wireless World there are three wireless direction-finding stations being erected at the mouth of the Mississippi River for the purpose of directing ships to New Orleans. Eight stations of this nature are also in course of construction along the Pacific Coast from San Diego to Alaska. One station, that on the Farralone Islands, is nearly completed. The sites of the other seven are at Pt. Reyes, Bird Island, Pt. Montara, Pt. Hueneme, Avalon, Pt. Firmin, and Imperial Beach.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE dealt in our last article with the square root, and now will proceed with the more complicated and tedious process of finding the cube root. We would again take the opportunity of recommending readers to familiarize themselves with the use of tables for this work. It is a good thing to know how to extract cube root in the ordinary way, but no busy man has got the time to go through its labored processes. The use of tables also reduces the risk of error, especially in quantities involving the roots of decimal numbers.

In extracting the cube root, the number is divided into periods of three figures each, instead of two, as in square root, beginning at the unit figure, and going to the left. The figures would be pointed off thus:—

1231456

The first step is to find a number whose cube is smaller than the first period, and this number will go in the quotient as the first figure of the root to be found. The cube of this figure is then subtracted from the first, or left-hand period, of the number, and the remainder set down. The next period is then brought down in line with the remainder, and this forms the next dividend.

The procedure so far would be as follows. Suppose we have to find the cube root of 15625. Point off into periods:

151625

Then find a number whose cube is less than 15. The cube of 3 is $3\times3\times3=27$, which is too high. The cube of 2 is $2\times2\times2=8$, which will do, as it is less than 15. Then we have

```
151625(2
  8
  --
 7625
```

The next thing is to find a divisor for 7625. To obtain this the first figure of the quotient is squared, and then multiplied by 300. This is the trial divisor. The quotient is put down after the first figure of the root. To complete the divisor, the two figures in the root are multiplied together, and the product multiplied by 30 and added to the trial divisor. The second figure of the root is squared, and also added to the trial divisor.

The sum of these operations must be multiplied by the second figure of the quotient, and the product subtracted from the remainder. If the product is greater than the remainder, the second figure of the quotient must be reduced by one, and the trial divisor altered accordingly. Let us apply these rules to the example we have:

```
151625(26
  8
  --
 7625
2×2×300=1200
2×6×30 = 360
  6×6  =  36
       ----
       1596
```

Here we have taken 6 as the second figure of the root, and used it in the operation of finding a trial divisor. The sum of the various factors of the divisor is 1596, and a glance shows that when this is multiplied by 6 the product will be greater than the remainder. We must therefore reduce the second figure of the root by 1, and try again:

```
15625(25
  8
  --
 7625
 7625
 ----
2×2×300=1200
2×5×30 = 300
  5×5  =  25
       ----
       1525
```

This divides out exactly, and the cube root is 25.

The rule as worked out above can be stated briefly as follows:

Divide the number whose root is to be found into periods of three figures each, starting from the unit figure. Find a number whose cube is less than the first period and this figure will be the first figure of the quotient, or root. Subtract its cube from the first period, and bring down the second period, which, with the remainder, forms the next dividend. To find the second divisor square the first figure of the quotient, and multiply it by 300. The product forms the initial trial divisor. The quotient of this trial divisor must be set down after the first figure of the quotient, forming the second figure of the root. To the initial trial divisor add 30 times the product of the first and second figures of the quotient, and to these add the square of the second figure of the quotient. The sum will be the final trial divisor, and is multiplied by the second figure of the quotient, and the product subtracted from the remainder. If the product is too large to subtract from the remainder, reduce the second figure of the root or quotient by 1, and correct the factors of the trial divisor accordingly.

It will be readily appreciated that unless one is using these rules very frequently, they cannot be retained by the ordinary memory. It can also be seen that there are lots of opportunities for error, in the various calculations to be made. It is a notable fact that it is very rarely one finds a designer or mathematician who can find cube root by the ordinary rules. They invariably use tables or logarithms.

We will give a few more examples of cube root, to familiarize the reader with the process, and will then leave it with no regrets.

To find the cube root of 764,839,412, we divide off into periods, and find the first figure of the quotient, which will be 9:

```
                                764,839,412(914.4
                                729
                                ---
  9×9×300=24300                 35839
  9×1×30 =  270
    1×1  =    1
           -----
           24571                24571
                                -----
 91×91×300=2484300              11268412
 91×4 ×30 =10920
    4×4   =   16
           -------
           2495236              9980944
                                -------
914×914×300=250618800           1287468000
914×4 ×30 =  109680
    4×4   =      16
           ---------
           250728496            1002913984
                                ----------
                                284554316
```

We could safely say that the cube root is 914.5. If this is multiplied out, it will be found its cube is not quite in agreement with the number, but the discrepancy can be reduced by taking further places of decimals.

To find the cube root of a decimal number, proceed the same way. Suppose we want the cube root of .5. In order to have the necessary three figures add two ciphers to the .5, making it .500. Then the first figure of the root will be .7. Thus:

```
                                .500(.7937
                                343
                                ---
  7×7×300=14700                 157000
  9×7×30 =  1890
    9×9  =    81
           -----
           16671                150039
                                ------
 79×79×300=1842300              6961000
 79×3 ×30 =   7110
    3 × 3 =      9
           -------
           1849419              5548257
                                -------
793×793×300=188654700           1412743000
```

The cube root of .5 is therefore .7937. Let us multiply this out to see how near it comes:

.7937
.7937
55559
23811
71433
55559
62995969
.7937
440971783
188987907
566963721
440971783
.499999005953

We see it is practically correct.

If we want the cube root of .005 we find the nearest cube to 5 first, as we have three figures after the decimal point. The work would be then as below:

.005(1709
1

1×1 ×300= 300 4000
7× 1×30 = 210
7× 7 = 49
559 3913

17×17 ×300= 86700 87000000
170×170×300=8670000
170×9 ×30 = 45900
9×9×300=24300 35839
8715981 78743829
.8256171

The cube root is .1709. Proving this by multiplying out we get:

.1709
.1709
15381
11963
1709
.02920681
.1709
26286129
20444767
2920681
.004991443829

which is almost exact.

It will be noted that there is a cipher in the root at the third figure. This occurs on account of the trial divisor, 86700 being too large to divide into the remainder. When this happens in any problem, add a cipher to the root and bring down three more figures in the remainder, and proceed as before.

The cube root of a fraction is found by taking the cube root of the numerative and denominator separately. Thus would be written thus:

the cube root of $\frac{125}{512}$ would be $\frac{5}{8}$ and would be thus:

$$\sqrt[3]{\frac{125}{512}} = \frac{5}{8}$$

If the fourth root of a number is required, the square root of the square root is taken. If the 6th root is required the cube root of the square root, or the square root of the cube root, is taken. or any higher roots or powers it is advisable to use tables.

The writer thinks that the preliminary ground has been covered fairly well, but if there is any point not clear to a reader, he will be glad to explain it in more detail. We will now be able to take up in the next articles definite problems relating to the requirements of the various certificates.

A CORRECTION

In the issue of June 5th, in the article on Instructions for Graded Certificates there is an error in the solution of one example. This is in the solution of the statement.

$$\frac{\frac{7}{16} \div \frac{3}{8} \div \frac{9}{27}}{\frac{5}{32} \times \frac{7}{8} + \frac{1}{2}} \div \frac{3}{4}$$

In solving the terms of the numerator of the compound fraction for the new numerator the two first turns were added before the division was performed. This is wrong as the division is merely multiplication with the terms reversed, and the two turns connected with the division sign should be simplified first.

This would then be solved as follows:

$$\frac{7}{16} + \frac{3}{8} \times \frac{27}{9} = \frac{7}{16} + \frac{81}{72} = \frac{7}{16} + \frac{9}{8} = \frac{7+18}{16} = \frac{25}{16}$$

which makes the sum

$$\frac{\frac{25}{16}}{\frac{163}{256}} \div \frac{3}{4}$$

or $\frac{25}{16} \times \frac{256}{163} \times \frac{4}{3} = \frac{111}{489}$, which is the corrected result.

In the statement that terms connected by a multiplication sign must be simplified before others, division is included, as to divide we transpose the numerator and denominator and multiply.

Coming From Germany.—According to an Ottawa despatch the articles being imported from Germany into Canada at the present time are chiefly metal, for use inclusively in mining or metallurgical operations, machinery composed wholly or in part of iron or steel, and iron or steel integral parts thereof, musical instruments and precious stones, while the importation from Austria is practically confined to electric insulators. This information was given in answer to a question by Fernand Rinfret (St. James, Montreal), in the House of Commons.

HYDRO-ELECTRIC ENTERPRISE

One of the largest electrical manufacturing groups in Great Britain has made efficient preparations for undertaking complete contracts for Hydro-Electric enterprises. The business of a prominent firm of water-power engineers and contractors has been acquired in order to provide facilities for making the largest sizes of water turbines, while the resources of the group are available for the electric generators, the construction work, the transmission of power, and all the other sections of Hydro-Electric work in any part of the world. Valuable patents have been acquired in connection with this development. A French company associated with the group is undertaking the construction of water turbines with a total output of 300,000 kilowatts, two hundred electrical locomotives, and other electrical machinery required in an important scheme of railway electrification.

ARMOR PLATE SCRAP AT SANDY HOOK

The Oxweld Acetylene Company, of Newark and Chicago, which was recently awarded the Government contract for cutting 4,000 tons of armor plate scrap to charging box size at Sandy Hook, now has a crew of oxy-acetylene cutter on the job. The plates, 3 in. thick by about 9 ft. by 13 ft., weigh between seven and eight tons each, and are being cut into sections 13 in. by 25 in., each weighing around 300 pounds. The weights vary somewhat owing to the necessity for cutting through the shell holes, each plate having been punctured six times by heavy artillery shells for which they were made the targets in the big gun tests conducted at Sandy Hook during the war.

This is one of the largest jobs of the kind that has ever been undertaken and several weeks will be necessary to complete the work.

New Cockshutt Warehouse.— The Cockshutt Plow Co., Ltd., who for the past four years have had their offices over the C. N. R. Telegraph office in Edmonton, are erecting a two-story brick building with a full concrete basement on 9909,102 A. on Rice street, opposite the city market square. The building will be fifty feet wide and eighty-five fet long. The main floor will be used as a display room, while the second floor will be used entirely for offices, from which all of the company's work for central and northern Alberta will be directed. Manager Fred Pickles says that business in the machine line this year is better than ever, and that the prospects for the future are better than at any time during the five years that the company have had their offices located here. With a display room in the centre of the city he expects that they will be able to more efficiently handle the local trade.

Some Points on the Theory of Combustion

A Paper Read Before the 31st Convention of the Canadian Association of Stationary Engineers—With Special Notes on the Selection of Suitable Mechanical Stokers.

By H. B. GARDNER

THE present practice in boiler-room operation has been virtually forced upon the engineer, this being largely due to the advance in coal costs and other operating costs. The increase in operating economies has stimulated further effort to effect still more favorable conditions. New coal-burning plants (exclusive of those burning prepared coal) are being erected, which will yield an overall boiler efficiency of from 75 to 83 per cent. The majority of the older plants, however, are not enjoying such economy. Nevertheless, except where a plant is economically obsolete an operating efficiency of less than 75 per cent is unnecessary. Adjustments may be made, improved attachments applied, and inteligent supervision and care required. Since the obtaining of heat energy at high potential is the first requisite for boiler operation, it is apparent that the success of the plant is contingent upon the economy realized in this process. It is therefore my intention to mention combustion conditions, possibilities, achievements, and recommendations, and to submit them to you for confirmation or question. I shall not touch upon effects which are not direct functions of the burning of coal or the manipulation of the resultant products.

The losses that may result from the burning of coal under a boiler are (1) that due to combustible in the ash; (2) that due to incomplete combustion; (3) that due to excess air; (4) the stock loss; (5) that due to the deposit of soot and clinker on boiler tubes, and (6) radiation from the grate and settings.

The heat lost due to unburned coal or carbon, a loss sometimes approaching 10 per cent. of the total heat value of the coal-fired, is dependent largely upon the mechanical design of the stoker or grate and the condition of the coal, though with hand-fired furnace the care in firing is a determining factor. Since a great deal of the sifting occurs very shortly after the coal is fired it has been found that in many cases a decrease in this loss of from 2 to 5 per cent. has been obtained by a preliminary moistening of the coal. Within the limits of 0 and 5 per cent. an increase of 2 per cent. of moisture on or in coal increases the stack loss by only 1 per cent. A decrease in absorption efficiency due to the reduction of furnace temperature when additional moisture is present must also be taken into account. The decrease in sifting loss, nevertheless, usually overbalances the additional losses incurred from moisture content. It is also found that by increasing the thickness of the fuel bed other conditions permitting, a reduction in sifting will result. This loss is a source of aggravation and annoyance to the boiler engineer, and I sincerely hope that a grate, and more especially an automatic stoker, may be designed which will practically eliminate it and yet preserve the advantages now enjoyed.

Loss, due to incomplete combustion, is usually of small import when considering the combustion of the ordinary coals, for practice recognizes that within limits the elimination of CO is to be preferred to the sacrifice of excess air. When the furnace is in good operation—that is with 10 per cent. or more CO_2—for each per cent. of CO in the flue gas a loss of 6 per cent. of the heating value of the combustible will be suffered. For a decrease of 1 per cent. in CO_2 in the flue gas (under this same operation) approximately 1½ to 2 per cent. of the fuel value will be lost. Engineers, therefore, prefer comparatively low CO_2 to the presence CO. As I shall later mention the practice of reducing CO_2 to prevent CO is for the most part not necessary.

Of the combustion of hydrocarbons in coal very little is understood. Most gas sampling apparatus does not separate them from the nitrogen, for until recently the effects of their presence was considered negligible. Investigations are now being made with a view to obtaining definite data as to their relative importance. Their effect is, nevertheless, small, though perhaps not negligible, since the unconsumed hydrocarbons should be small in quantity, and, moreover, as their ignition temperature ranges from 900 to 1,200 degrees Fahr., far below ordinary furnace temperatures, they should be completely burned unless there is excessive stratification of the gasses.

Many Boilers Set Too Low

Neglecting the effect of sulphur, the maximum CO_2 that can be obtained from the combustion of coal with air, may be computed from the expression

$$M = \frac{21}{1 + 2.38} \cdot \frac{(H - \frac{1}{8}O)}{C}$$

where H, C, and O, represent respectively percentages of hydrogen, carbon and oxygen in the coal, as determined from the ultimate analysis. A small percentage of CO_2 represents excess air. It has been found in many plants that complete combustion could not be attained without an unreasonable amount of excess air. This trouble may usually be attributable to a restricted combustion chamber; either a bridge wall too far forward or a boiler set too low. The general tendency is to raise the boiler, and where this has been done a marked improvement has been noted. Some water tube boilers have been raised to 12 feet above the grates. It is reasonable that with the overloads carried in modern plants the combustion space should be bigged than that which was designed for the rating of the boiler, for the older installations were made with very little, if any, allowance for overload. The more excess air, the lower is the furnace temperature and the greater is the loss of heat due to the escapement through the stack. When the CO_2 is less than 10 pe rcent. at ordinary stack temperatures, the stack loss increases rapidly. At 6 per cent. CO_2 with a stack temperature of 500 degs. Fahr. this loss is approximately 30 per cent. At 8 per cent. CO_2 it is 23 per cent.; at 15 per cent. CO_2 it is 12 per cent. These figures clearly show the necessity of obtaining as high CO_2 as possible.

How to Test Effect of Soot and Clinkers

The effect of the presence of soot and clinkers on boilers tubes is apparent. A good test for ascertaining the extent of this effect is to take the flue gas temperature before and directly after cleaning the boiler tubes. If the inside scale of the tubes is negligible a marked reduction, sometimes 50 deg. Fahr., is noted. Scrapers for the lower tubes, and soot blowers throughout should be applied to every boiler. The difference between the flue gas temperature and the steam atmosphere depends on the condition of the boiler tubes, the velocity of the gases around them, and the location and arrangement of the baffles. The stack loss is, therefore, a function of the boiler with the exception that the velocity of the gases depends upon the amount of excess air required for combustion. The maximum boiler efficiency occurs at comparatively light loads, whereas the maximum combustion efficiency is obtained with most stokers at about 125 to 175 per cent. rating. As the variation in the boiler efficiency is slight between rating and 100 per cent. overload, the maximum overall efficiency is ordinarily reached between 125 and 175 per cent. rating. When, with increase in load, the stock loss increases more rapidly than does the gain from higher combustion temperature the efficiency falls off. Incidentally, inclined baffles are found to reduce stack temperature and thus increase the boiler efficiency.

Radiation losses, which amount to from 1 to 5 per cent. in ordinary settings, are dependent upon the lagging. Leaving a dead air space in the wall has been tried with some satisfaction, though a live air space has proved much more beneficial. By passing combustion air through those portions of the

side and bridge walls which are in contact with or directly above the fuel bed, much of this radiant heat is reclaimed. If this air, moreover, is admitted into and directly above the fuel bed through openings in the wall a much greater advantage still is to be obtained. The high cost of clinkers on furnace walls is well recognized; its deteriorating action on the walls, its clogging effect on the fire, and its assumption of grate area which could otherwise be utilized are some of its main undesired results. By passing air through the brickwork on the side walls a cooling of the brick results, and an adhering surface for the clinker is thereby eliminated. A CO_2 increase of 2 per cent. has many times resulted from the better air distribution possible with the absence of side wall clinkers. A decrease in side wall radiation is also observed.

As these losses are largely dependent upon the type of grate or stoker employed it might be well to give a brief discussion on the stoker situation. It may be said that stokers designed for the work expected of them, installed with intelligence, properly handled with reasonable attention and consideration are admitted to be a great saving device. It is unfortunate that a stoker cannot be economically designed for the conditions existant in a specific plant. Although a number of different types of stokers are available there are few cases in which complete satisfaction is found. Great care is therefore necessary in the selection of a stoker, for it is preferable to have a hand-fired grate to a misplaced stoker. Such a stoker is a detriment to the pant. Many such examples are, unfortunately, existent. A slight discussion of the advisable choice of stoker for prevalent coals and definite service is therefore warranted.

Data on Canadian Coals

Canada has the second highest coal reserve of the countries of the world, this reserve totalling aproximately 1,270,000 millions of tons, consisting of 2,000 million tons of anthracite, 284,000 million tons of bituminous, and 984,000 million tons of sub-bituminous, brown coal, and lignites. This shows that the majority of the domestic coal is of the coking and high ash varieties. Professor Parr, of the University of Illinois, has specified the distinction between coking and non-coking coals. He states that if the heavier hydrocarbons (tar products) flow at a temperature below which they volatilize, the coal is a coking coal; if they volatilize first, the coal is non-coking. Most Canadian coals come under the class of coking coals. The ash content of Canadian coals varies from as low as 3.8 per cent. in the case of a coal of 16.9 per cent. moisture and 38.6 per cent. other volatile matter, to 34.2 per cent. ash with a coal having 13.4 per cent. moisture, 22.6 per cent. other volatile matter, and only 29.8 per cent. fixed carbon. The coal of highest heat value in the Dominion (14,500 B.T.U. per pound) which is found in the Crows Nest seam in British Columbia has 1.65 per cent. moisture, 6.49 per cent. ash 23.68 per cent. volatile, and 67.70 per cent. fixed carbon. This is, of course, a very good fuel. Until recently it has been common practice to import coal, mostly from the United States, it being possible to obtain the coals desired. The likelihood of a continuance of such conditions is somewhat meagre. It will, therefore, be necessary to utiize the Canadian coals and equipment should be designed especially for their consumption.

The coals which have been used in the East are mainly the semi-bituminous and bituminous coals from West Virginia, Pennsylvania and Maryland. This coal can be successfully burned in the overfeed, inclined underfeed, and some types of single retort underfeed stokers. The ordinary chain grate does not apply with this coal on account of the coking and consequent binding of the fuel bed. Some chain grate stokers have coking plates and pushers which are intended to agitate the fuel after it cokes, and in some instances such installations have proved generally satisfactory. Because of the usual thin bed carried by such stokers, however, many holes are often left between coke lumps, and this causes an excessive air stratification through the combustion chamber.

Use of Stokers Efficiently

For most industrial service when high overloads are not expected to occur, an overfeed inclined grate is very often economical. The chief advantages in such cases are in the saving of auxiliary steam and in the decrease in sifting, this latter condition being due to the fact that very little coal reaches a grate bar or tuyere before coking has occurred. Where, however, great flexibility and overloads of more than 100 per cent. are to be expected, the multiple retort inclined grate underfeed stoker is far more advantageous. The efficiency of this type of stoker will also drop off rather rapidly at high overloads, but since such overloads are usually of short duration, the saving in overhead of additional units predominates. The majority of central stations operate with this type. The sifting in the inclined underfeed stokers has been somewhat excessive, but these stokers are, nevertheless, the general favorite.

The chain grate finds its greatest application in the burning of lignites and such sub-bituminous coals. This is not due, however, to the general satisfaction of this type for such coals, but rather to the lack of any suitable design. The lignite coals present quite a distinct problem for furnace and stoker design. Their high volatile content causes a long flame which requires a long combustion chamber and at the same time necessitates a chamber which is able to offer good radiation to preserve satisfactory combustion. Attempts have been made to use a distinct coking chamber and separate gas burning chamber. I consider this method to be along the right line, though a great deal of soot has resulted with such installations, due to premature cooling of the gases. This could be relieved by a small secondary fire burning anthracite or a good grade of semi-bituminous coal in the gas burning chamber. Lignites could in this way be burned in an approximate ratio of 5 to 1 of the anthracite. The application would, of course, depend upon factors such as space available, excess equipment, and furnace construction costs. I have never heard of a plant utilizing this idea, but believe it feasible.

In connection with the installation of any stoker, the various costs incurred should be borne in mind. These costs may be classified as follows:

1. Purchase cost of equipment.
2. Installation cost.
3. Maintenance cost.
4. Cost of shut-downs.
5. Cost of labor.
6. Losses in the equipment.

It is the sum of these costs which should present a minimum in order that a particular stoker be chosen. The small points of any stoker in which trouble is found may usually be adjusted after familiarity with the operation has been acquired, but the main points of operation should be very carefully analysed, and if knowledge of operation in existing installations is not at hand, engineering advice should be obtained. Too many plants stand to-day as the so-called "horrible examples" of attempts at progressiveness without reasonable assurance of results.

Remember that the salesman of a stoker manufacturing concern can conclusively prove that any particular stoker is the best for your service.

DUPLICATE BELTS

In a color and paint factory there were in service a number of grinding and pulverizing machines. These machines were belt-driven, and because of the excessively hard service to which they were subjected, as well as the unfavourable working conditions, difficulty was frequently experienced with broken belts. The belts often broke open at the joints, when an abnormal stress was produced. As a rule, this resulted in the shutting down of the machine for a half-hour or so while the millwright was sought out and the belt fixed up and put back in service. These breakdowns usually tied up other operations, too.

The millwright finally hit upon the following scheme: He made up duplicate belts for all of the machines that gave trouble, fitted these belts upon the pulleys, and then took them off and hung them in closets adjacent to each machine. Then when the belt in service broke the machine operator had only to go to the closest, get out the duplicate belt and slip it onto the pulleys, involving a tie-up of but a few minutes. The broken belt was promptly fixed up by the millwright, and put back into the spare belt closet for future use.

While this plan ties up a little money, it eliminates delays in connection with the grinding operations, and can well be duplicated in other establishments where troublesome belts are found.—*Factory.*

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone 8971 Rector. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, JULY 5, 1920 No. 13

PRINCIPAL CONTENTS

Power Plant Features of the Canadian Ford Co.	301
Description of a Large New Gas Engine	307
31st Convention Is Now History	310
The Theory and Practice of Electricity	313
A Course of Instruction	316
Some Points on the Theory of Combustion	318
Editorial	320
Progress in New Equipment	322
Our Question Box	324

The Fuel Problem

AN item in the news from Montreal discloses the fact that a shortage of fuel is causing great inconvenience there. Montreal uses large quantities of soft coal, which in the years before the war was shipped up the St. Lawrence in ample quantities to supply the needs and furnish a substantial reserve. In those days the methods of using coal which have largely contributed to the present shortage were very much in evidence, not only in that particular district, but all over the country where coal was used. During the strenuous days of the war a great cry for conservation was raised, and our Government came very nearly achieving something in the direction of teaching fuel users better methods.

With the passing of the high productive period of the war, the Government enthusiasm waned, and little more was heard of conservation from an official source. The mounting cost of coal and the difficulty of getting it is causing interest in this question again. The necessity for education of the men who are responsible for the proper burning of coal is as great as ever.

It is as true now as it was five years ago that the average efficiency of the steam plants in Canada would not reach the 50% mark. In some places it is feasible to use oil fuel, and the owner then comforts himself with the thought that he is getting good combustion efficiency. Perhaps he is, but it is just as easy to burn oil inefficiently as it is coal.

From the point of view of economy, and also the conservation of natural resources, it is time that a really comprehensive effort was made to make the problems of combustion better understood among the rank and file of power plant operators. It would well repay a group of manufacturers in a district to pool together and get a combustion expert into the district to personally visit each plant and set them in the right way. The saving that can be made in a steam plant by the exercise of a little care with no expense at all for instruments is enormous. We speak of the average plant, not of course of large installations where the best of scientific methods are in force. The average power house operator is anxious to do the best by the plant, and it is up to the owner of the plant to give him every facility.

If half the energy that is devoted to other forms of propaganda were to be put into this question of fuel efficiency, it would not be long before the country would be getting along with half its present consumption of coal. What is needed is a concerted effort, and representative bodies of manufacturers and engineers should get together and devise a programme of education that would cover the country. The question of expense need not deter them, because they will get it back a hundred fold. It will be a long long time before we can do without coal or oil fuel in this climate, and it will be a considerable time before the hydro-electric power entirely supplants steam, if it ever does. The more general use of the internal combustion engine will no doubt relieve the situation to some extent, and the installation of more economical steam engines is a factor in the right direction. The greatest source of waste is still the boiler furnace. and that is the place where the remedial measures should be applied in the first instance.

Culling Out the Weak Spots

SOME idea of the care needed in turning out special steel can be gathered from points brought out in a paper by Mr. De Mare, superintendent of the open hearth department of the Midvale Steel and Ordnance, Philadelphia.

Speaking of the tests made in armor-piercing projectiles, he stated:—

"From each lot of 500 projectiles, four are selected to be fired against a face hardened armor plate at a certain velocity and angle of impact of which two must pass through the plate and remain in effective bursting condition. Should this test be a failure, four more projectiles may be selected and fired, of which three must pass through the plate and remain in effective bursting condition. In the case of 16 in. shells, the cost to the contractor of this second test would amount to about $20,000. Should it fail, the whole lot of 500 projectiles may be condemned or the contractor may be permitted to retreat it and resubmit it as a new lot, which would entail an extra expense of approximately $100,000. It is thus evident that every possible attention must be paid to the quality of this steel, in order to avoid great financial loss, as well as loss in reputation."

There is a point here that could very well be brought out and emphasized, viz., that each piece is good or bad by itself. There is no such thing as an average.

Other lines of industry should get that idea. It would pay and pay handsomely.

A mechanic can work it, so can the foreman—so can the manager or owner.

Each day's work, each day's output can be put up against that simple standard.

The Engineering End of the Convention

By T. H. FENNER

A FEATURE of the C.A.S.E. convention that could hardly escape notice was the fact that the only engineering paper read before the delegates was contributed by a gentleman outside of the organization altogether. This paper, which was on a subject of consuming interest to every power plant engineer, found the assembled delegates completely unprepared to ask a question or offer a suggestion. In fact, it was very apparent, although the reader was thanked very heartily for his effort, that the members of the convention looked upon the paper as something to be laid aside to some future indefinite date, the immediate concern being to get on with the entertainment. Power House has called attention to this tendency of the convention delegates before, and though recurrence to the subject may not tend to popularity, yet we feel that something should be said on the matter.

There is no disguising the fact that a time is approaching when the stationary engineer, if he does not wish to be relegated to the position of a mere operator, has got to widen his vision, and get a more general idea of engineering matters. The art of starting up and stopping a plant is one that can easily be acquired by an untrained man in a very short time. The broad engineering education that will enable a power plant engineer to step into an owner's or manager's office and discuss power plant problems from a business point of view requires infinitely more. One would expect a gathering of representatives of an association that prides itself on its educational features, to have had some questions and discussions on the agenda that would have given a lead to every power plant engineer in the country, whether members or otherwise. Nothing of this sort took place.

There have been many defections from the ranks of the association during the past year, many of those dropping out having cast their lot with the union. While we have nothing to say against unionism, on the contrary, believing that the workman owes much of his advancement to a safe and sane use of union principles, we believe strongly that it is not in unionism alone that the best interests of the stationary engineer lie. The man who is earnestly working to advance himself to a position of importance and prominence in his chosen line of endeavor has nothing to gain from a union, but on the other hand, may easily find it a handicap. However, an association for the advancement of knowledge, and interchange of thought, offers him the kind of communion with his colleagues which he needs.

The C.A.S.E. was founded by men who earnestly wished and worked for the advancement of the stationary engineer. It has no more sincere well wisher than the writer of this article, but one cannot help feeling that in some way it has fallen short of its high endeavor. After working for years for a graded certificate act, the passing of that act was the signal for a howl of protest from a large number of engineers, many of them members of the C.A.S.E. who seemed to think that the passing of the necessary examinations was all right for the other fellow, but not for them. The lack of interest in engineering matters displayed at the convention is also a sign that there is something radically wrong.

The stationary engineer seems to be in a condition of apathy towards education. We say the engineers seem apathetic because in Toronto, where there is a free technical school right at their doors, but little advantage is taken of it. The C.A.S.E. has a golden opportunity to lead the way, and attract the younger men, who may reasonably be supposed to be imbued with ambition into their ranks. A broad and comprehensive scheme of education should be set under way, instead of the spasmodic attempts made by individual lodges. If the finances are hampered, the dues could very well be revised. The average man does not appreciate anything he gets too cheaply. If he has to pay a reasonable sum, he takes more interest and will want to know what he is getting for it.

To stimulate interest, for instance, why could not the Grand Lodge choose a subject, or number of subjects, for the members to write a paper on, and offer a prize to the best one. This paper should be in the hands of the executive at least three months before the convention, and be circulated among every lodge. Set a definite time at the convention for the reading and discussion of these papers, as is done at every meeting of any other engineering society. The C.A.S.E. says stationary engineering is a profession, not a trade. Well, then, let them conduct their deliberations in a professional manner, and set the lead to the others. The preparation of these papers would lead the competitors into a deeper research than probably any other method that could be tried.

It may perhaps be felt that Power House is pressing this subject unduly. Our reason is that we wish to see the stationary engineer become a bigger and better man, and that we believe the C.A.S.E. is the institution that can help him to help himself. Education is a duty the engineer owes himself, his family, his employer, and his country.

In the British Market

FOR the most part Canadian goods are well thought of in the Old Country markets. Britain has been for some time, and continues to be, our best customer when it comes to selling. In 1919 Canada sold to Old Country buyers $528,000,000 worth of goods, or 43 per cent. of the total amount of our sales.

Formerly the bulk of our trade to Britain was in raw materials or farm produce, but more and more we have been sending in the finished material, and it is getting a good reception in the British market. One firm recently went to a number of the larger stores in Britain to find out how the Canadian goods were received. In groceries, provisions, flour, rolled oats, bacon, cheese and salmon it was found that the Canadian article was considered as the standard of the trade. Strange as it may seem, our spaghetti and macaroni are competing with the article made in Italy for the London trade. It was hard to get a British dealer to admit that Canada, or any other country for that matter, could make jams to equal the Old Country product. Canned fruits were severely criticized in many particulars, although Canadian apples are acknowledged as being the best reaching the market.

Canadian made garden utensils, tools and garden furniture sell well and are popular. The Britisher is wedded to white enamelware, and in that essential the Canadian product, which is often finished with a grey or brown speckle, is lacking. They consider our tinware rather clumsy, but oil stoves compete with anything sent in from American makers. The Canadian kitchen range is perhaps a little too heavy and large for the British requirement.

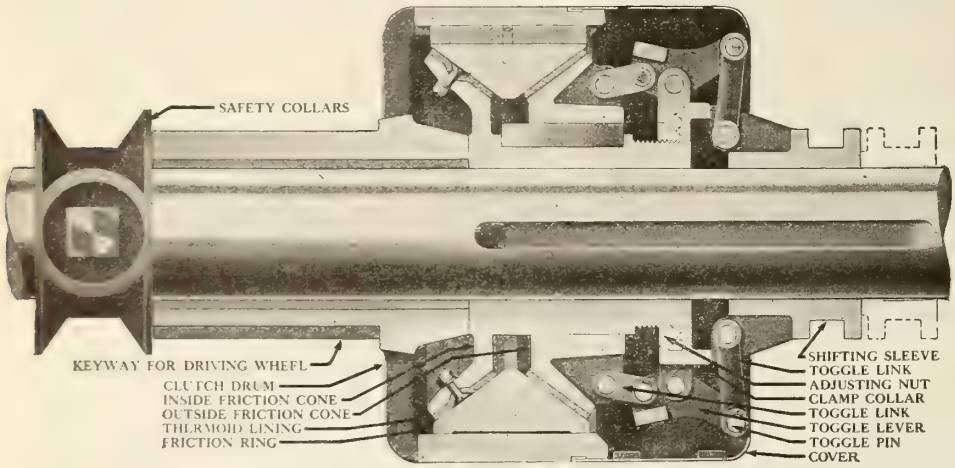
For electrical equipment there seemed to be a real opening for Canadian-made goods. Only a few lines appeared in the stores visited, but these had sold well against all competition. It must be remembered that there are many voltages met with in Britain, and electrical goods going in there should be of the universal type. Woodenware, kitchen cabinets, fibreware, etc., from the Dominion are acknowledged to be the best reaching the British buyer.

In spite of all that was said during the early stages of the war about Canadian-made shoes, there is a good sale for the Canadian article.

Progress in New Equipment

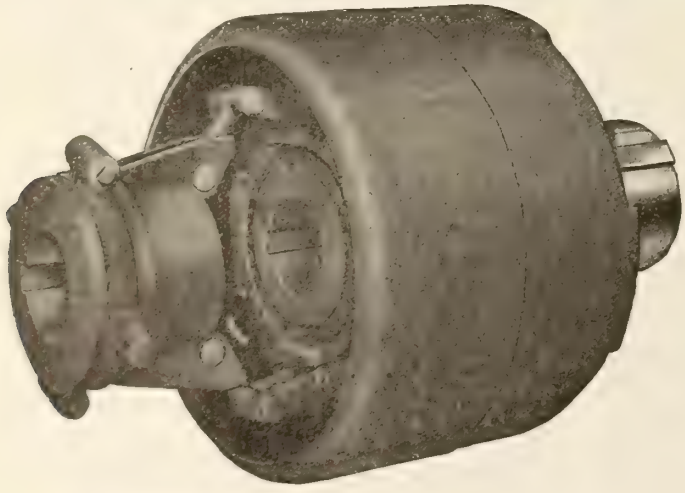
TWYNCONE FRICTION CLUTCH

The Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., have placed on the market what is known as their Twycone friction clutch. One of its exclusive features is that it has a one point adjustment. All moving parts are inclosed, making for absolute safety. The clutch is also perfectly balanced, this feature allowing it to run at high speed without causing it to throw in—or out.



SECTIONAL VIEW OF THE CLUTCH.

The construction is very simple. Moving parts are reduced to a minimum, and high speed does not affect its operation. The clutch has to be eased in when running at any speed, and the friction cones are lined with thermoid. Every part is easily accessible, and if necessary can be easily replaced. The accompanying photographs will still further show the construction and appearance of this new style clutch.

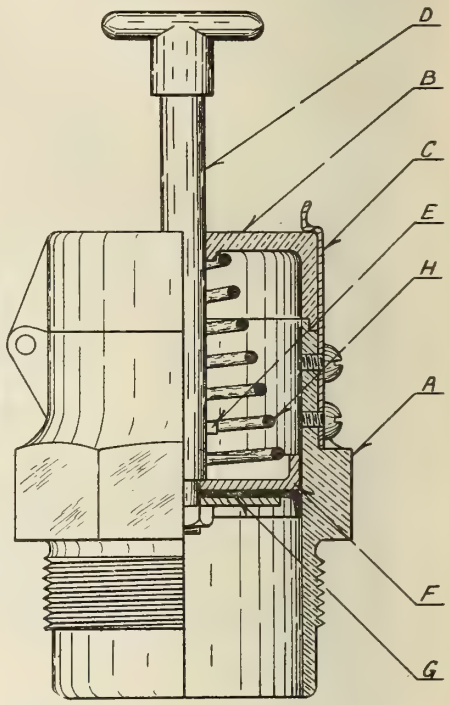


GENERAL VIEW OF THE CLUTCH.

AUTOMATIC GREASE CUP

The need of effective lubrication to bearings and all surfaces subjected to friction, has been, and probably always will be, an outstanding factor in engineering problems. The varied conditions under which many mechanisms are required to operate makes it imperative that ample facilities be provided for proper lubrication in order to avoid the inconvenience and even destruction that frequently follows from insufficient foresight in this connection.

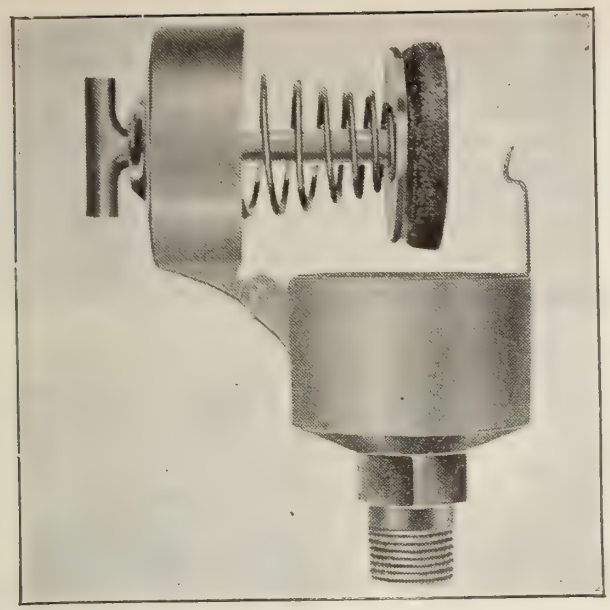
The illustrations depicted show a new design of grease cup which is automatic in its action, for when the cup is once filled and pressure applied, the feeding process is constantly maintained until all the grease has been delivered to the bearing. These grease cups are made in a variety of sizes and designs to suit any desired purpose or condition, the action of the automatic principle being identical in every instance. In Fig. 1 it will be seen that the body A is bored clear through, but the lower portion may be made to any desired shape and threaded to suit.



SECTIONAL VIEW THROUGH THE CUP.

The cover B is hinged to the body, and when closed is locked in position by the steel spring C. When filling the cup the spindle is raised to its extreme position, the small pin passing through a slot in the cover. A slight twist of the spindle locks it in this position and the cover is opened. It will be seen from the construction that the cover can only be swung open when the pressure disc F is retained within the cover. An accurate fit within the cylinder is maintained by the cupped leather washer G. The spiral compression spring H provided a steady pressure upon the grease in the cup so that an automatic feed to the bearing is always assured.

The action of this spring prevents the formation of a vacuum beneath the pres-



THIS SHOWS CONSTRUCTION OF THE CUP.

sure disc as the latter will follow the grease down as it is gradually delivered to the bearing. Suitable springs are provided for the different grades of grease. All parts are interchangeable on each size of cup so that separate pieces are available for any replacements. The cup may be inverted or located in any position without affecting its efficiency. These cups are adapted to locomotives, marine, gas or stationary engines, and all mechanical equipment where grease cups are used. These cups are made and sold in Canada by the Edward A. Robinson Co., 228 Craig St. W., Montreal.

PROMET BEARING METAL

HEAT treatment as a means of increasing the efficiency of steel has become a universal factor in engineering problems, but little knowledge has been acquired as to the heat treatment of non-ferrous metals for adding to their strength and durability. In Promet metal the manufacturers, the American Crucible Products Company of Elria, Ohio, have obtained a metal that possesses all the advantages that has been accorded to the bronze and other non-ferrous metals of olden days, when such metals contained all the tempering characteristics now possible only in steel tools. While the actual process used by the Egyptians of olden times will probably always remain a mystery, the results obtained in the making of Promet are in many respects identical with existing specimens of those pre-historic bronzes and other metals.

While the analysis of Promet is the same before and after heat treatment, the process undoubtedly changes a relatively good bearing metal into one of incomparable superiority in both bearing and lubricating qualities. The accompanying cuts will show the remarkable change in structure and the marked similarity to steel before and after treatment. It is claimed that the properties of this metal will remain permanent under any and all conditions; heating up to 2,000 degrees F., time or exposure, conditions of storage or long and exacting service, have no deteriorating effect upon the metal, and the metal can be remelted and re-used over and over again, and still retain all the advantageous qualities of the virgin metal.

It is also claimed that it has many times the bearing properties of any tin base babbit, and many times the lubricating properties of any lead base babbit. Many working tests have been made with material, and loads of 9,700 pounds per sq. in. have been carried without distorting the metal, and the co-efficient of friction is remarkably low, particularly where lubrication has been seriously neglected. It will melt at 600 degrees F., and can be heated to 2,000 degrees without the least injury. The recommended temperature for pouring is between 700 and 850 degrees F., and it is claimed that the metal is non-shrinkable when worked at this heat. An important feature of the metal is that it will not stick to the shaft when the bearing becomes overheated. Hot slag and molten metal cars, fitted with Promet, have shown no signs of wear after four or five months' service. Promet is equally adapted to high speeds and heavy loads. The Engineering Sales and Service Company, 55 St. Francis Xavier Street, Montreal, are the Canadian distributors.

MACHINE VISE

The Hoosier Drilling Machine Company, of Goshen, Ind., are now making a new line of machine vises. The jaws are of hardened steel, but may be modified to meet specific needs.

SINGLE-END DRILLING MACHINE

The Cadillac Tool Company, of Detroit, Mich., are placing on the market a single-end machine similar to the one recently designed for double-end tapping. The spindle feed is operated by a lever above the spindle head. The machine has a capacity of 17/32 inch drilling in steel, and may be provided for either belt or motor drive.

AERIAL GRINDER

The Van Dorn Electric Tool Company, of Cleveland, Ohio, are now building a small aerial grinder, which may be obtained for operating either with d.c. or a.c. installation. The grinder has a 12-inch extension that carries the wheel well out from the frame. Ball bearings are used throughout and grease lubrication is provided.

RE-DESIGNED SHAPER

The re-designed 20-in. crank shaper of the R. A. Kelley Company, Xenia, Ohio, incorporates many improvements over the old design. The machine is constructed for either belt or motor drive. The link connection from the rocker arm is such that the ram is forced on to the bearings, which helps to neutralize the upward thrust of the tool. The apron is so mounted that it may be completely rotated. Table is located by means of a hardened taper plug. Ball bearing thrusts are provided for elevating the screw. A special feed box is fitted to the end of the cross rails, and the amount and the direction of the feed may be controlled without touching any moving part of the machine. Feed is automatically disengaged at the end of the travel. Helical teeth are used on all gears and pinions.

CATALOGUES

We have received a catalogue illustrating the Stowe Stoker, manufactured by Laclede Christy, St. Louis. The booklet is well illustrated and contains much detailed information on the stoker. The Stowe is claimed to be a progressive fuel stoker, and as such, differing from both the under and over feed types. The advantages claimed for it are well set forth in the catalogue.

The Barnstead Still and Sterilizer Co., of Boston and Chicago, have issued a bulletin descriptive of their water purifying apparatus. Besides the descriptions of the various types of units employed for different purposes, some useful information on the chemistry of water is given. The machines include types suitable for industrial, laboratory, domestic, and special purposes, such as hospitals. A list of users and a number of letters from purchasers expressing their satisfaction are included.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

REFRIGERATION

Question.—I have a few questions regarding an ice machine that I have to take care of. It is a small York machine and I would like to know how to purge the condensing coils, these being the high pressure coils. There is a needle valve located on the top of these coils with an outlet to the atmosphere. If I shut machine down to stop the flow of gas in the discharge would the air raise to top of coils to be blown off? There is no other outlet on coils except inlet for charging system with ammonia at end of condenser bottle.

How many pounds of calcium will be needed to raise a chloride of calcium test instrument one degree on same, and does this apply equally the same for each degree as the brine gets stronger?

What is the most practical method for dissolving the chloride of calcium, that is, when a full charge has to be mixed for a brine tank?

Answer.—The purge valve on the top of the condenser coils is the proper place to get rid of air. It is usually best to blow into a pail of water by means of a hose connected to the purge pipe. The air will bubble up through the water, the stopping of the bubbles being the signal that all air has been blown out. Another method is to allow all the ammonia to drain to the low pressure side of the system. The valve between the high pressure coils and expension coils is shut, and the discharge and suction valves on cylinder shut. The by pass between the discharge and suction pipes is then opened, and the purge valve on the cylinder. If the machine is now started, all the air will be pumped from the high pressure side. When a vacuum shows on the gauge, stop the machine, close the cylinder purge valve, and allow the pressure to equalize on the system through the cylinder stop valves. The air will then be got rid of. The condenser should always be cooled down before purging.

The following table will show the amount of chloride of calcium required at various points from 0 to 100 on the salometer.

The best way to dissolve the calcium chloride is to put a steam jet into it from a steam hose.

TABLE—CALCIUM CHLORIDE BRINE.

Degrees on Salometer	Lbs. C C per gal.	Freezing point Degrees F.
0	0.	32.
4	0.167	31.1
8	0.333	30.3
12	0.5	29.48
16	0.667	28.58
20	0.833	27.82
24	1.	27.05
28	1.167	26.28
32	1.333	25.52
36	1.5	24.26
40	1.667	22.8
44	1.833	21.3
48	2.	19.7
52	2.167	18.1
56	2.333	16.61
60	2.5	15.14
64	2.667	13.67
68	2.833	12.2
72	3.	10.
76	3.167	7.5
80	3.333	4.6
84	3.5	1.7
88	3.667	—1.4
92	3.833	—4.9
96	4.	—8.6
100	4.167	—11.6

A RUPTURED TUBE IN WATER TUBE BOILER

To a great many engineers who have not been fortunate enough to have the chance of handling or operating large units, the thoughts of them are mingled with a certain amount of trepidation and awe. I speak from experience, there was a time when I felt the same way. My idea of writing the following experience was brought about by Mr. Coombs' paper on "Modern Boiler Practice," in which he deals with one of the large units now running at the Power House named. When these units were first installed our firemen rather stood aloof and I am afraid that a certain amount of fear was felt by them and more especially after the accident which is described later.

The accident in question occurred about five weeks after the boilers had been in operation, and took the shape of a burst tube, the picture of which I enclose so that all the readers of Power House may see that it was not an ordinary split tube, but a complete burst. The sound of the explosion was more like the bursting of a guage glass than anything else. If readers will look in the May 20th issue on pages 228 and 229, Figs. 5 and 6, the fourth tube from end facing reader, is where rupture occurred. The boiler at the time of the accident was evaporating 46,000 lbs. of steam per hour, at least that was as far as the flow meter hand could go. How much more it is impossible to say, because an enormous body of water came over the header rupturing the

PHOTO OF SPLIT TUBE

joints and stretching one set of bolts at the last elbow about 3-16 of an inch and then almost brought the turbine to a standstill. I can say without exaggeration it was about the busiest 15 minutes I ever spent in my life. Just picture to yourself, reader, if you can, one minute everything going rosy and next minute, without any warning, Bang! the engine room was flooded with steam. I made my way through the steam to the boiler room, but was met with worse conditions, not only blinded with steam but over two inches of boiling water on the floor. We raised the stoker doors of the boiler (as we guessed what had happened), by myself and another getting near the boiler where the water was pouring through the iron casing, and receiving a warm bath.

However, after raising the stoker doors we placed the fire hose on the fire. It's all very well to say close the dampers, or smother the fire with ashes, but try and think how much coal there was on the grate heated to a state of incandescence. The grate was carrying 5" fire at the time. This would work out

at 224 ft. by .417=93.4 cubic feet of coal, now the Admiralty regulations call for 40½ cubic feet per ton, in stowing this=2.3 tons at a temperature of 2,800 deg. F., of course, there would not be that amount of hot coal in ordinary times, but the boiler was being forced and a large amount of unburnt coal was piled up against back wall, which more than out-balances the green coal just entering the stoker door, but I am wandering away from the subject. We kept the emergency feed wide open, and as the steam commenced to disappear we found the poor fireman lying down with all his clothes literally blown off his body. Well, I draw a veil over that, as the sight is not good to remember. After normal conditions had been restored and the boiler opened up, the ruptured tube was discovered and the tube had laid itself over the tube at each side of it, striking it so hard as to loosen them from the upper headers.

Now comes the query for the engineering world to answer: Why did that body of water come over the header when the tube burst?

A few solutions from the readers of Power House would oblige the writer.

—H. WRIGHT.

CORRESPONDENCE

The Editor, "Power House,"
Toronto.

Dear Sir,

The writer has received numerous requests from engineers for an interpretation of a paragraph in the new regulations for stationary engineers, and the writer believes that if a ruling were obtained from the board of examiners and published in your journal, it would relieve a great amount of uncertainty.

The paragraph in question is respecting: "Partial Operation of Plants at Night," page 17 in the 1919 issue of the regulations.

At first sight it would appear that it is necessary for a plant over 300 B.h.p. to be partly operated by a second class engineer at night. However, the regulations state " . . , said plant may be operated by an engineer holding a certificate one grade lower than would be required by the Act if the same was in full operation."; and under the conditions of the preceding paragraph, i.e., where a plant is operated in two or more shifts under a chief engineer, only the chief need hold a certificate corresponding to the grade of the plant, and an engineer holding a certificate one grade lower may take charge of a shift, under full operation, when the chief is absent Thus, for partial operation an engineer holding a certificate one grade still lower than shift engineer under full operation is required, or a third class engineer may partially operate at night a first-class plant, or a fourth class engineer may partially operate at night a second class plant. The above is the interpretation put upon the above paragraph by the writer, but a ruling by the board of examiners would be welcomed.

Notwithstanding the fact that the board may give a ruling on the above, there is nothing in the Act specifying that the board shall have absolute power in the interpretation of the regulations, and any prosecutions under the Act would therefore be decided by the trial judge according to his own interpretation of the regulations, and the writer believes that the above interpretation is the one which a judge would be most likely to make.

Yours very truly,
M. B. WATSON.
Director, Dept. of Engineering,
Toronto Technical Schools.

Editor of "Power House."

Dear Sir,—We are very much interested in the communication of Mr. J. G. Kingston on page 297 of your issue of June 21. In this communication Mr. Kingston calls attention to the advisability of having inspectors appointed by the school boards and city councils to make a study of combustion of coal, and make such changes and improvements in boiler plants of public buildings to conserve the supply of coal.

This very thing is being done by all of the larger municipalities in the States where, as a rule, chief engineers are appointed by the school boards to make a study of the different problems in connection with boiler room practice in the power plants of these public institutions. With coal at its present prices there is a very large field for this work, and immense savings can be accomplished by properly educating the firemen and by installing the proper kind of furnace equipment. In the larger cities the boilers in all schools and public buildings are equipped with stokers, which effect savings in the amount of fuel used of from 10 to 25 per cent. The intermittent firing by hand is naturally very wasteful, while the stoker, which feeds continuously, overcomes this waste. Many makes of stokers are equipped with magazines of considerable capacity, so that these magazines can be filled with sufficient coal to run the stoker for periods of an hour or more before the magazines require refilling. This gives the engineer an opportunity to attend to other duties and does not require his constant attention and care as is necessary with a hand-fired furnace.

Another very important matter to be taken into consideration is the fact that school buildings are installed in residential districts where the elimination of the smoke nuisance is a very important factor. Continuous, even firing of a stoker practically eliminates all smoke, which cannot be accomplished by hand firing unless the most expert firemen are employed to give the firing their constant attention.

We think the points brought out in Mr. Kingston's article are very well taken and that the savings that can be accomplished by the employment of an engineer to make a study of these matters amount to a great deal more than his salary—even in the smaller municipalities.

DETROIT STOKER COMPANY.

INTERNATIONAL STANDARDIZATION OF WIDTHS ACROSS FLATS ON NUTS AND BOLT HEADS

The Swiss Standards Association has addressed a communication to the national engineering standardizing bodies of the various countries, proposing the international standardization of the widths across flats on nuts and bolt heads.

The proposal covers the range of ¼ in. (6 mm), 3 in. (80 mm), diameter of bolts. The numerical values proposed are a compromise between the United States Standard, the British, or Whitworth, and the metric "Systeme Internationale." The communication states as follows:

"If at this moment the parties concerned were willing to do their best to bring about an agreement, a satisfactory international standard could be attained, while, when nationally individual standards would be introduced into practice, an attempt to reach an agreement could hardly be expected to be successful. We hold it advisable to subject the matter to a referendum of widest possible scope. It seems to us that by generous cooperation we ought to be able to find some system, which could induce France to agree upon, and at the same time form a foundation which would render possible the adoption by America and England.

The V. S. M. Committee of Standards being ardently urged by the Swiss industry, is compelled to decide upon a system of widths across flats in the near future, but doesn't care to do this unless one more attempt to bring about an international agreement in this matter be made by the V. S. M. Bureau of Standards." The communication was addressed to the standardizing bodies of America, Belgium, England, France, Germany, Holland and Sweden.

The most novel application of electricity to industry is the purification of clay. A machine designed for this purpose was recently exhiited before the Royal Society, London, England. It consists of a trough with a cylinder which slowly revolves over a grating through which the "slip"—a mixture of clay and water—is forced. When the cylinder is connected to one pole of an electrical circuit and the grating to another, the electrical effect separates the fine particles of clay from the water and deposits them on the cylinder, whence they are removed by a scraper. By this simple and ingenious process, known by the name of "electrical osmosis," low grade and dirty china clays can be used to produce pure fine clays for pottery and for the manufacture of "art" paper. The clays used for fire-clay are made more plastic and also more fire-resisting as a result of the electrical treatment. The same process can be applied in tanning leather and in the preparation of glue and gelatine.

NEW VICE-PRESIDENT

Mr. C. J. Brittain, formerly managing-director of the Winnipeg, Calgary and Saskatoon branches of the Canadian Fairbanks-Morse Co., Ltd., has been appointed vice-president and general sales manager of that organization, with headquarters in Montreal. Mr. Britfain succeeds Mr. C. Graham Drinkwater, who has been vice-president in charge of sales for many years, and who has resigned to join the banking firm of Aldred and Company, Ltd.

G. J. BRITTAIN

Mr. Brittain brings to his new post a wide experience of many years and a splendid record of achievement. He was one of the first salesmen engaged by the Canadian Fairbanks-Morse Co., Ltd., in the early days of the company, and he has made good in every position to which he has been appointed. He has the entire confidence and hearty support of all those who know him, both in the organization and as customers.

Mr. Kenneth Forbes, who has been manager of the St. John, N.B., branch, goes to Winnipeg to assume charge of that branch, together with that of the Regina branch, which is under construction at the present.

Mr. Forbes is succeeded at St. John, N.B., by Mr. W. J. Hill. Other changes in the management of the sales department—all of which represent well-earned promotion and increased opportunity to assume greater responsibilities—are the appointments of Mr. Malcolm Cordell to be Montreal manager, and Mr. George L. Nies and Mr. Archibald Turnbull, who will become managers of the Calgary and Saskatoon branches respectively, taking on a portion of the duties which formerly came under the direction of Mr. Brittain.

The Economy Fuse & Manufacturing Co., of Chicago, manufacturers of "Economy" renewable fuses, announce the appointment of Mr. F. L. Easton as district sales manager of their Denver office, 205 Commonwealth Bldg., Denver, Colorado. Mr. Easton succeeds Mr. R. M. Olsen, who resigned recently. Mr. Easton formerly was connected with the Economy Fuse & Mfg. Co., but more recently has been doing sales promotion work for the Gates Rubber Company.

U.S. AND CANADIAN FIRMS COMBINE

On April 2 the stockholders of J. H. Williams & Co., manufacturers of drop-forgings and drop-forged tools at Brooklyn and Buffalo, N.Y., and of The Whitman & Barnes Mfg. Co., makers of twist drills, reamers, wrenches and drop-forges, at Akron, Chicago and St. Catharines, Ont., ratified the agreement providing for the consolidation of the wrench and drop-forging plants and business of Whitman & Barnes at Chicago and St Catharines, with J. H. Williams & Co.; The Whitman & Barnes Manufacturing Co. retain their twist drill and reamer business and will continue as an entirely separate organization and on an extended scale, the manufacture of these tools at Akron, Ohio.

J. H. William & Co. have long been known as the largest manufacturers of drop-forgings and drop-forged tools in the world, and was one of the first to enter this field commercially. The business was founded in Flushing, L. I., as a partnership in 1882 by James H. Williams and Matthew Diamond under the style of Williams & Diamond, later Williams & Brock. It located in Brooklyn in 1884, assumed its present name in 1887, and was incorporated in New York State in 1895.

The company is widely and favorably known, not only for its special drop-forgings made to order, but also for the quality of its catalogue product, drop-forged wrenches, "Vulcan" chain pipe wrenches and vises, lathe dogs, clamps, and numerous other standard lines of drop-forged tools. Many of these were originated and patented by the company. At the successive World's Fairs at Chicago 1893, Paris 1900, St. Louis 1904, and San Francisco 1915, the company's products in each case received the highest award in their field.

The Brooklyn works employs about 750 persons, occupy two adjoining square blocks of city property, including the street between, which is closed, and contain about 197,000 sq. ft. of floor space. In 1914 the Buffalo works, an entirely new plant, began operation; they now employ over 1,000 persons and comprise 47 acres, with about 233,000 sq. ft. of floor space.

The Whitman & Barnes Manufacturing Co. was founded as a partnership in 1846 by Augustus Whitman and Alfred G. Page under the title, Page, Whitman & Co. In 1868 the Akron factory was built, and in 1877 the business was combined with that of George Barnes & Co., of Syracuse, N.Y., the enlarged concern assuming its present name, The Whitman & Barnes Mfg. Co. The St. Catharines plant was acquired in 1882, and eleven years later the Chicago works were built. They now consist of forty-five acres of land, with 320,000 sq. ft. of floor space, and are connected by private trackage with four railroads. They employ about 800 people.

The St. Catharines works manufacturing special drop-forgings to order and standard lines of drop-forged wrenches, pipe wrenches, adjustable wrenches of various styles, pliers, hammers, hatchets, sledges, etc., are located on the Welland Canal and obtain power therefrom. They occupy about 2½ acres with floor space of 35,000 sq. ft. The company owns some six acres of additional property, which may be utilized in the near future for the erection of larger and improved facilities to care for the Canadian trade. This business has the distinction of having every jobbing house in the Dominion on its books. About 200 persons are now employed.

Two of the works, that at Buffalo and the new forge shop, 500 by 100 feet, and 3,000 h.p. power house at Chicago are the most up-to-date forging plants in the world, while those at Brooklyn and St. Catharines are admirably adapted to the tool-making end of the business.

Through this consolidation of the four plants, Brooklyn, Buffalo, Chicago and St. Catharines, the ultimate geographical ideal for the service of customers has been attained. The merger also emphasizes the leading position of the company in the manufacture of drop-forgings and drop-forged tools.

The company has been particularly fortunate in its relations with its men. Operating throughout its history on the principle of the highest wages in the industry for the most efficient work, supplemented (but not substituted) by expenses liberally incurred to provide the best possible working conditions, it has succeeded in establishing a relation of mutual confidence that has frequently been the subject of comment in the industrial and social press—in 1912 this was the cause of an unsolicited visit from Theodore Roosevelt, followed by a special article by him in "The Outlook" on the subject.

The Brooklyn factory, in 1893, had the distinction of being the first factory in this country to provide shower baths for its workmen, and again, in 1914, of leading its industry in the establishment of separate pension and life insurance systems for the direct benefit of its employees, and, of course, for the indirect benefit and satisfaction of its stockholders.

The business will continue to be operated by those who have been continuously identified heretofore with the business of J. H. Williams & Co., and with the Chicago and St. Catharines plants of The Whitman & Barnes Manufacturing Co., the organization being as follows: President and managing director, J. Harvey Williams; vice-president, A. D. Armitage; secretary and treasurer, W. A. Watson; controller, R. S. Baldwin; general sales manager, F. W. Trabold; Eastern district sales manager, A. S. Maxwell; Western district sales manager, W. E. Rowell; Buffalo district sales maanger, J. C. Cotter; Detroit district sales agent, A. M. Thompson; publicity manager, Hugh Aikman; general works manager, Capt. W. N. McMunn; chief engineer, Willard Doud; superintendent Brooklyn division, R. J. Smith; superintendent Buffalo division, T. F. Du Puy; superintendent Chicago division, Barney Nelson; general purchasing agent, J. C. Scanlon; general traffic manager, J. B. Payne; Canadian manager, W. J. Elliott.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank, add	$1 50
Nuts, square, tapped, add	1 75
Nuts, hexagon, blank, add	1 75
Nuts, hexagon, tapped, add	2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A. list, plus	43%
Emery cloth, list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

ORGANIZATION CHANGES OF WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY

Several appointments have been made in the organization of the Westinghouse Electric International Company. At East Pittsburgh they are as follows: H. F. Griffith, assistant to general manager; R. W. Everson, manager of merchandising department; H. C. Soule, manager apparatus department; and H. S. Rizensteiz, manager price department.

In New York they are: G. H. Bucher, assistant to general manager; J .H. Payne, supervisor of agencies; and F. M. Sammis, manager of incandescent lamp department.

A. B. Cole, assistant manager, Department of Publicity, Westinghouse Electric & Manufacturing Company, has been placed in charge of the advertising and promotion work for the Westinghouse International Company.

The following men have been appointed sa foreign managers of the Westinghouse Electric International Company: F. M. Rodgers, of London, England, European manager; J. W. White, Royal Bank of Canada Building, Havana, Cuba, manager for Cuba, and L. T. Peck, Bartolome Mitre, 754, Buenos Aires, manager for the Argentine.

WESTINGHOUSE CATALOGUE OF INSULATING MATERIALS AND SUPPLIES

Miniature catalogue No. 5-A-1, giving a complete list of all insulating materials and supplies, has just been issued by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Included in the list of products described are: mica, Micarta and Bakélite Micarta plates and tubing, treated and untreated cloths and papers, insulating and soldering compounds, insulating oils and tapes.

STOKER MANUFACTURERS ASSOCIATION MEETING

At a recent meeting of the Stoker Manufacturers Association held at Lakewood, New Jersey, the following officers and executive committee were appointed: Sanford Riley, president; M. Alpern, vice-president; A. G. Pratt, treasurer; S. A. Armstrong, and H. A. Hatton; J. G. Worker, secretary.

This committee is to meet in New York at an early date to name the standing committees of the organization for the coming year. A vote of appreciation and a round of cheers was tendered to P. A. Poppenhusen, the retiring president.

When asked for a statement after the meeting regard to his policies for the organization during the coming year the newly-elected president, R. Sanford Riley, made the following statement:

"I have always believed that the stoker business is a good one, but it has not even yet taken its proper place in the business world. I have seen it develop from a very crude business, conducted on a comparatively low plane, to a large business conducted on a much higher plane. We are getting an increasingly large percentage of able men in the business, which makes it good, not only for those in the business but also for our customers. After all, we can profit only as we serve, and the service possible by our business is one of the greatest in any line of business.

"We are no longer the leading propagandist in the art of conserving fuel. The Government seems to have taken over the position, and all we have to do now is to live up to the demands made of us.

"Our field is being enlarged every day by economic pressure, and my hope is that we, as an association, may conduct ourselves so as to be worthy of the field."

BOILING POINT OF AMMONIA

A subscriber asks us what is the boiling point of ammonia. This question is somewhat vague. The boiling point of anhydrous ammonia, such as used in the compression system of refrigeration, is 28.5 Fahr. while that of aqua ammonia is 146 Fahr at atmosphere pressure, and a specific gravity of .95.

One of the most important developments of electric welding in Great Britain lies in its application to building construction. The steel roof of a large factory recently erected in London was entirely welded, not a single rivet being employed. Each truss was completed on the ground, the various sections being merely laid in position and welded with mild steel by the arc process. When a truss was completed it was hoisted into position and welded on to the steel supports. The whole process of erection can be carried out much quicker than when riveting is employed, and there is also a great saving in material.

Great interest has been aroused in Great Britain by announcements concerning a textile material called "cotton substitute." It is not, however, a new thing, but its revival at the present time is due to the advancing price of raw cotton. It was invented ten years ago by a British engineer, and is a result of a special process of treating "china grass." By steeping the grass in certain chemicals the inventor obtains a fibre which can be spun in ordinary cotton spinning machinery. The resulting material takes dye readily, has a good lustre, and when mixed with cotton yarn produces a hard-wearing fabric. Apparently the only objection to it is its hairiness and harshness, but for certain purposes these qualities would not prove a serious drawback. Experts consider that its main value will be as a union fibre with cotton and wool.

INTERESTING BOOKLET

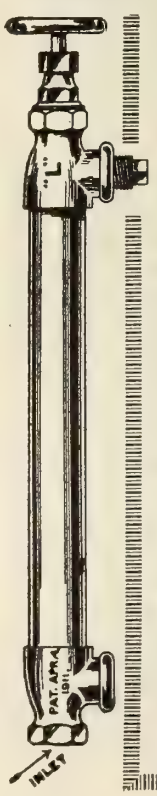
The Silver Mfg. Co., Salem, Ohio, have issued an interesting booklet entitled: 'Silver Drills in Service." It is out of the ordinary run of material and really tells a story of service of the Silver drills at the American sector of war. The tale is told by H. D. Parker, who was a First Lieutenant in the Ordnance Department, and we are told that a copy of this booklet will be forwarded to anyone interested.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

Use The LONG STEAM for TRAP SATISFACTION



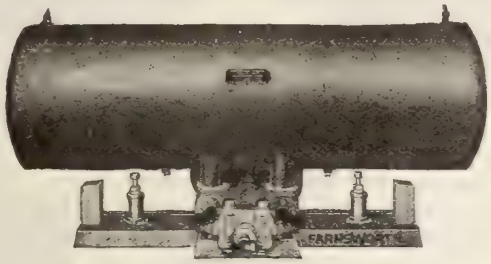
kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.
The Hamilton Powder Works, Beloeil, P.Q., use them with great success. Read this letter.
Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.
(Signed) J. Murray Wilson,
Superintendent
Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

J. T. LONG
48 ADAM ST.
MONTREAL - CANADA
If your dealer does not sell it, write direct.

A Real Canadian Boiler Feeder

THE BEST IN THE WORLD

Ask the Canadian Farnsworth Company about these machines for your steam plant. We build boiler feeders from 20 to 1,000 H.P. each.

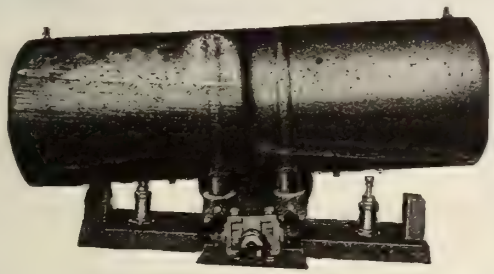


The Farnsworth "Duplex"

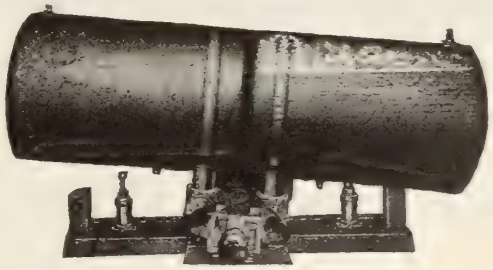
Our Engineers will give you expert advice on boiler feeding and condensation problems. No plant too large.

This Machine is the Product of Canadian Brains and Skill—Made in Canada by Canadian Engineers—the Last Word in Efficiency.

Study the Construction of this Machine.
Have you ever seen a Simpler Machine for the Purpose?
Everything designed for simplicity.
Least moving parts of any boiler feeder on the market.



No springs—No levers—No weights—No check valves to give trouble. Nothing to adjust. No necessity for adjustment. No trunnions, or bearings to bind and stop the action, or leak, and mess up your boiler room.



No open vents to waste your steam—A mechanically perfect Duplex steam valve—Can't leak and can't stick—No renewing of faulty discs.

Study the action of this machine—You have seen the common Return Trap in action—You have seen it "Hold up" the return lines—You have heard it "Pounding" and seen it blow steam through the open vent.

An open vent will waste at 50 lb. pressure about 15 H.P. per hour of your steam—Surely an expensive proposition.

Our Duplex boiler feeder or pump can't waste steam—It's a complete closed loop system, impossible with the common return trap.

Gives a continuous flow to boilers—Continuous drainage from heating apparatus—Continuous equalization between boiler and apparatus.

THE

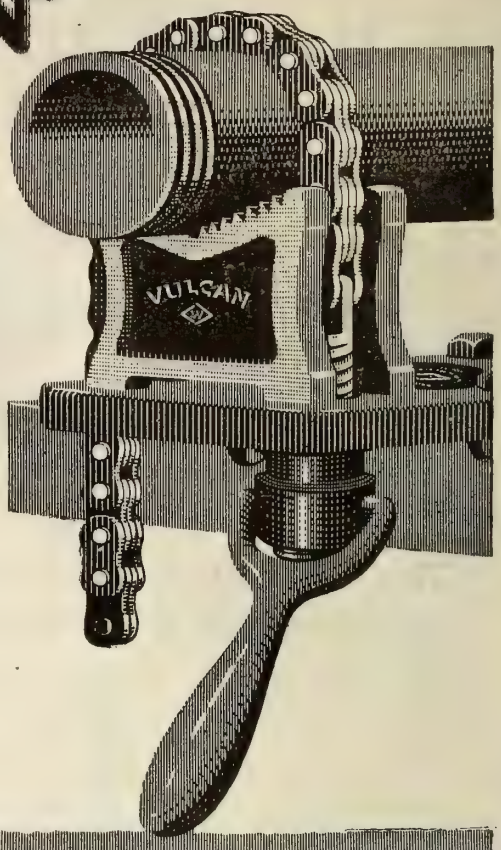
Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE



A PIPE vise, like any tool intended for rough usage, should be so designed and constructed that the severe strains and stresses of hard, continuous service cannot cause breakage or failure in operation.

Williams' "Vulcan" Chain Pipe Vises have no weak parts to fail through faulty design. Though they are far lighter and cost less than the conventional cast pipe vise, they are unbreakable. These Vises are made entirely from wrought metal, tested in our Laboratories before use. Each Chain is hand made.

Nothing that engineering experience and technical skill can suggest to improve them is omitted in their manufacture. All are backed by our unconditional guarantee.

Three sizes for ⅛ to 8" pipe. Booklet on request.

J. H. WILLIAMS & CO.

"The Drop Forging People"

78 So. Clinton St. Chicago, Ill. | 78 Vulcan St. Buffalo, N.Y. | 78 Richards St. Brooklyn, N.Y.

Western Canadian Agent: W. Bruce Campbell, 78 Confederation Life Bldg., Winnipeg

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS

BOILERS & TANKS, WATER FILTERS THERMOMETE GAUGES RS,

E. J. Philip & Sons, Engineers 57 Queen Street, West, Toronto, Canada

POWER HOUSE advertisements will give you last minute up-to-date information of educational value. Are you using this opportunity?

Largest manufacturers of white metals in the world

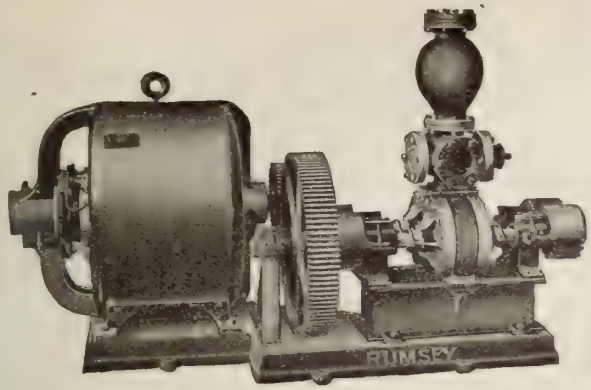
Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Street Car Journal Bearings

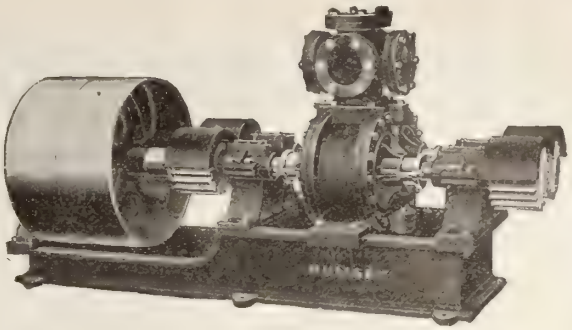
Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG



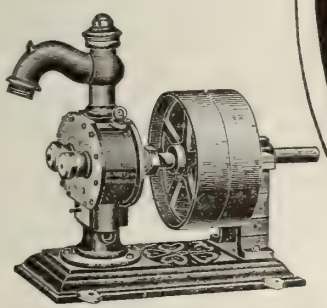
Rumsey Electric Rotary Fire Pump. Designed for general service as well as fire duty; 100 pounds pressure for fire service, and 75 pounds pressure for general service is recommended.



Rumsey Power Rotary Force Pump, for elevation up to 170 feet and pressures up to 75 pounds. Designed for water supply, oils or special liquids and for general pumping in mills and factories wherever a moderate priced pump of large capacity is desired.

RUMSEY ROTARY PUMPS

SENECA FALLS, NEW YORK



Rumsey Rotary Power Force Pump. An inexpensive pump of large capacity for handling water, oil, paint, varnish or special liquids. This pump is in big demand in industrial plants of all kinds and is suitable for elevation up to 80 feet.

Rumsey Rotary Power Force Pump. Very small; designed for pumping lubricants for cutting tools or monitor lathes, pipe, threading machines, bolt cutters, etc., also to return oil to reservoir from drip pan under machines, and for any work where a light-duty machine is required.

Sectional View of Heavy Service Rotary Pump, showing the arrangement of the packing strips with which the toes of the cams are provided.

Used in mills and industrial plants for general water supply, pumping to sprinkling systems, handling special liquids and for fire protection.

RUMSEY Hand and Power Rotary Force Pumps will handle almost any liquid that will flow—water, oil, paint, varnish, gasoline, grease, tar, ink, extracts, sizes, soaps, chemicals and commercial liquids of all kinds—liquids of a gritty nature, or those that have a chemical action unsuitable to iron or bronze excepted. The compactness and convenience of Rumsey Rotary Pumps, their large capacity and low cost make them the preferred Pump for all kinds of general pumping.

THE ARTHUR S. LEITCH CO.

1001-2 Kent Bldg., Toronto, Ont.

The Publisher's Page

TORONTO July 5th, 1920

Improving Our Service

THE Directors of the Canadian Press Association decided last year that the MacLean Publishing Company was the largest and most important newspaper organization in Canada and must therefore pay the highest annual fee to the Association. The Montreal **Star** with its two big weeklies comes second, but the **Star** group had been doing business for 18 years before the MacLean Company began. While we have not the details upon which the Press Association based their decision we understand they figured that the MacLean Company had a larger advertising revenue. This is not the case. Lord Atholstan's properties probably carry a third more advertising, use more paper and have a greater total circulation. The MacLean papers on the other hand get more revenue from circulation; have to pay perhaps three times as much in salaries and wages and show considerably less profit.

Extra good service to readers first and advertisers next has been the cardinal principle upon which Colonel Maclean has built during these 33 years. In this work every man, woman and junior apprentice on our staff has had a share. We have tried to gather about us and train the best experts in the country. Here is the latest example of what we are doing:

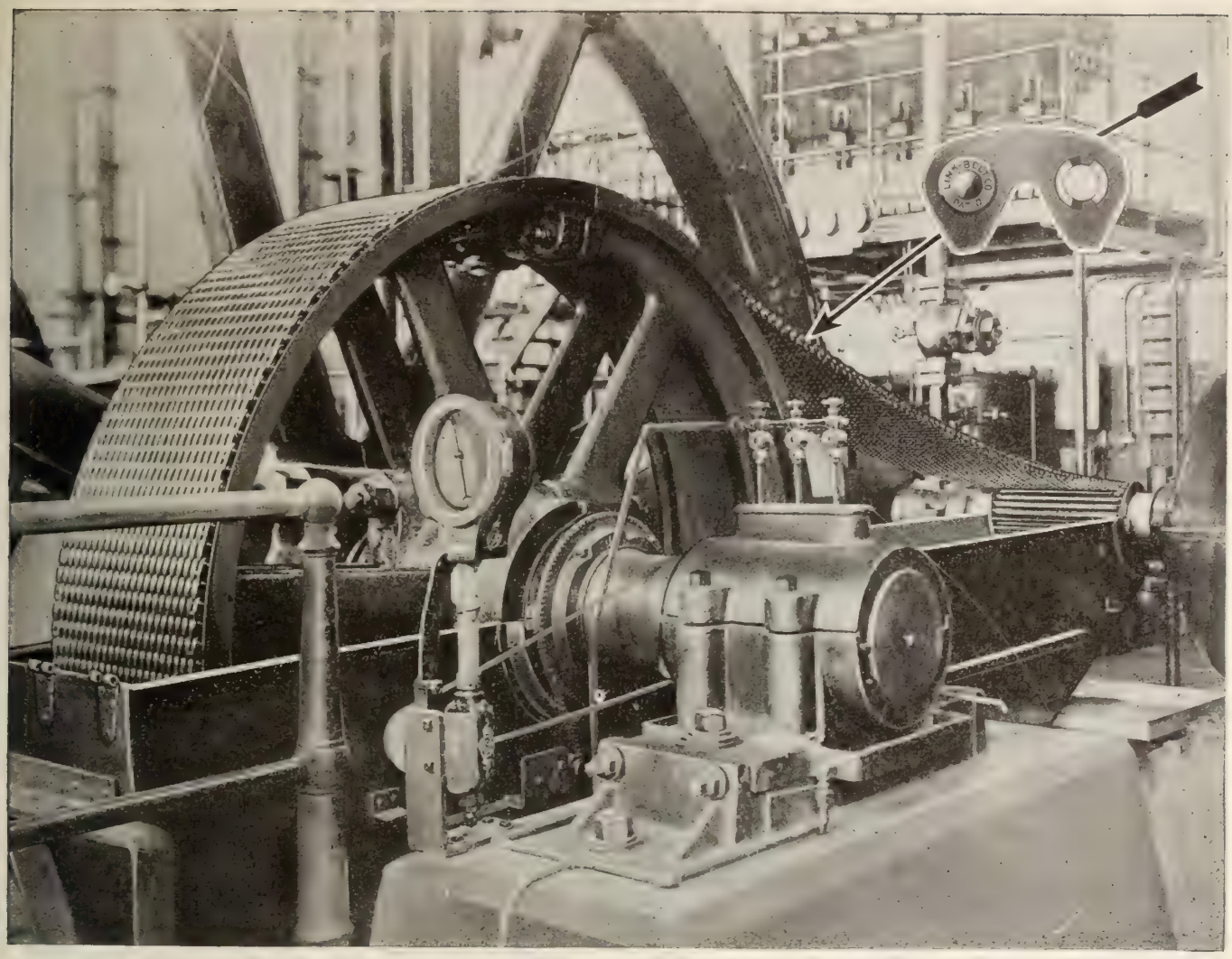
In the recent annual examinations of the Toronto Technical School, session 1919-20, in the Typography branch—that is the department where they learn how to set type—only 27 boys out of the whole city passed, of whom 10, or nearly 38 per cent. were boys of our own Composing Room, while in two out of the three classes MacLean boys stood at the head.

Several of our papers are the best of their class in the world but we are still far from satisfied with the service we are giving. As we can afford it, as the country grows, as our business grows, the service will be improved. We ask our readers to take these Technical School results as an evidence of our efforts to serve them better and better, for by giving a superior training to these boys we are laying the foundation for the still better work we hope to do in the future.

Readers can help us to give them a better service by sending in—direct to the President, Vice-President or General Manager—criticisms and suggestions.

POWER HOUSE

Montreal Toronto Winnipeg Vancouver



MODERN Science believes that, some day, Industry will draw its power directly from the sun. Science is probably right. But, in the meantime—

Business Science has to solve immediate problems, as, for instance, the problem of efficient and economical transmission, by mechanical means, of power developed by mechanical means.

And this can be, and is being, done in a scientific way—with Link-Belt Silent Chain Drives.

This method of transmitting power is as far advanced from the methods of Yesterday as Modern Science is advanced from the Science of the day of Columbus.

Witness above a 275 horsepower Link-Belt Silent Chain Drive, operating in the refrigerating plant of the Burgess Sulphite Fibre Company, at Berlin, N. H.

Link-Belt Silent Chain is Flexible as a Belt, Positive as a Gear, More Efficient than either.

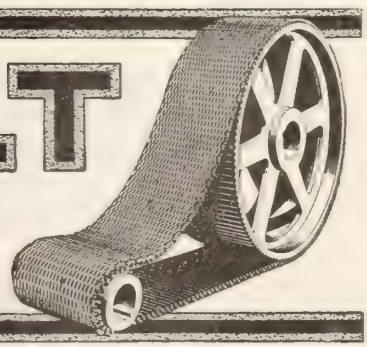
It delivers 98.2% of every unit of power developed.

It operates smoothly, surely, at the highest speeds. It is steel-encased, protected from dust, and safeguarding workmen, and is lubricated by a constant oil bath.

It represents the highest achievement of power transmission engineers. It is the Ideal method of driving all types of machinery.

CANADIAN
LINK-BELT Co., LIMITED
WELLINGTON AND PETER STREETS
TORONTO

LINK-BELT
SILENT CHAIN
FOR POWER TRANSMISSION



"Tuff Stuff"

300 Foot Conveyor Belt

"Efficiency" Brand

This is not a very big belt, in fact we have another ready for delivery over 1100 feet long. "Efficiency" Brand Conveyor Belts have achieved the ideal in construction for

Strength ***Durability***
Adaptability ***Easy Troughing***

In "Efficiency" Conveyor Belting there is an extra thickness built in where the idlers contact, insuring longer wear to the belts.

If you have Conveyor Belt or Transmission Belt problems, let our expert endeavor to assist you. Your communication will be always welcome and will receive our prompt attention.

GUTTA PERCHA & RUBBER LIMITED

Manufacturers of High Grade Mechanical Rubber Goods

Head Offices and Factory, TORONTO

REGISTERED
COPPUS
U.S.PAT.OFFICE

In the Refrigerating Industry

COPPUS TURBO BLOWERS EFFECT STEADY SAVINGS

In the modern plant of the New York Ice Company, New York City, this 22" COPPUS Turbo Blower has been saving time, money and labor ever since installation in April, 1917. It has **made possible** the use of cheap fuel, and **made sure** the maintenance of constant steam pressure. So satisfactory has been the service of this COPPUS Blower that two more blowers have since been purchased for other plants of the New York Ice Company.

COPPUS Turbo Blowers are cutting down fuel costs and keeping up steam pressures in cold storage and artificial ice plants all over the country. Automatically regulated, self-oiling, quiet-running—COPPUS Turbo Blowers are by far the most efficient means of securing mechanical draft.

Let our engineers tell you just what COPPUS Blowers can save you in your boiler room. Write for Blower Catalog.

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 PARK AVE., WORCESTER, MASS.

Agents for Montreal
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block
Calgary, Alberta

COPPUS TURBO BLOWER

ECONOMY
RENEWABLE
FUSES

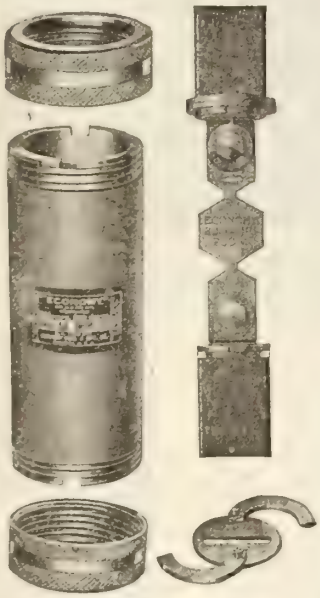
Economy Fuses cut annual fuse maintenance cost 80%.

The only part destroyed when an Economy Fuse blows is the inexpensive strip of fusible metal.

This is almost instantly replaced by a new Economy "Drop Out" Renewal Link. The main portions of the fuse assembly — fibre cartridge — end caps — winged washers — are used again and again.

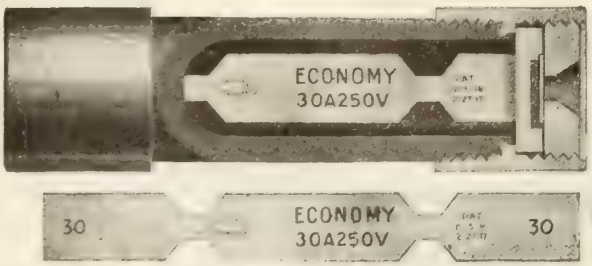
Dependable protection is obtained by the absolutely accurate rating of the link. Thus does economy and dependability combine to make Economy Fuse Serviceability.

Sold by all leading electrical jobbers and dealers.



Disassembled view knife-blade type showing Economy "Drop Out" Removal Link and Winged Washers.

Economy Fuse & Mfg. Co. of Canada
Limited
Unity Building
Montreal - Canada



Sectional view, ferrule type Economy Fuse.

Economy Fuses were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be approved in all capacities by the Underwriters' Laboratories.

Starrett Hack Saws

For forty years the products of The L. S. Starrett Company have helped machinists serve the country's need.

Copy of Hack Saw Chart C. D. will be sent free on request.

The L. S. STARRETT Company
The World's Greatest Toolmakers. Mfrs. of Hack Saws Unexcelled.
Athol, Mass.
42-49

Starrett Tools

Simplifies and Speeds Valve Operation –

No ladder needed. No risk incurred. No time lost. Simply pull the chain of the ingenious.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

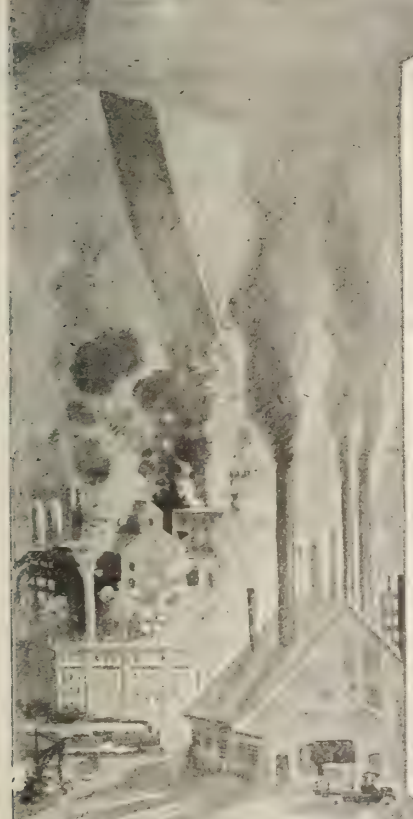
—and any overhead, out-of-reach valve can be quickly and easily operated FROM THE FLOOR.

For efficiency's sake get this safe, most practical and inexpensive device—from your dealer.

BABBITT STEAM SPECIALTY COMPANY
NEW BEDFORD, MASS.
93-48

FAIRBANKS-MORSE

FAIRBANKS-MORSE QUALITY
F M
100%



The Power behind the Wheels of Industry

POWER—mechanical force—harnessed, transmitted and utilized in its most economical phase—is always associated with The Canadian Fairbanks-Morse Co., Limited, whenever the modern oil engine is mentioned.

Wherever boats ply the waters the Fairbanks-Morse C-O engine is found. In the fishing boat the sturdy Type "M" does it duty. A quarter of a million farmers are helping to increase the world's supply of food with the Type "Z". In hundreds of the country's great industrial plants the powerful Fairbanks-Morse Type "Y" is furnishing the power that is speeding up production, keeping down costs, and helping the world of commerce right itself.

Saving time and labor, lowering operation cost, and giving a service that is as near 100% as possible is the record of Fairbanks-Morse engines, for behind each Fairbanks-Morse engine is that 100% quality standard on which the Fairbanks-Morse institution is founded.

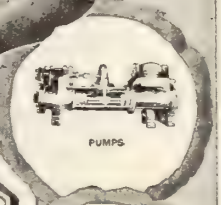
Back of every Fairbanks-Morse oil engine is the service of our experts. Avail yourself of this quality and this service. Concentrate your buying and make the Canadian Fairbanks-Morse catalogue your guide.

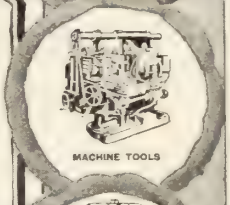
The Canadian Fairbanks-Morse Co. Limited

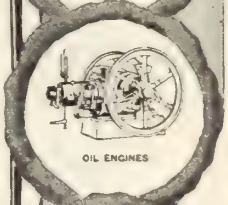
Canada's Departmental House for Mechanical Goods

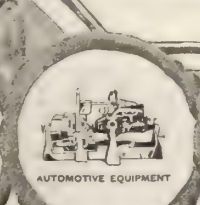
Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina Saskatoon Calgary
Vancouver Victoria

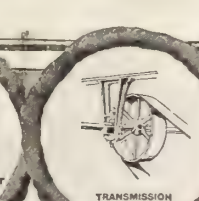
6

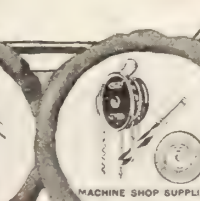


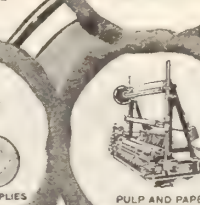












Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

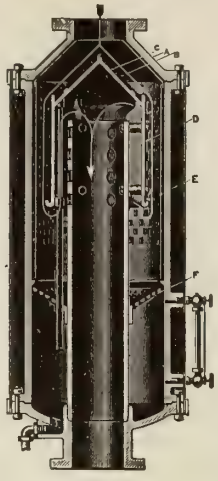
Booklet on Request

The Canadian Fairbanks-Morse Co., Limited

Sole Distributors for Canada

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY

218 South Geddes St. SYRACUSE, N. Y

General Sales Agents

Canadian Fairbanks-Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

AVOID THE FREQUENT REPACKING OF VALVES IN UNHANDY PLACES.

You can save yourself unnecessary trouble by packing the valves in out-of-the-way places with a packing that you know has the long-service quality.

You take no chances when you Pack the Valves with

TRADE MARK
"PALMETTO" Twist Packing
REG U S PAT OFFICE

BECAUSE it's made of materials having high tensile strength with such lubricant in each single strand as to cause it to retain its packing qualities.

Why not use "Palmetto" Twist?

If you are in doubt about "Palmetto" let us send you a sample spool to test. At the same time we will send you a working sample of the braided—no charge—we wish to convince you.

GREENE, TWEED & CO.

Sole Manufacturers

109 Duane St. - New York

Canadian Agents:
The Canadian Fairbanke-Morse Co., Limited
Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver

If It's Rubber—We Make It

In every factory, office, store and household some article of rubber is used daily as an important part of the equipment. Few users recognize its utility or its quality—to them the important item is price.

When you buy rubber goods be certain that you get a Dominion Rubber System Product. It is your assurance of superior quality and satisfactory service. These products include rubber goods for every conceivable purpose, in standard stock sizes, or specially made to meet your needs in factory, mill, mine, lumber-camps, shipbuilding, marine and other industry.

Dominion Rubber System Products

BELTING—Dominion Friction Surface Belting for power transmission prevents practically all power waste.

HOSE—For steam, air, water, oil, acids, fire and every other regular and special purpse.

PACKINGS—Our special packings for high and low compression service, meet every requirement of modern engineering conditions.

FIRE EQUIPMENT—Hose, coats, salvage covers, reels, brass fittings, helmets and every fire fighting requirement.

MOULDED RUBBER—Our lines are particularly complete and include matting, sheeting, floor treads, tiling, gaskets, plumbers' supplies, and moulded and cut goods for every conceivable purpose.

No matter what rubber goods you may need, or what your problem may be, our technical experts can remove all element of doubt and save you many dollars in time and costly experiments.

Phone or wire our nearest service branch for information or catalogue.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the Same High Standard as Dominion Friction Surface Belting

Dominion Rubber System Service Branches

Halifax	Fort William	Toronto	Edmonton
St. John	Winnipeg	Hamilton	Calgary
Quebec	Brandon	London	Lethbridge
Montreal	Regina	Kitchener	Vancouver
Ottawa	Saskatoon	North Bay	Victoria

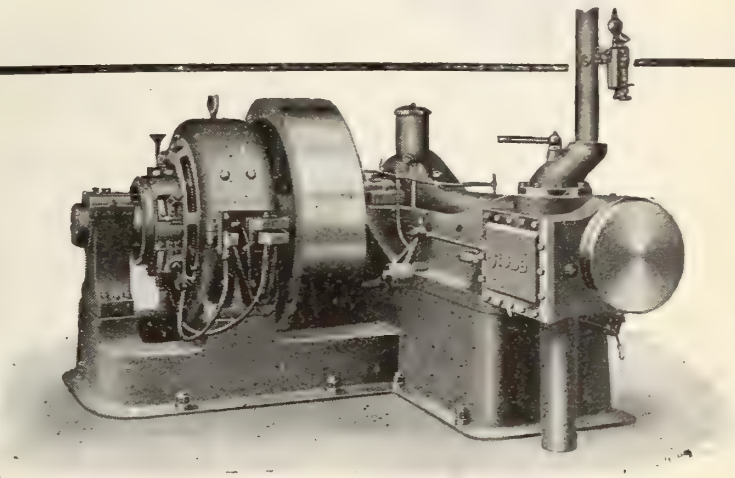
97

ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
Phone
Westmount 6800

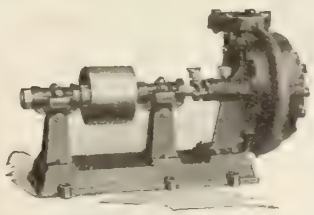
Toronto Office:
20 Victoria
Street

AMERICAN-MARSH PUMPS

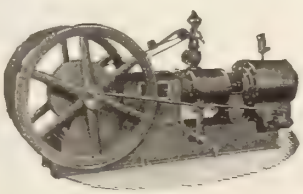
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

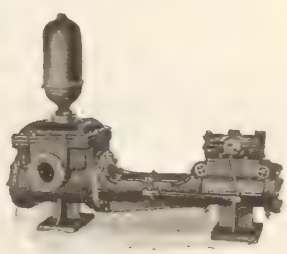


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



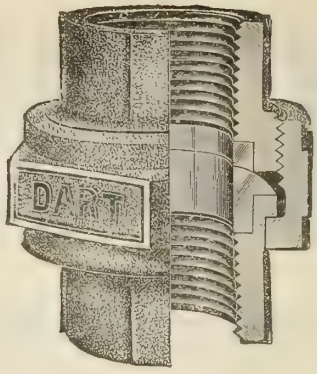
Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

Dart Unions



Really Troubleproof and Economical

Give the Dart Union a trial and you'll say you've connected up with a real time, money and worry-saver.

The Bronze Face and Seat prevent deterioration and loosening up in service.

Manufactured by Dart Union Co., Limited, Toronto, Canada

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office

Fireman's CO_2 Guide on Boiler Front

Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet

"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 EMPIRE BLDG., NEW YORK

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

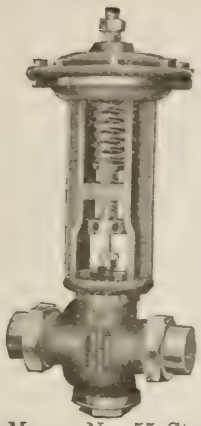
The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

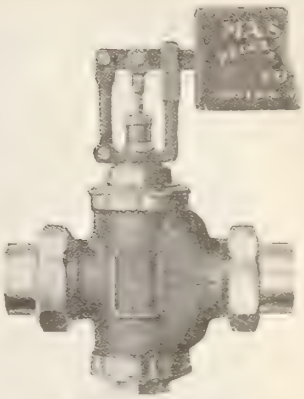
Trimont Mfg. Company

Roxbury (Boston,) Mass., U.S.A.

SERVICE
RELIABILITY
POSITIVE ACTION
DEPENDABLE REGULATION



Mason No. 55 Style
Pump Pressure
Regulator



Mason Balanced Valve
Weight & Lever Type

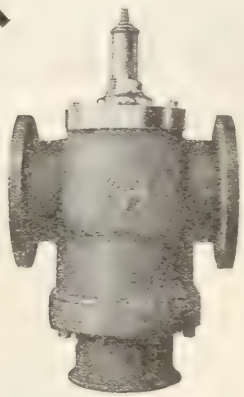
THE TRADE MASON MARK

TRADE MASON MARK

MASON

Mason Standard
Reducing Valve
Bronze Body

Mason Standard
Reducing Valve
Iron Body



ON REGULATING APPLIANCES
MEANS
THE SAME AS THE
"STERLING" MARK ON SILVER

THE MASON REGULATOR CO.
BOSTON, MASS.

MADE IN CANADA BY
THE MASON REGULATOR & ENGINEERING
COMPANY LIMITED

The New Lincoln Electric Headquarters

ON WEDNESDAY, June 30th, the Lincoln Electric Co. of Canada, Limited, moved their Head Office from the Temple Building—as well as their Welding Plant from the foot of Jarvis Street, over to their new quarters at 136 John Street, Toronto.

With all departments under the one roof, users of Lincoln Electric Welding are assured a most efficient service.

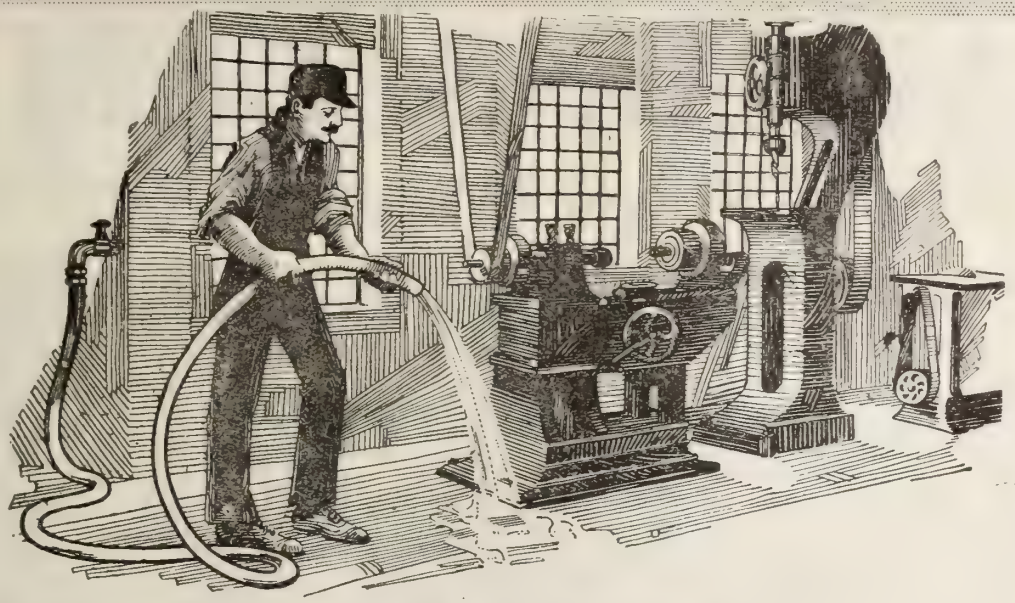
All readers of this publication are cordially invited to call and inspect these new quarters. You will note that the new telephone number for all departments is Adelaide 7200.

"Link Up With Lincoln"

The Lincoln Electric Company of Canada, Limited

136 John Street, TORONTO Phone Adelaide 7200

Also in the Coristine Building, Montreal



Tradition was Disregarded When Goodyear Built Hose

THE beaten path of established customs has rarely been followed by Goodyear scientists.

Rapidly-changing industrial conditions demanded new and more efficient methods.

Breaking away from preconceived ideas of tire-building created the Goodyear Cord Tire—the finest tire in the world.

Applying the same analytical methods to industry, Goodyear redesigned Industrial Hose—scientifically developed it to meet the needs of present-day industry.

Take Goodyear Water Hose as an example.

Water Hose is rarely destroyed through high pressure. But every year thousands of feet is prematurely worn out because the *outside covering* is not sufficient to stand the constant scuffing and pulling over cinders, pieces of iron—against the edges of machines—and so on.

To overcome this, Goodyear Water Hose is built with an extra thick covering of exceptionally tough rubber. A cover which gives greater protection, *longer wear*—lowers costs. And a good inner tube and strong fabric are in keeping with its superior covering.

There is a particular Goodyear hose scientifically designed—as in the case of Goodyear Water Hose—for every Industrial use.

A man trained by Goodyear will be sent to study *your* hose problems—without obligation. Phone, wire, or write the nearest branch.

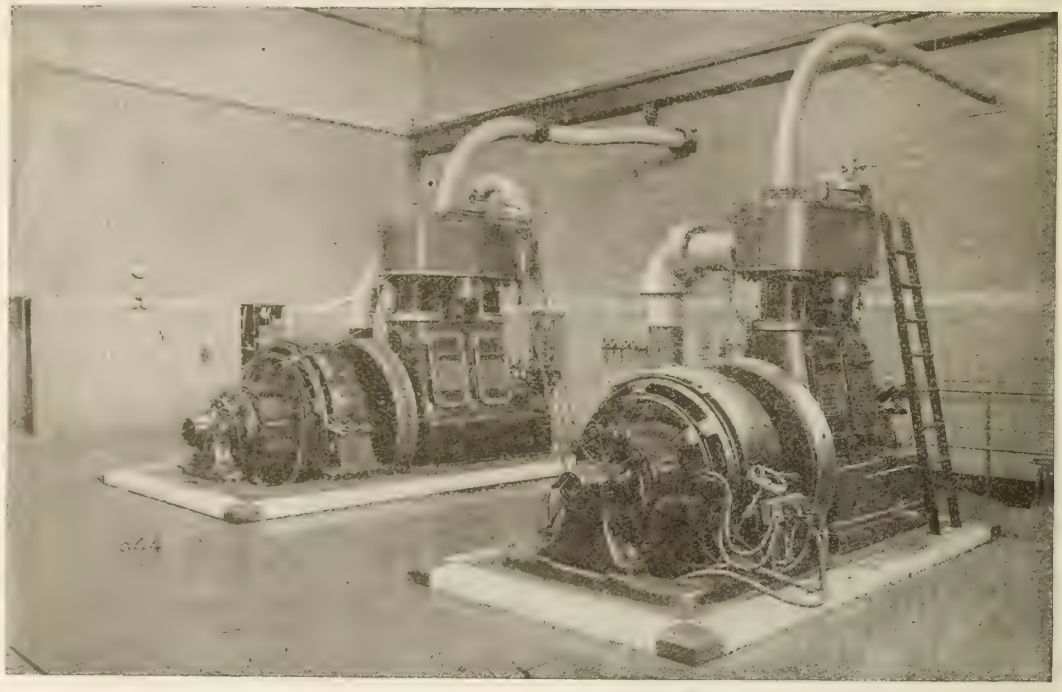
The Goodyear Tire & Rubber Co. of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.

GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE

LAURIE & LAMB

"Quality' Power House Equipment



Belliss & Morcom Engines
At McGill University Power House. Total Horse Power, 1010 B.H.P.

What Better Estimation of Worth Than This?

The Belliss & Morcom engines shown in illustration were chosen in preference to other makes by the engineers of the McGill University as best adapted for their power house requirements. This is not the first instance where Belliss & Morcom engines and air compressors have been shown the preference. Their scientific principles and design, and their long-service records are sufficient proof of merit for any practical engineer. That's why you'll find them in many of Canada's most modern engine rooms. When you're in the market do not fail to investigate the Belliss & Morcom line. *Literature on request.*

We are Prepared to Supply and Install

Steam Engines	Condensing Plants	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Complete Power Plants Designed and Erected

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. MONTREAL

The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

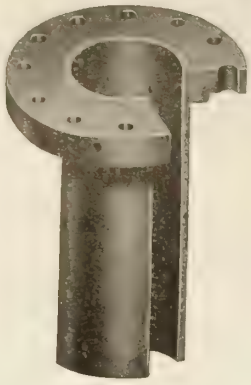
OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

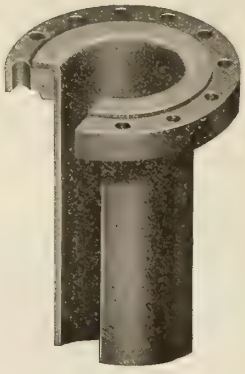
Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

P&H FLANGED PIPE JOINTS



SCREWED



P.H. LAP

P&H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

Made in Canada by

PAGE-HERSEY IRON, TUBE & LEAD CO. LIMITED

Head Office: **100 CHURCH STREET, TORONTO, ONT.**

CRANE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

WE WELD EVERYTHING

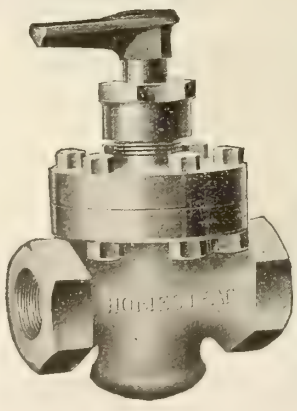
Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

HOMESTEAD
Quarter-Turn Valves

For All Classes of Service



Whenever the duty is exceptionally severe and frequent opening and closing is required insist upon Homestead **Quarter Turn Valves.** They are the "last word" in valve efficiency. A quarter-turn closes Homestead Valves tight — a quarter-turn opens them to a straightway unobstructed flow.

Tightness is absolutely assured by a patented wedging cam that automatically forces the plug downward in closing and instantly releases it again when the handle is turned to open the valve.

Homestead Valves embody the highest quality workmanship and material and will stay tight under any specified pressure up to 5,000 lb. Made in two, three and four way types with semi-steel, brass, or cast steel bodies.

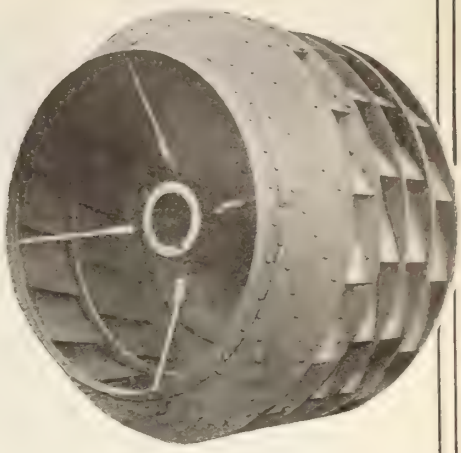
The Homestead Way is the only way. Investigate!

Homestead Valve Mfg. Company
Homestead, Pa. **Works: Homestead**

GREEN'S

HI-EFFICIENCY HI-SPEED

RADIAL FLOW FANS

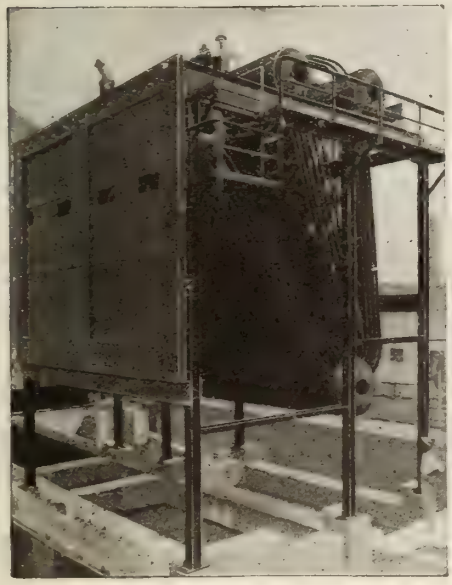


For Reliable, Economical Service
Instal This Fan

It is recommended for its lower power cost, accessibility, sturdy construction and other superior features which we will be pleased to point out to you. Let us have your name and address by the next mail.

Our new Radial Flow Fan Bulletin No. 152H sent on request.

GREEN'S ECONOMISER, LIMITED.
TORONTO



Connelly Water Tube Boilers (Patented U.S. & Canada)

are of the 4 drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crow bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. Leonard & Sons, Ltd. Head Office & Works
LONDON, CANADA

Branches
1790 St. James St., Montreal, Que. 62 Water St., St. John, N.B.

AGENTS
E. J. Philips & Sons, 57 Queen St. West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. Johns, Nfld.

Established 1834

LEONARD

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

Turbo Generator Units

25 Cycle

1—8000 K.W. (Normal rating) Allis Chalmers Turbo-Generator, 3 phase, 4 pole, 6600 volt, rotating field, condensing high pressure 175-lb. gauge at throttle, 28-in. vacuum. Will not exceed 18-lb. dry steam per K.W. when working under full load. Condenser: 16,000 sq. ft. surface Condenser with auxiliaries. Will sell with or without Cendenser.

1—6000 K.W. General Electric-Curtiss Horizontal Turbo Unit, 3 phase, 6600 volts. 1500 R.P.M., non-condensing, with exciter, expansion joint, etc., 170-lb. steam pressure.

1—2500 K.W. Westinghouse-LeBlanc Turbo Unit, 3 phase. 2 pole, 2400 volts, 1500 R.P.M. Condensing, 150-lb. pressure, dry and saturated steam, 28-in. vacuum. With Condenser.

1—2500 K.W. Westinghouse-LeBlanc Turbo Unit, 3 phase, 2400 volt, condensing 150-lb. steam pressure. 28-in. vacuum.

1—2500 K.W. Westinghouse-Parsons Turbo Unit, 3 phase, 2200 volt. 1500 R.P.M. 150-lb. steam pressure.

1—2000 K.W. General Electric-Curtis Vertical Turbo Unit, 3 phase, 2200 volt, 750 R.P.M., 4 pole, 150-lb. steam pressure. 6750 sq. ft. Surface Condenser with auxiliaries.

1—950 K.W. Westinghouse-Parsons, horizontal Turbo Unit, 3 phase, 380 volt, 1500 R.P.M., 150-lb. pressure, 3000 sq. ft. Surface Condenser with auxiliaries.

1—750 K.W. Westinghouse-Parsons, mixed pressure Turbo Unit, 3 phase, 380 volt, 1500 R.P.M. Steam conditions 15.5-lb. absolute, 23-in. vacuum, with condenser.

1—750 K.W. Westinghouse Turbo Unit, 2 phase, 440 volt, 1500 R.P.M. Condensing. With Condenser and auxiliaries.

1—500 K.W. Westinghouse-Parsons Horizontal Turbo Unit, 3 phase, 2 pole, 370-400 volt, 1500 R.P.M. Condensing. 150-lb. steam pressure, no superheat. With condenser and auxiliaries.

MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, Seattle Plants: Lincoln, N.J., and Linden, N.J.

Buyers and Sellers of New and Used Machinery

A Continent-Wide Service

Not Primarily a Fuel Saver, Yet It Has a Top-Notch Record for B.T.U.s Saved.

We are extremely conservative when stating the fuel-saving ability of the Dunham Radiator Trap.

In home heating systems, the methods of firing vary so, that we positively refuse to make any definite claims regarding economy. But large installations form a different story—and one which you will find most interesting. May we tell it to you?—that you may see just where the Dunham Radiator Trap fits into your fuel-saving scheme.

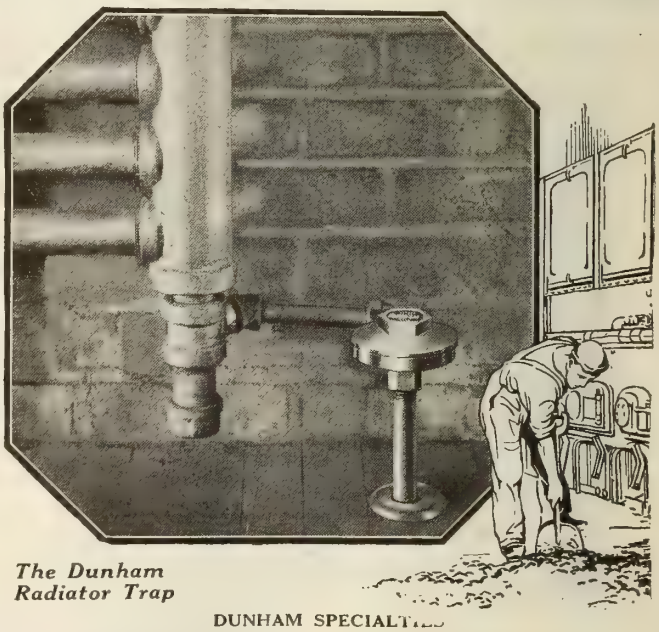
"The Dunham Hand Book" is full of facts. Send for your copy.

C. A. DUNHAM CO., LTD.

TORONTO, CANADA

Halifax Vancouver Winnipeg
Ottawa Montreal Calgary

London: 64 Regent House, Regent Street W. 1.



The Dunham Radiator Trap

DUNHAM SPECIALTIES

Packless Radiator Valves
Radiator Traps
Drip Traps
Blast Traps
Air Line Valves
Vacuum Pump Governors
Reducing Pressure Valves
Oil Separators
Suction Strainers
Air Vents
Return Traps
Check Dampers
Damper Regulators

MADE IN CANADA

The DUNHAM HEATING SERVICE

"MEAD-MORRISON"

CANADIAN MM ©

COAL and ASH HANDLING MACHINERY

Manufactured in Canada

DEPENDABLE SERVICE

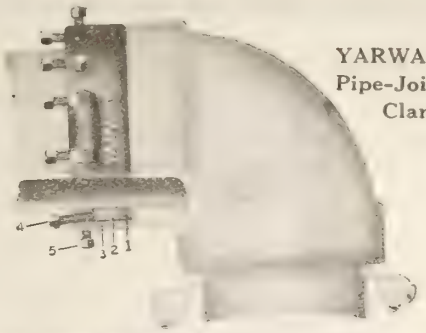
Coal Handling Bridges
Weighing Larries
Coal Crushers
McCaslin Conveyors
Clam Shell and Orange Peel Grab Buckets

Put Your Problem Up to Us!

AGENTS' NAMES:

Howard Turnbull, Toronto
Kelly Powell, Winnipeg
Robert Hamilton, Vancouver

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.



YARWAY
Pipe-Joint
Clamp

Description.—1. Split ... 2. ... screws 4. 3. Outside ring, bolted around pipe by bolts 6, secured by ... adjusting screws 4.

The Best Insurance Against Leak Losses

With a Yarway Pipe Clamp, one workman can stop most any steam-line leak, large or small—stop it permanently and in less than ten minutes.

Any leak in your steam lines, whatever its size, is a serious matter with coal at its present prices. Yet the cost of a shut-down to replace the damaged section of pipe is even more serious.

Perhaps, in order not to interfere with production, you are overlooking the leaks—and paying the increased coal bills. But if you could have these leaks completely and permanently repaired in a few minutes, with no interference to work, wouldn't you rather save your coal?

YARWAY

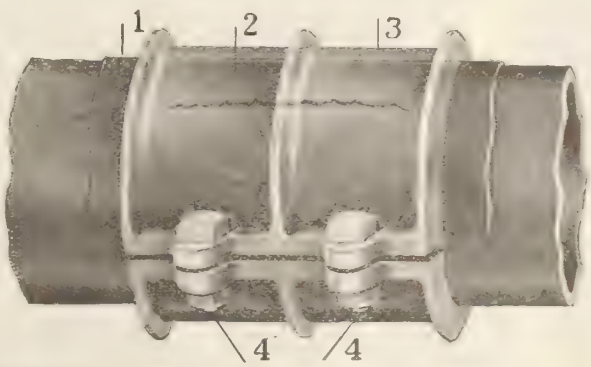
Pipe Clamps

The Yarway Pipe-Joint Clamp stops leaky joints. The Yarway Holtite Pipe Clamp stops holes and splits in straight pipe. Both are stocked in all the usual sizes for immediate shipment.

A supply of Yarway Pipe Clamps on hand is the best possible insurance against leak losses. We'll be glad to send you one to test, without obligation. Write for Bulletin No. C-805, and see what users say about them.

Yarnall-Waring Company
7604-20 Queen St.
Chestnut Hill Philadelphia

Carried in stock by dealers in thirty principal cities



Yarway Holtite Pipe Clamp

Packing (1) is placed over hole or split (2) in pipe; metal clamp (3) is then placed over packing and around pipe; bolts (4) tighten clamp and hold it in place.

Every Boiler—Whether Fired by Coal, Pulverized Fuel, Oil, Waste Heat, Natural Gas, Bagasse or Refuse—To Operate Economically Must Be Cleaned at Frequent, Regular Intervals.

Every type and grade of fuel produces soot. When certain kinds of fuel are used under favorable conditions of combustion, the deposit is less than at other times. But under no circumstances is the deposit of insulating matter ever so small as to warrant the omission of frequent, regular cleaning.

As an illustration, it would be hard to find a cleaner fuel than natural gas. Yet one of the country's large central stations which uses natural gas at certain seasons of the year, recently found that, due to its failure to operate its mechanical soot blowers regularly after the Spring switch from coal to gas, its flue gas temperatures were 200° higher than they should have been. By using the soot blowers once or twice in 24 hours, they kept the boilers clean—reduced flue gas temperatures—saved fuel—and increased boiler efficiency and capacity.

When it comes to boilers fired by blast furnace gas and waste heat from open hearth or reverberatory furnaces, the gases are so loaded with foreign material that boiler capacity and efficiency can only be maintained by the use—four to six times a day—of mechanical soot blowers.

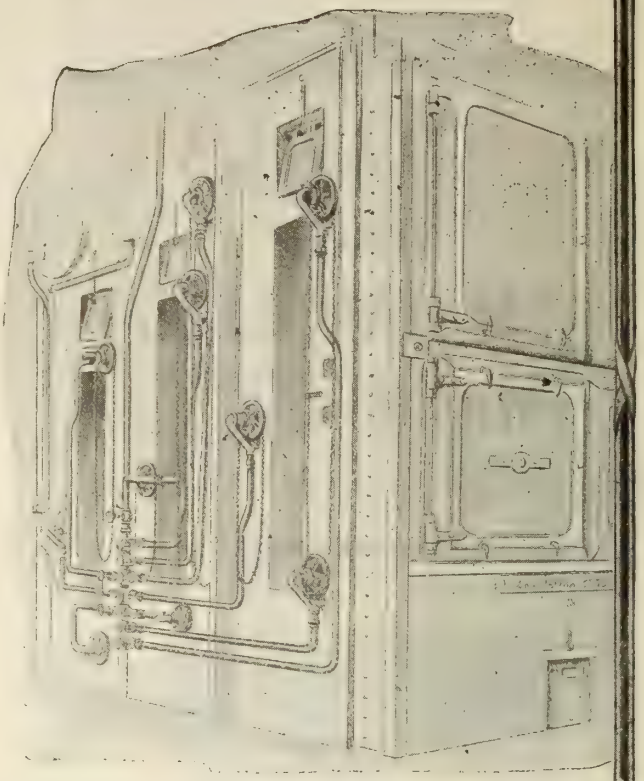
What is true of gas-firing is doubly true of oil and coal firing. You can not get proper heat transference through soot and ash covered surfaces. Diamond Soot Blowers are a necessary part of every steam boiler and every economizer.

Write for full information, requesting your copy of Bulletin 280.

DIAMOND POWER SPECIALTY COMPANY
WINDSOR, ONTARIO

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL



When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.
Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

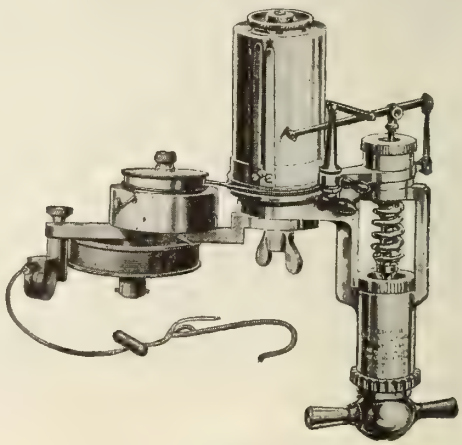
Canadian Agents:
Milton and Prentiss,

Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recordi Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

Mr. Engineer!

DO YOU OWN AN AMERICAN THOMPSON IMPROVED INDICATOR?



You owe it to yourself to purchase one of these NOW and secure all the benefits it makes possible. The price is right and easy terms can be arranged.

Write us.

Our Canadian Agents:

Canadian Fairbanks-Morse Co., Ltd.

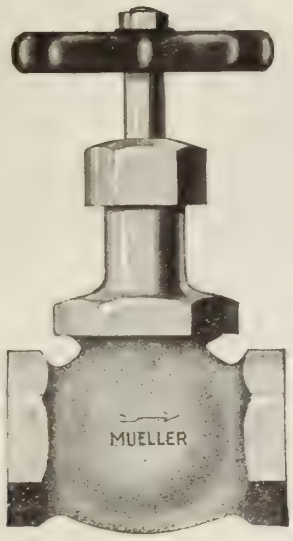
St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria

American Steam Gauge & Valve Mfg. Co.

New York Chicago BOSTON Atlanta Pittsburgh

MADE IN CANADA

MUELLER
BRASS GLOBE VALVES



Registration Numbers:

Province of Ontario No. 1780
for 175 lbs. pressure.

Province of Alberta No. 1116
fo 150 lbs. pressure.

MUELLER Brass Globe Valves are recommended for a working pressure of 125 lbs. The special features appended justified voluntary registration for working pressures of 175 lbs. and 150 lbs. by the Chief Boiler Inspectors of Ontario and Alberta respectively:

DESIGN
Special barrel shaped body. Female thread on bonnet.

METAL
High copper and tin content giving a tough, close grained casting with pressure resisting qualities.

PACKING
Special packing composed of asbestos and graphite with lead core wire to resist high pressure.

MUELLER Globe Valves are being substituted for competitive patterns of composition disc Valves.

Samples on Request

H. MUELLER MFG. CO., LTD.

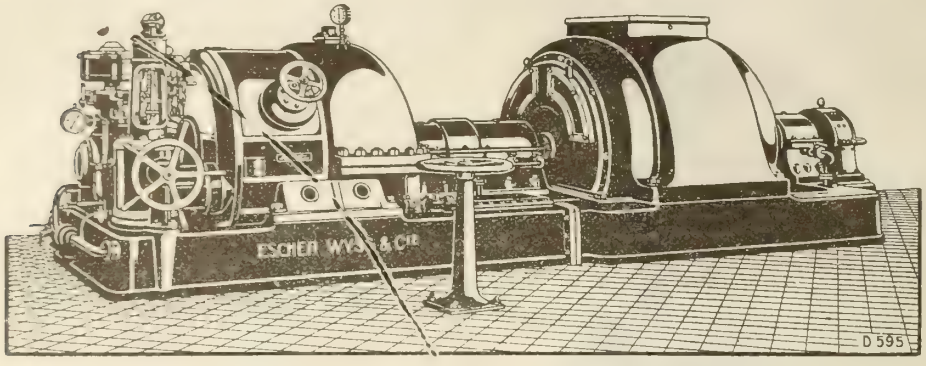
SARNIA CANADA

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

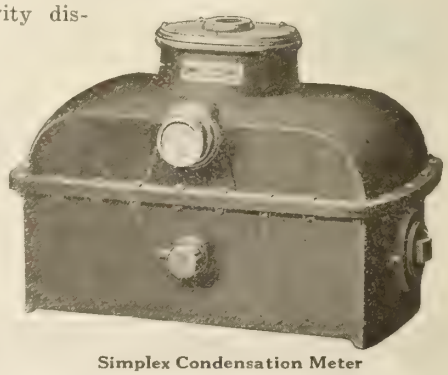
TRAPS AND METERS

ments for:

Heaters
Insulation
Variators
Separators
W.I. Pipe and Standard Flanged Fittings
Companion Flanges
mospheric Heating.

For low pressure service ideal results are secured by the use of the Empire Steam Trap. It is the result of 35 years' experience in the manufacture of steam traps. The inverted valve seat absolutely prevents any sediment lodging on seat, and causing the trap to blow or leak. The blow-off plug is located directly under the valve seat. Float is of guaranteed seamless electro-plated copper, tested to 150 pounds pressure. The automatic air valve operates by expansion. It is placed on the highest point in cover of trap, thereby preventing the formation of an air pocket. There are two inlets, and one outlet, making it convenient to pipe; it is particularly adapted to working where there is slight head room.

The Simplex Condensation Meter gives an accurate record of the flow of condensate or other liquid, where there is a gravity discharge. Its measuring chambers are controlled by an automatic oscillating arm, which combines simplicity of operation with accuracy of measurement. It is practically noiseless in operation and requires no attention. Its construction is strong and substantial, with all parts carefully machined.



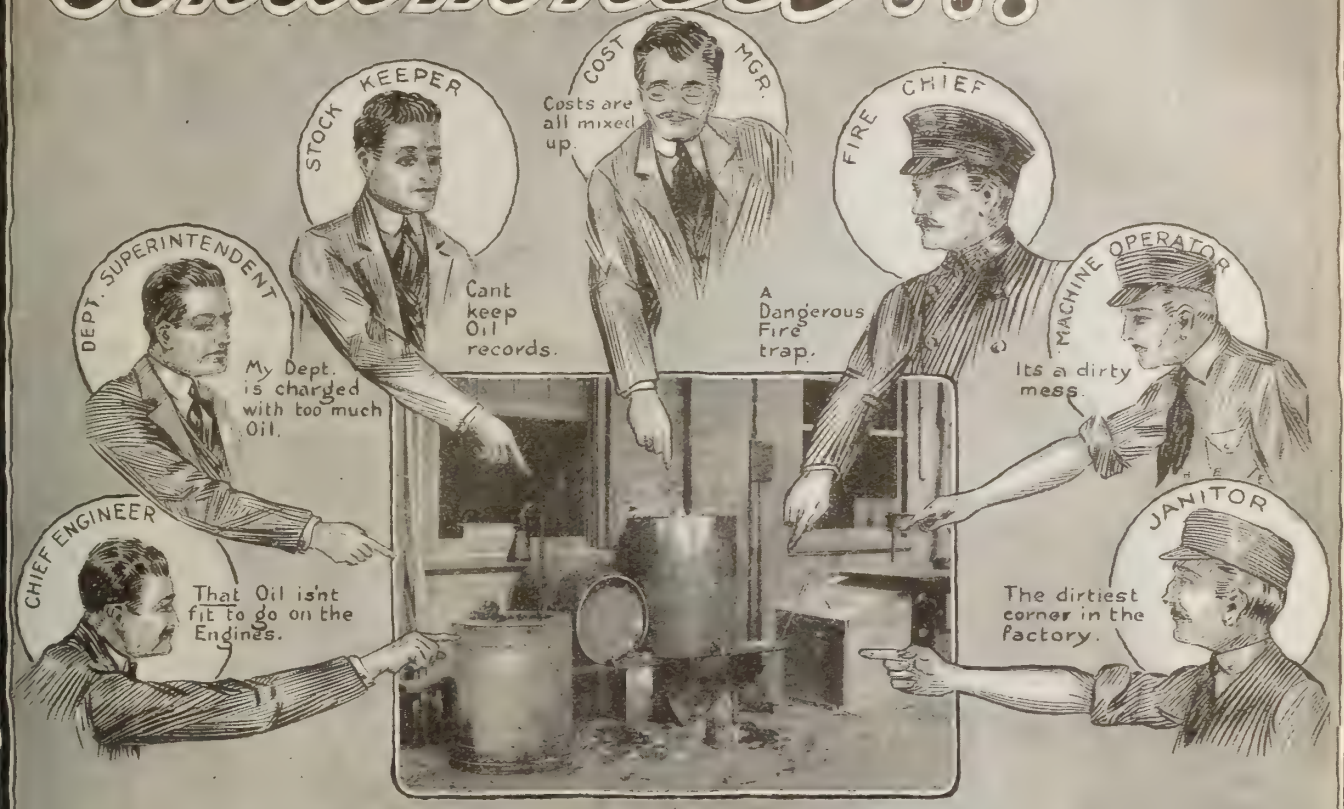
Simplex Condensation Meter

AMERICAN DISTRICT STEAM COMPANY

General Office and Works:
NORTH TONAWANDA, N.Y.

Representatives:
A. R. Williams Machinery Co., Ltd., Toronto, Ont., and Branches

Condemned!!!



MEN WHO KNOW, condemn tin tank and barrel storage, because they *waste time, money, labor,* and *oil.* Besides they are a *dangerous fire risk.*

BOWSER
ESTABLISHED 1885

Systems Remove Such Conditions

They are clean, safe and compact; efficient, accurate and reliable. Fire and explosion proof.
"THE OIL YOU'VE LOST WOULD PAY ITS COST"
Start buying yours today. Write for details.

S. F. BOWSER & COMPANY, LTD.
66-68 FRASER AVE., TORONTO, CANADA

Offices in principal cities in the U.S.

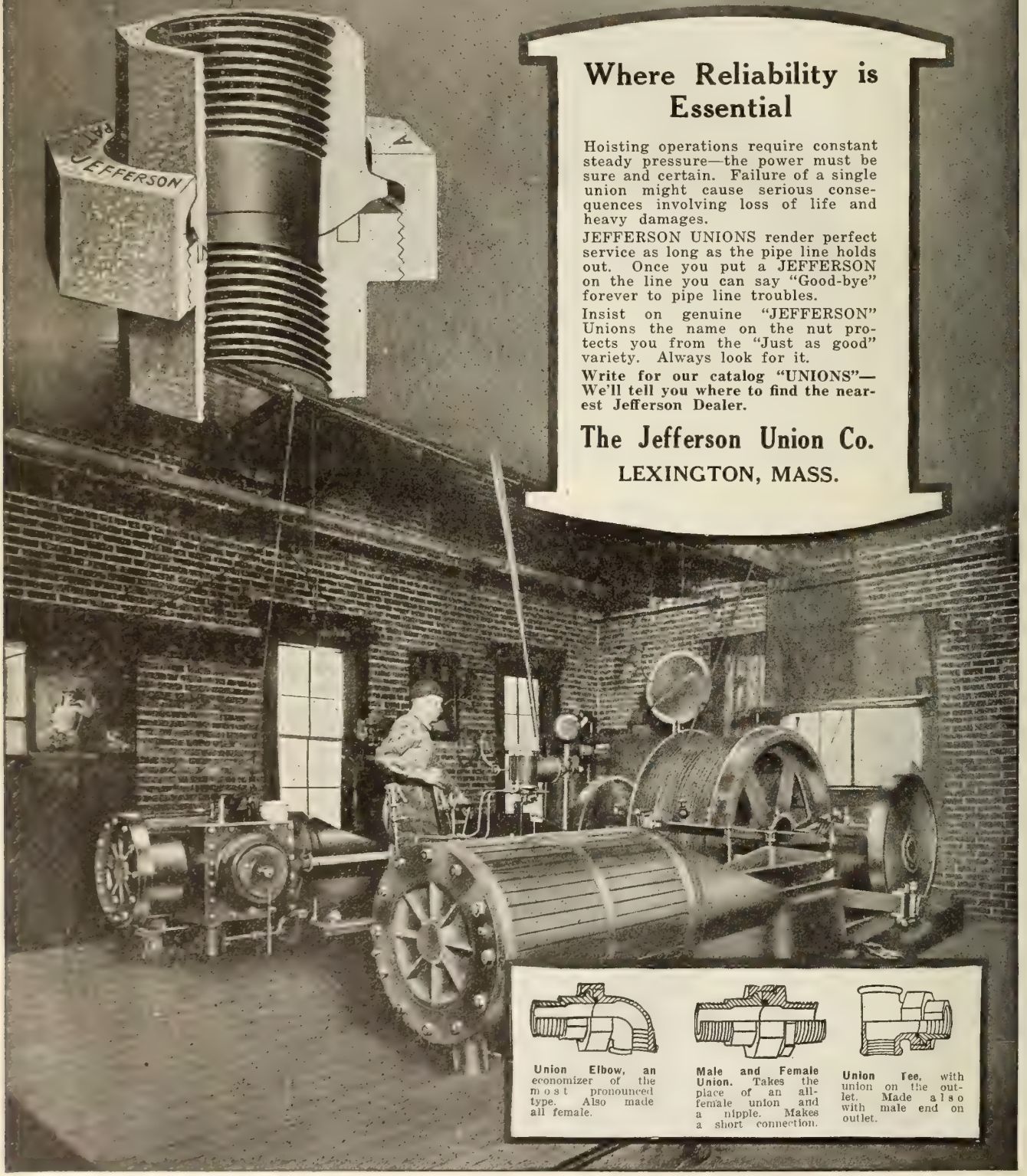
LONDON
32 Victoria St S W 1
HAVANA
Lonja del Comercio 427
PARIS
5 Rue Denis-Poisson
SYDNEY
6 Castlereagh Street

Illustration at the left shows Bowser Battery, Fig 64's, installed in place of the barrels shown in above view

Notice the improvement in surroundings and method of handling oils

JEFFERSON

"Look for the Name on the Nut"



Where Reliability is Essential

Hoisting operations require constant steady pressure—the power must be sure and certain. Failure of a single union might cause serious consequences involving loss of life and heavy damages.

JEFFERSON UNIONS render perfect service as long as the pipe line holds out. Once you put a JEFFERSON on the line you can say "Good-bye" forever to pipe line troubles.

Insist on genuine "JEFFERSON" Unions the name on the nut protects you from the "Just as good" variety. Always look for it.

Write for our catalog "UNIONS"—We'll tell you where to find the nearest Jefferson Dealer.

The Jefferson Union Co.

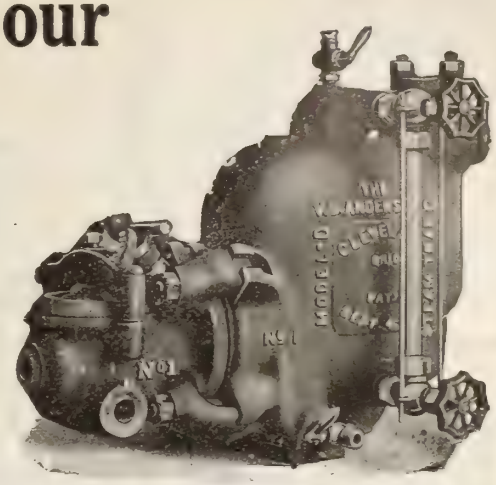
LEXINGTON, MASS.

Union Elbow, an economizer of the most pronounced type. Also made all female.

Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.

Union Tee, with union on the outlet. Made also with male end on outlet.

Leaky Traps Increase Your Operating Expenses



How much steam are you wasting by allowing it to escape into the air or the sewer, past poor steam traps?

Stop this needless increase in your operating expenses by installing

ANDERSON
Model "D" Steam Traps

They are designed to give long, tight service. The deep water seal prevents the escape of steam. Operated by a simple counter-balanced float mechanism that can not get out of order.

All dirt and sediment is caught in the self-contained removable strainer and cannot enter the trap. An outside gauge glass shows how quickly the trap is filling and discharging.

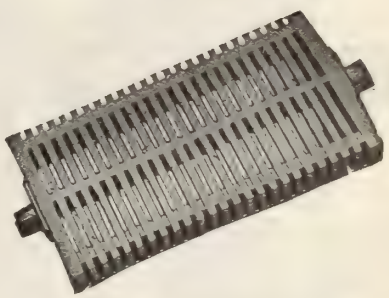
They'll quickly pay for themselves by keeping your pipe lines free from condensate **without steam loss.** Write for descriptive catalog.

The V. D. Anderson Company

1935 West 96th St., Cleveland, Ohio

Cyclone Grates Give Better Results

You can get maximum results from any grade of hard or soft coal or screenings with Cyclone Shaking or Dumping Grates. No clinker formations or fuel in ash-pits where they are installed. Their 60 per cent. air space and 90 per cent. under-draught insures perfect combustion.



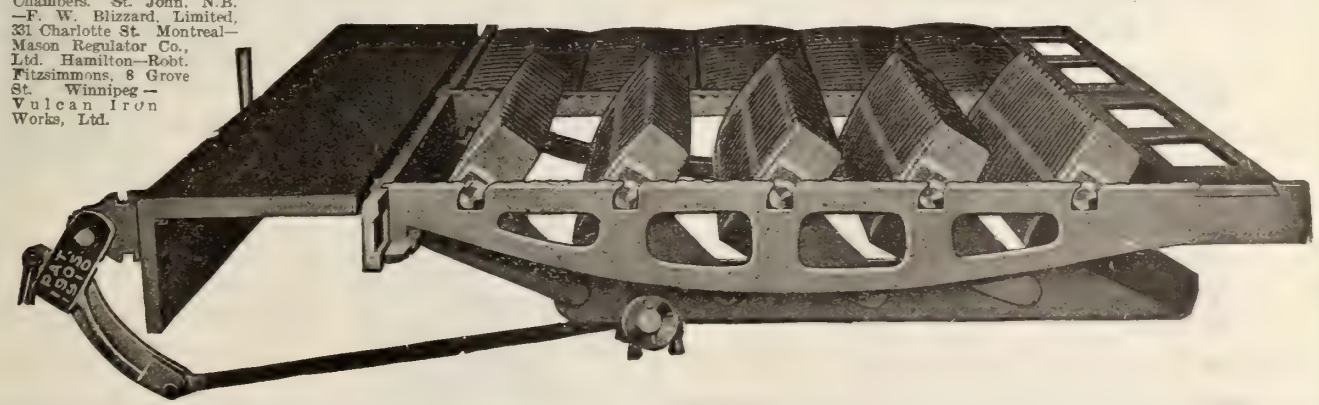
To prove to you that Cyclone Grates are easy to install and when installed will save you considerable fuel expense, and give complete satisfaction in every way we are prepared to make you a thirty day free trial offer. Have us send you the full particulars.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGhee Street Phone G. 2660 Toronto, Ont.

AGENTS: Ottawa—J. W. Anderson, Room 7, Street Chambers. St. John, N.B. —F. W. Blizzard, Limited, 31 Charlotte St. Montreal—Mason Regulator Co., Ltd. Hamilton—Robt. Fitzsimmons, 8 Grove St. Winnipeg — Vulcan Iron Works, Ltd.



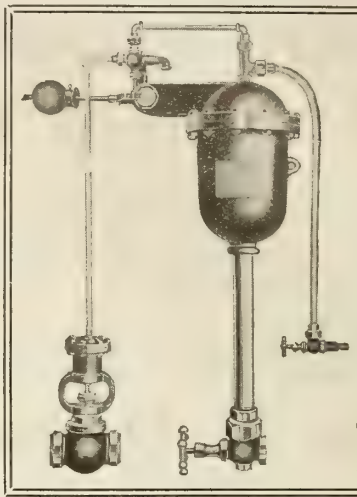
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



Insure Constant Level

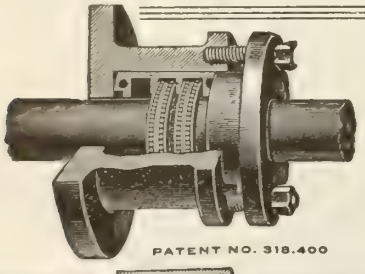
The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gauge the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way.
They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers and they feed continuously with perfect uniformity.

Write for full particulars.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.



PATENT NO. 318,400

PAT. NO.	566,899	PAT. NO.	829,116
" "	584,104	" "	830,530
" "	602,328	" "	866,103
" "	614,541	" "	878,238
" "	654,542	" "	894,587
" "	725,488	" "	895,791
" "	774,490	" "	898,086
" "	775,193	" "	905,108
" "	778,194	" "	934,629
" "	791,800	" "	979,208
" "	805,689	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
Incorporated 1897

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

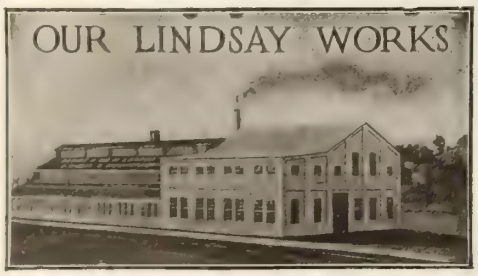
Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotland

Canadian Representative:
W. J. WALL, 134-136 Bleury St., Montreal

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo — **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

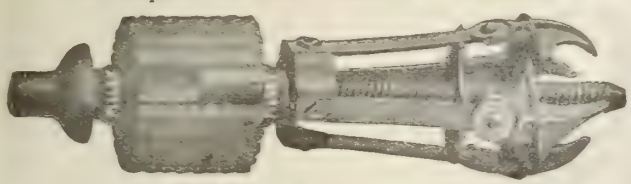
NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo

Eastern Office: 71 Fulton St., New York.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co

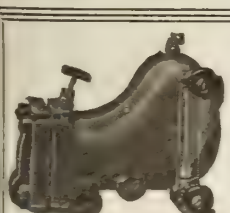
27 COTE ST MONTREAL, QUE

The J. C. Wilson Mfg., Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

MAKERS OF THE "LITTLE GIANT" TURBINE

Put Your Water Wheel Proposition Up To Us



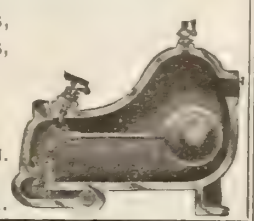
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY

26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.

No. 146 N. 7th Street, PHILADELPHIA, Pa.

ECONOMIC Carling BLOWERS SUPERIOR

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

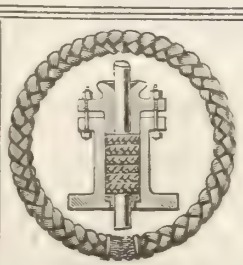
CARLING TURBINE BLOWER COMPA

Engineers and Manufacturers WORCESTER, MASS

Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities

Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

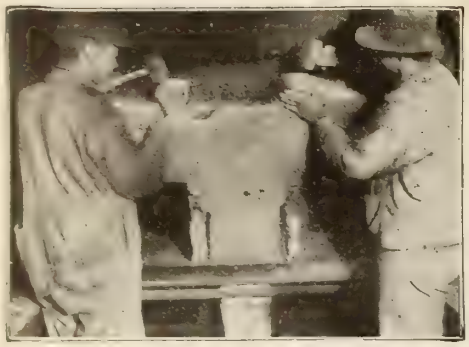
DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB
Board of Trade Building, Montreal



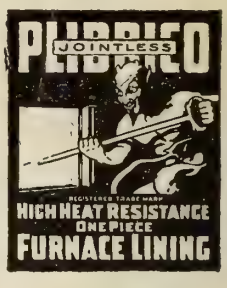
Plibrico is molded into place; needs no forms and requires minimum time and labor.

PLIBRICO Makes Air Tight Furnace Linings

Air leaks in furnace lining joints, boiler settings and baffles are the greatest preventable losses in a boiler plant. No argument should be necessary to establish the fact that **An Air Tight Furnace Lining** is a great fuel economizer.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Send for book on furnace building



Trade Mark
Reg. U.S. Pat. Office.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.
Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

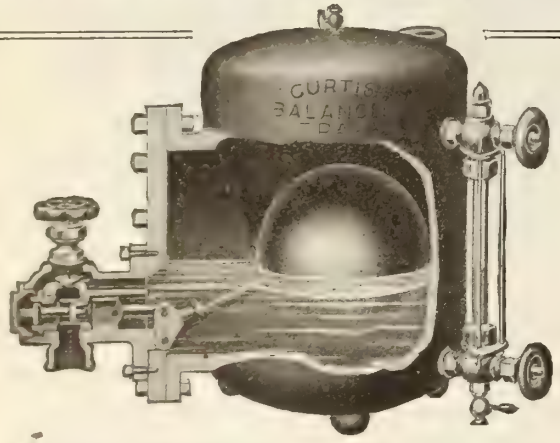
BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties.
Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14 Mass.

Agencies: 83 Barclay St., New York City
174 N. Market St., Chicago, Ill.

"SAFETY FIRST"

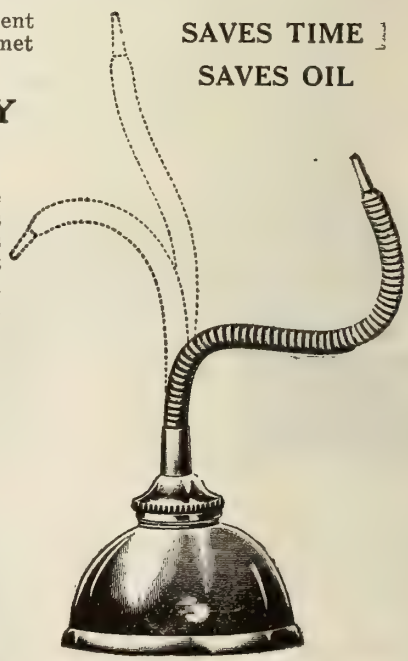
Bend the Spout

to suit position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL



Note the flexible spout. It enables you to oil all places — many places that previously could only be reached with force pump cans with specially bent spouts.

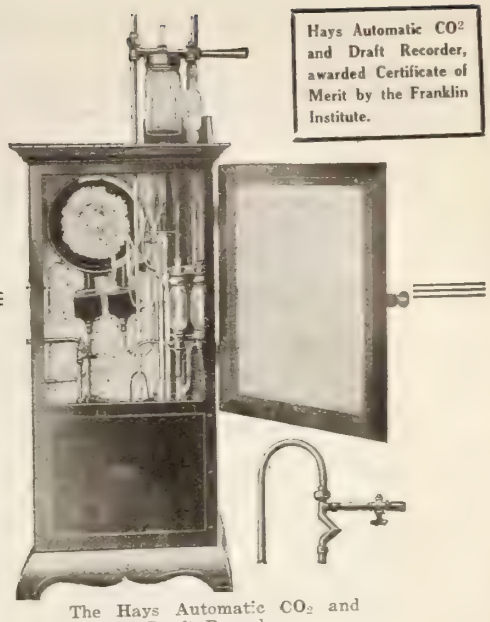
Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY

196 KING STREET, WEST - TORONTO, ONTARIO

Hays CO_2 and Draft Regulator



Hays Automatic CO^2 and Draft Recorder, awarded Certificate of Merit by the Franklin Institute.

The Hays Automatic CO_2 and Draft Recorder (Patented)

Tells Exactly Why Too Much Fuel is Consumed

With these appliances installed, your firemen can fire intelligently; instead of groping in the dark they will work with accurate facts before them. For the Hays CO^2 and Draft Recorder permanently records the story of your combustion efficiency.

Even the most modern power plant may waste 25% of its coal unless proper steps are taken to correct errors in firing, draft, boiler settings, etc.

Modern equipment is just as efficient as its operation allows. Accurate facts of your combusion and the knowledge to apply these facts are necessary—

The Hays CO^2 and Draft Recorder, supplies the facts and the Hays Book—"How to Build Up Furnace Efficiency"—helps you interpret and apply them. This interesting book is in no sense a catalog—and it has gone through fourteen editions.

The coal shortage is becoming more acute.

As the first step towards securing better results with less fuel—investigate Hays Apparatus.

Hays Gas Analyzer
1919 Model
Patent No. 1,077,342

The Jos. W. Hays Corporation

MICHIGAN CITY INDIANA, U.S.A.

General Representative for Canada:
Stephen H. Payne, 30 Church St., New York.

Representatives in Canada:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto. Edward A. Robinson Co., Limited, 228 Craig St. W., Montreal. Wm. Goold, 701 Merchants Bank Building, Winnipeg.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken. but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co. Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. General Rubber Co., Ltd., Montreal
Goodyear Tire & Rubber Co., Toronto.

BELTING, GRAIN ELEVATORS
Goodyear Tire & Rubber Co., Toronto.

BELTING, LINK
Waterous Engine Works Co., Brantford

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.

BELTING, ORE ELEVATORS
Goodyear Tire & Rubber Co., Toronto.

BELTING, RUBBER
Can. General Rubber Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Goodyear Tire & Rubber Co., Toronto
Gutta Percha & Rubber, Ltd., Toronto
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto,
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Torontc, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que
Waterous Engine Works Co., Brantford

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
J. C. Wilson Mfg. Co., Ltd., Belleville

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

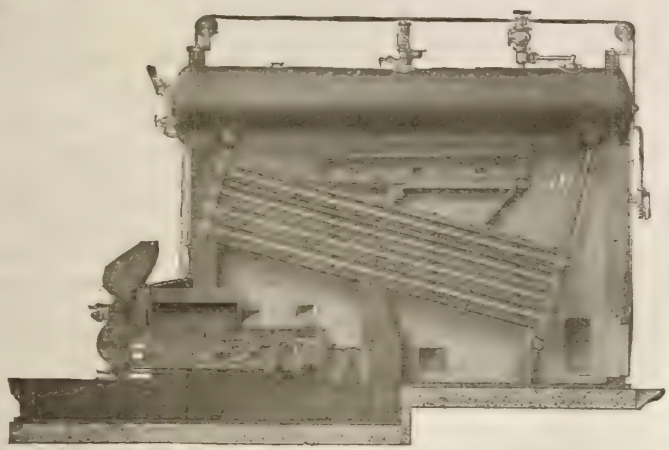
CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

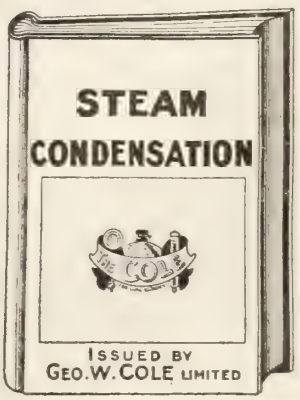
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

SECOND EDITION OF OUR BOOK "STEAM CONDENSATION"



Just off the press.

Have you received your copy?
It's free. Send for it.

Geo. W. Cole, Limited
2002-4 Dundas St. W.
TORONTO

Winnipeg	Vancouver	New Glasgow, N.S.	Montreal
Geo. A. Young	Robt. Hamilton & Co.	H. N. Brown	76 St. Gabriel St.
203 Scott Block			

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.Y.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Shurtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Shurtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Shurtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Shurtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

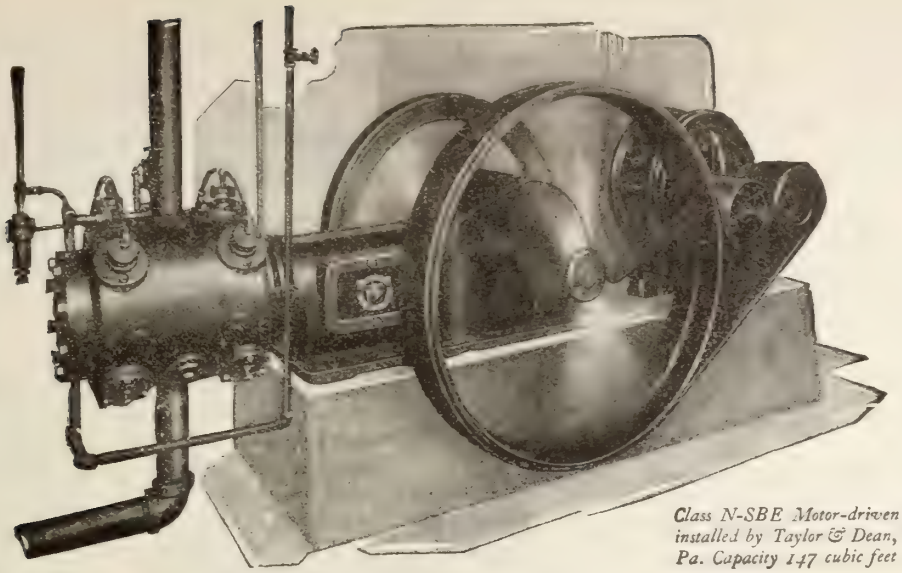
FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.



Class N-SBE Motor-driven Compressor installed by Taylor & Dean, Pittsburgh, Pa. Capacity 147 cubic feet per minute.

An ideal unit for moderate air power needs

CHICAGO Pneumatic Short-Belt Motor-Driven Air Compressors are ideal units for the small air power plant. Their compact construction economizes space. The short-belt drive with idler pulley prevents belt troubles

These units embody the same advanced principles of design and construction as the larger Chicago Pneumatics—Simplate Indestructible Flat Disc Valves, automatic regulation and lubrication, great rigidity, liberal bearing surfaces—all insuring more power with less waste; longer service with less upkeep.

Electric motor, steam and belt-driven types of these units are usually available from stock at the Company's branches listed below. Capacities 69 to 1197 cubic feet per minute.

Ask for Bulletin.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-52-H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMEL-WARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Preity & Sons, Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
[illegible]

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
[illegible]
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

BOILER ROOM ECONOMICS—

have assumed an importance unthought of in the past. Due to the scarcity of coal and a poorer quality of what can be obtained; and also to increased costs in every item of boiler and furnace operation and maintenance, only the best operating conditions are economically permissible to-day.

THE BERNITZ METHOD—

of furnace wall construction offers many distinct advantages over the old method of furnace lining, owing to the complete elimination of clinker formations on the brick work and a reduction of clinkers in the fire bed.

It will pay every user of coal to investigate the possibilities of this method of furnace wall construction. We have an interesting booklet describing it which we would like to send you.

BURLINGAME & GARDNER

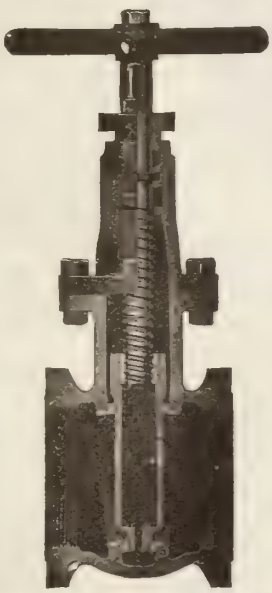
Engineers — *Engineering Materials*

110 STAIR BLDG. — TORONTO, CANADA

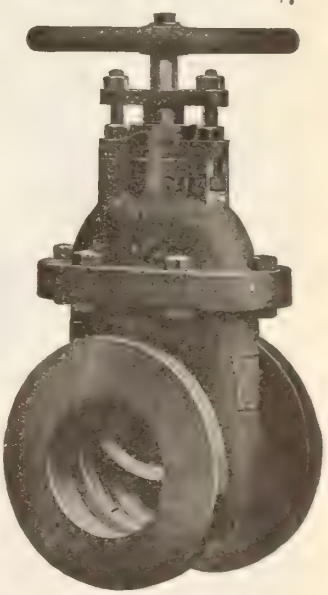
KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.



When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

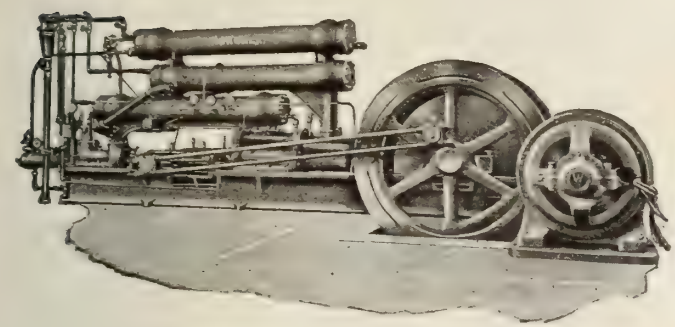
PUMP LEATHERS
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

NORWALK
AIR & GAS · COMPRESSORS

There IS a Way to Be Sure



Norwalk 24-in. Stroke Chain-Driven
Four-Stage Air Compressor

There is never any guesswork concerning the results you will get from a Norwalk compressor. Our engineers study your operating requirements, your source of power, and all other installation details, before making a recommendation. When they do make it—**it's right.**

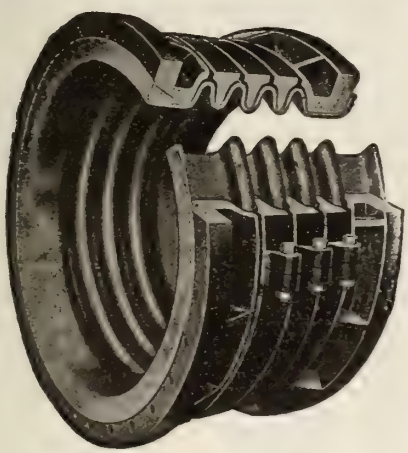
Whatever your compressing needs may be, the way to be sure of meeting them fully, lastingly and with economy is to select the Norwalk.

Norwalk bulletins on compressors for air, oxygen, hydrogen, carbonic acid gas or acetylene contain the information you are looking for. Write for the ones which interest you.

THE NORWALK IRON WORKS CO.
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

A. S. LEITCH COMPANY, TORONTO
Canadian Sales Representative

ANY·CAPACITY ANY·PRESSURE



BADGER
SELF-EQUALIZING EXPANSION JOINTS

are the best joints for absorbing pipe expansion—Note the corrugations that expand and contract, thus preventing leakage.

Write for our new book today

E. B. BADGER & SONS CO.
81 PITTS ST., BOSTON, MASS.

Canadian Agents:
FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

In Bulk

SAFETY PLASTIC
METALLIC PACKING

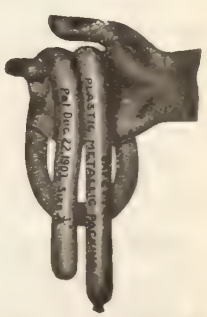
For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.
Pat. December 22, 1903.
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO.,
WINDSOR, ONT.



In Cotton Tubes

Darling Bros., Ltd. Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co. Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

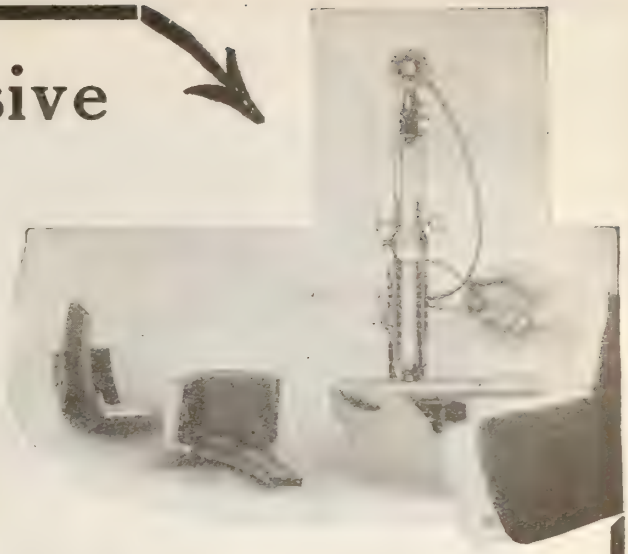
UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

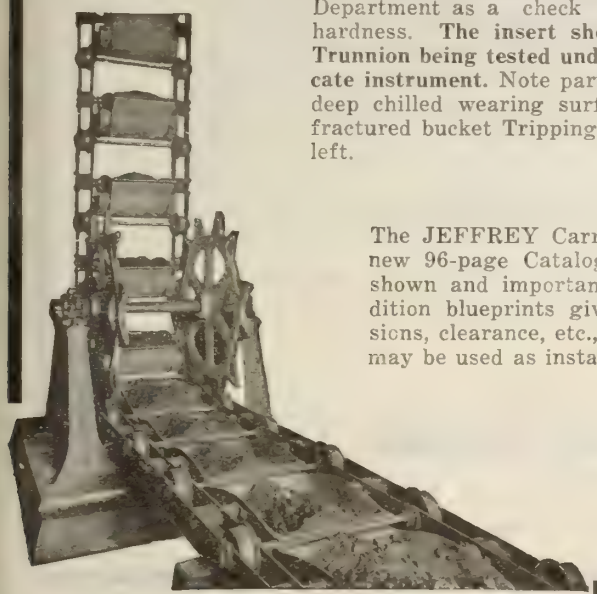
The Test is Conclusive

The extreme hardness of all wearing parts in the

Jeffrey Carrier



is proved conclusively by this test. The Scleroscope is used by our Inspection Department as a check for proper hardness. **The insert shows a Steel Trunnion being tested under that delicate instrument.** Note particularly the deep chilled wearing surfaces in the fractured bucket Tripping Cam to the left.



The JEFFREY Carrier is completely described in our new 96-page Catalog. Interesting shop views are shown and important installations illustrated. In addition blueprints giving all necessary general dimensions, clearance, etc., are included in the Catalogue and may be used as installation drawings.

Write TO-DAY for your copy of our new Catalog. Ask for No. 210—4. You'll find it valuable in making layouts for Coal and Ash Handling Installations.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms: MONTREAL

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR

H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

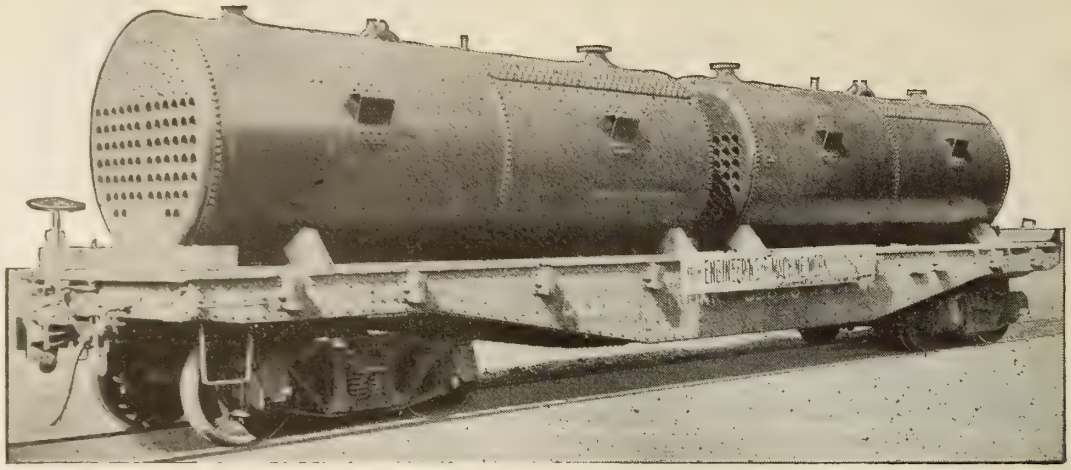
Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.



It Doesn't Often Happen—

but it is so at present—our facilities and our materials supplies are just so matched that we can take care of new orders promptly—Boilers, all types, tanks, plate work, etc.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

INDEX TO ADVERTISERS

A
All-Way Oiler Co. 76
American District Steam Co. .. 70
American Steam Gauge & Valve Mfg. Co. 68
American Steam Pump 67
Anderson Co., V. D. 73
Armstrong Cork & Insulation Co. 11

B
Babbitt Steam Specialty Co. ... 52
Babcock & Wilcox 79
Badger & Sons, E. B. 85
Betson Plastic Fire Brick Co.... 14
Boving Hydraulic Eng. Co. 74
Bowser & Co., S. F. 71
Burlingame & Gardner 83
Busch-Sulzer Bros.—Diesel Engine Co. 76

C
Can. Consolidated Rubber Co... 56
Can. Fairbanks-Morse Co. ...53, 54
Can. Farnsworth Co., The 45
Can. Johns-Manville Co. 5
Can. Link Belt Co. 49
Can. Mead-Morrison, Ltd. 67
Can. Steam Boiler Equipment.. 72
Carling Turbine Blower Co..... 76
Chaplin-Fulton Mfg. Co..... 1
Cole Ltd., Geo. W. 79
Coppus Engr. & Equip. Co.... 51
Crane Ltd. 64

D
Darling Bros. 74
Dart Union Co. 58
D'Este Co., Julian 76
De Laval Separator Co. 13
Department of Labor 74
Diamond Specialty Co. 68
Direct Separator Co. 54
Dominion Coal Co. 74
Dunham & Co., C. A..... 66
Durabla Mfg. Co. 54

E
Economy Fuse Co. of Can., Ltd. 52
Electric Welding Co. 64
Empire Mfg. Co. 3
Engr. & Mach. Works. of Can. 88
Escher, Wyss & Co. 70

F
Frick Co. 11

G
Garlock Packing Co. 15
Garth Co., The 75
Goldie & McCulloch Co..... 16
Goodyear Tire & Rubber Co... 61
Greene, Tweed & Co. 55
Green's Economizer, Ltd. 65
Gutta Percha 50

H
Hays Corporation, Jos. W. 77
Holden Co., Ltd., The 81
Holmes Metallic Packing Co.... 74
Homestead Valve Mfg. Co..... 64
Hoyt Metal Company 46

I
Inglis Co., John. Inside back cover

J
Jamison Cold Storage Door Co. 12
Jefferson Union Co. 72
Jeffrey Mfg. Co. 87
Jenkins Bros.....Inside front cover
Jointless Fire Brick Co..... 76

K
Kellogg & Co., E. H. 44
Kerr Engine Co. 83

L
La Clede Christy Clay Products Co. 8, 9
Laurie & Lamb 62, 75
Leitch, The Arthur S. 47
Leonard & Sons, Ltd., E.....7, 65
Linde Can. Refrig. Co. 10
Lincoln Electric Co. 60
Long, J. T. 44
Lunkenheimer Co. 2

M
MacGovern & Co. 66
Magnolia Metal Co. 4
Manny Co., E. S. 46, 75
Mason Regulator & Eng. Co... 59
Ministry of Munitions 63
Morrison Brass Mfg. Co., Jas. Outside back cover
Mueller Mfg. Co., H. 69
Murphy Iron Works 7

N
Northern Electric Co. ..... Inside front cover
Norwalk Iron Works Co. 85

P
Page-Hersey Iron & Lead Co., Ltd. 64
Penberthy Injector Co...Front cover
Philip & Sons, E. J. 46
Pilley Packing & Flue Brush Mfg. Co. 75
Pratt & Cady Co., Inc. 14
Publishers' Page 48

R
Robb Engineering Co. 57

S
Sanford Riley Stoker Co..... 7
Sexton Boiler Setting Co. 4
Scaife & Sons Co., Wm. B. ... 88
Schaeffer & Budenberg Mfg. Co. 68
Starrett Co., The L. S. 52
Steel Mill Packing Co. 85

T
Trimont Instrument Co. 58

U
Uehling Instrument Co. 58

V
Victoria Foundry Co. 74
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd. 46

W
Wall, W. J. 74
Waterous Engine Works Co.... 1
Watson & McDaniel Co..... 75
Williams & Co., J. H..... 46
Wilson Mfg. Co., J. C. 75
Worthing Pump & Machine Co. 6

Y
Yarnall-Waring Co. 67
York Mfg. Co. 12

WATER

WE-FU-GO AND SCAIFE

PURIFICATION SYSTEMS SOFTENING & FILTRATION FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

BOILERS
TANKS AND ENGINES

Of All Kinds for Any Service
Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.
14 Strachan Ave., TORONTO

Ottawa Representative :
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada:
JAMES W. PYLE & CO., LIMITED
232 St. James St., Montreal

MORRISON

Steam Goods

Morrison
Reducing Valve

Stop Valves,
Check Valves,
Gate Valves,
Safety Valves,
Relief Valves,
Reducing Valves,
Steam Traps,
Injectors,
Ejectors,
Inspirators,

Jet Pumps,
Steam Gauges,
Pipe, Tools, etc.,
Vacuum Gauges,
Ammonia Gauges,
Gauge Board Outfits,
Lubricators,
Pipe Fittings,
Steam Whistles,
Engine Indicators.

Merit never lacks opportunity. It cannot remain undiscovered because it is sought by too many anxious to utilize it.

The merit of Morrison Steam Specialties has been realized and depended upon for over fifty years. Their outstanding merit is demonstrated every time a specialty is used.

TRADE MARK J.M.T. A GUARANTEE OF QUALITY

The James Morrison Brass Mfg. Co. LIMITED

93-97 ADELAIDE STREET WEST

Toronto, Ontario

TRADE MARK J.M.T. A GUARANTEE OF QUALITY

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 14. Publication Office, Toronto—July 20, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

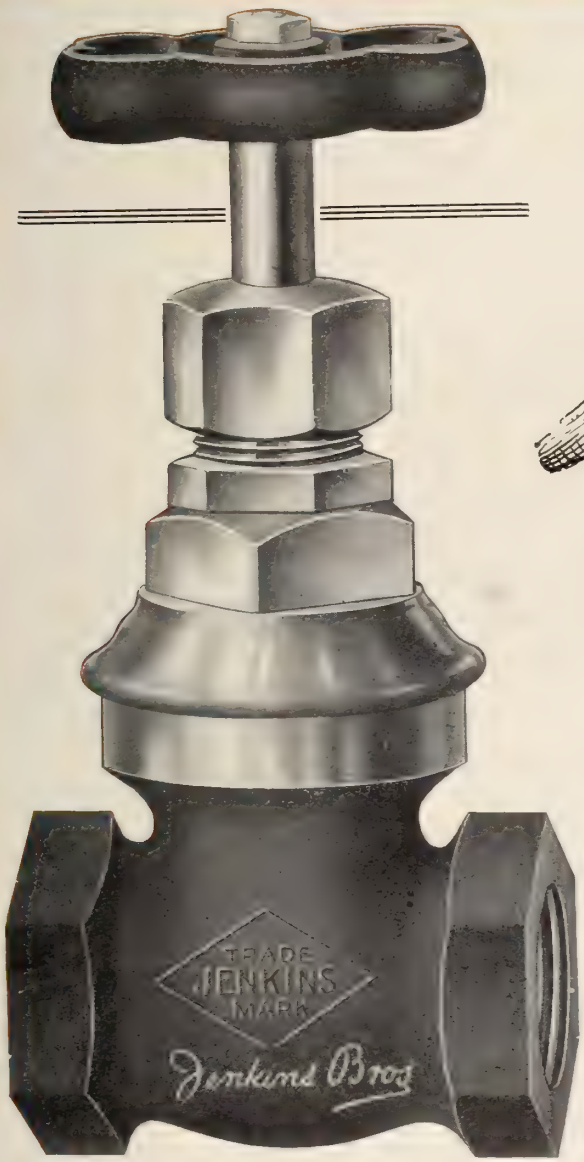


Fig. 300
Type "K" Brass Gate Valve
Screwed

It Will Stand The Test No Matter How Severe

Long and satisfactory service under the most trying conditions of usage, elimination of re-installation costs and replacement charges, upkeep expenses reduced to the very lowest minimum—these are the points by which to determine true valve value.

The type K gate valve illustrated herewith is one of the most popular of the Jenkins' line, and it will pay you to investigate its merits if entirely trouble-free service is a consideration.

First-class dealers everywhere stock genuine Jenkins Valves. Write for copy of Catalog No. 8 and see how complete the Jenkins line is—a valve for every purpose where a valve is required.

Look for this Trade Mark TRADE JENKINS MARK *Before You Buy*

Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal, can

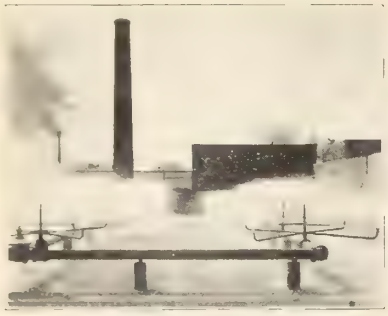
EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG.

Agencies in all the Principal Countries of the World

TRADE JENKINS MARK Jenkins Bros

"SPRA-RITE"

Cooling Systems for Cooling Condenser Water



Iowa Railway & Light Co., Marshalltown.

Central Illinois Public Service Co., Harrisburg, Ill. Capacity 10,000 G.P.M.

A System of Growing Importance

Owing to the rapid adoption of the Steam Turbine and Steam Condensation Equipment water cooling has become a factor of great importance to the manufacturer.

Whitman & Barnes Mfg. Co., West Pulman, Ill.

For this reason plant sites within easy reach of natural bodies of water for condensation are in demand. But such sites are not always available. It is then necessary to install Spray Cooling Ponds for cooling the condenser water so that the available supply can be used over and over again.

Cooling systems representative of the best practice a decade ago are virtually obsolete now. "The SPRA-RITE" System fills the bill to-day, meeting as it does all the requirements in the shape of capacity, flexibility and cooling efficiency.

Spray ponds can be in any shape, depending upon the space available. Concrete ponds are extensively used; this is conceded to be the best practice. Natural ponds and specially constructed earthen basins may also be used with success. If ground space is limited a building roof may be utilized.

We furnish plans and recommendation for any kind of installation.

A Safe and Profitable Investment

Spray Cooling Ponds, when equipped with our well-known SPRA-RITE Nozzles and Cluster Fittings are giving such remarkable cooling capacity that it has led to their adoption by the largest Power and Industrial Plants of this and other countries.

Tests made on the coal pile by means of the increased vacuum obtained prove that many systems have made a 50 to 100 per cent. return on the original investment in a year's time. Frequently a reduction in insurance rates are also obtained by reason of ample water supply close at hand for use by fire pumps.

SPRA-RITE Cooling Systems have proved their efficiency for ice plant service. They are now considered standard equipment by refrigerating engineers, and ice plant operators.

For Steam Condensing equipment SPRA-RITE Cooling Systems represent the highest standard of efficiency, but a spray cooling system will show its highest efficiency only when equipped with SPRA-RITE Nozzles, which were primarily designed for this application.

Your inquiries involving the cooling of water are invited.

SPRA-RITE Two-Vane Nozzle—its function is to discharge fine spray of equal density throughout their entire cross section.

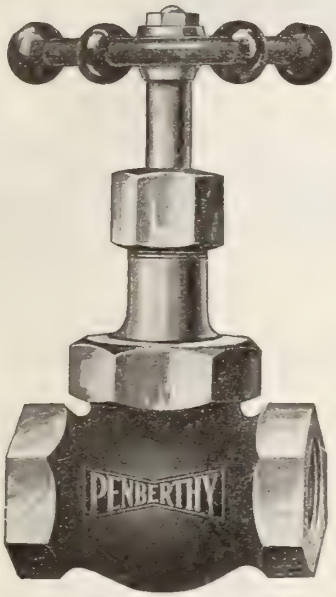
THE ARTHUR S. LEITCH CO.

1001-2 KENT BUILDING, TORONTO, ONT.

TRADE PENBERTHY MARK.

REGRINDING BRASS VALVES

MADE-IN-CANADA



With the Metal Disc

Registered and approved for 200 lbs. Steam Pressure

IN ONTARIO AND WESTERN PROVINCES

The Outside Bonnet Construction

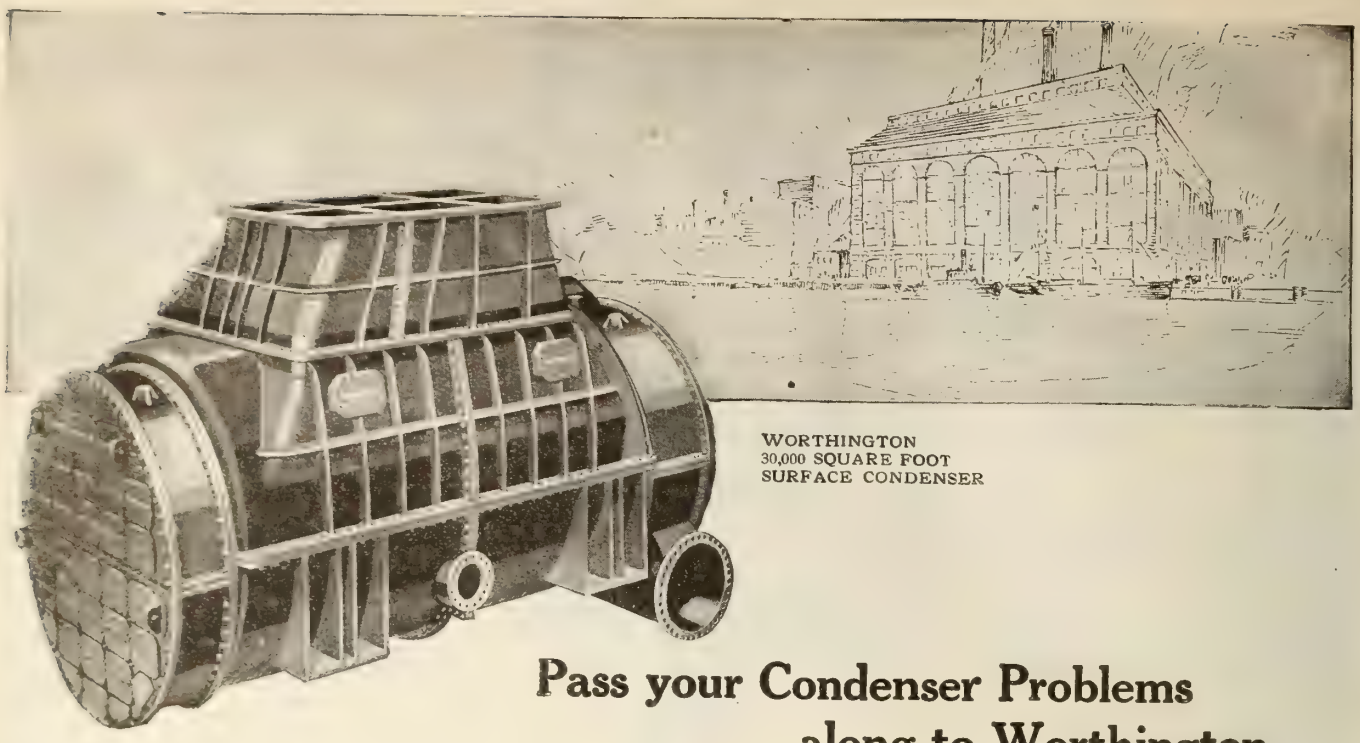
is used on all Penberthy Regrinding Valves. This feature permits easy accessibility to valve at any time because the threads on the bonnet end of body being on the outside makes the connection absolutely non-corrosive and the valve can be taken apart without strain or injury to any part.

They give dependable and reliable service under high steam pressure and severe conditions.

BE SURE This Name is on the VALVE You Buy!

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

POWER HOUSE, July 20, 1920, Vol. XIII., No. 14. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



WORTHINGTON
30,000 SQUARE FOOT
SURFACE CONDENSER

Pass your Condenser Problems along to Worthington

. . . for Worthington have had more than 40 years' experience in designing and building condensing apparatus for you to draw on.

And those years of experience have enabled Worthington to develop an efficient and varied line of condensing apparatus, building and installing each unit according to service needs and plant layout.

So even though you consider your needs exceptional, call in the Worthington engineering service. They have undoubtedly solved similar problems before in a thoroughly satisfactory manner with Worthington designed and built condensing apparatus.

Other Worthington Products:

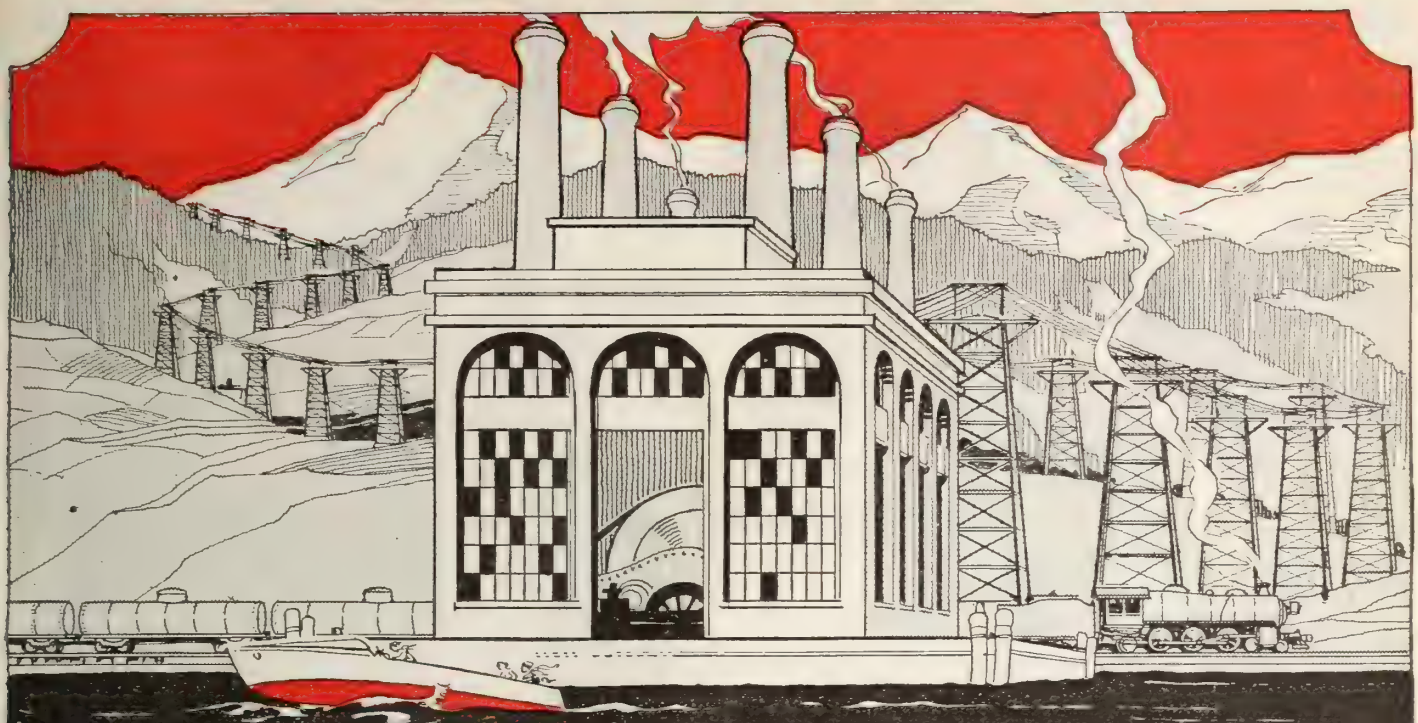
Steam, Power and Centrifugal Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*



IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Ario Compressor Oil

The Supreme Test—Service

THERE is only one test for a lubricant and that is "service"—service rendered under service conditions. The full benefit from capital sunk in expensive machinery can only be reaped through *correct* lubrication—*the best lubricants properly applied.*

Imperial Lubricants need no introduction. They are known and used from coast to coast. They are graded for every type of machine; are Canadian made from the finest crudes and readily obtainable in all parts of the Dominion.

Choose your lubricants from the Imperial line. Take advantage of our offer of free consultation. Both aim to assist you to insure that production shall bear a true relation to the time, thought and money expended in equipment.

Correct lubrication means the selection and proper application of the right lubricant for each machine. Correct lubrication actually promotes maximum profits, increasing production per unit and decreasing depreciation charges, fuel and repair bills.

Imperial Lubrication Engineers are at your service for consultation in solving troublesome lubrication problems. Their advice is free. Write to us at 56 Church St., Toronto, or to any of our branches.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

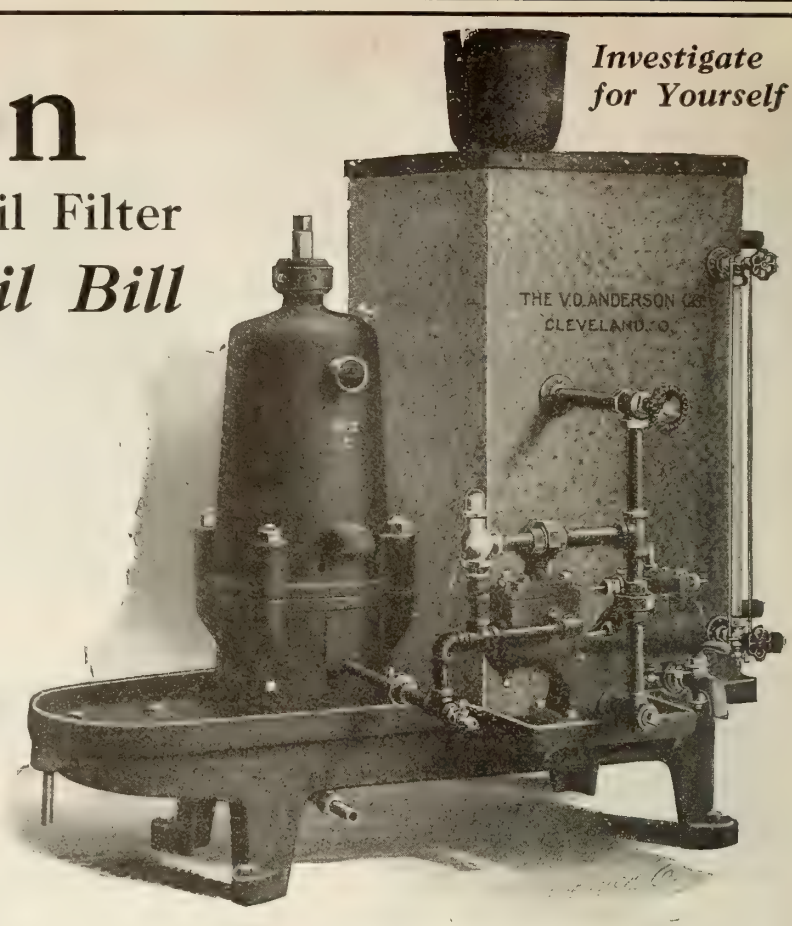
BRANCHES IN ALL CITIES

The **Anderson**

Pressure Oil Filter

Will Cut Your Oil Bill in Half ——

Investigate for Yourself



It is a fact by collecting the waste oil in drip pans, properly located beneath the engine or machinery; and running it through the Anderson Filter you can actually save at least one half of your oil bills. With the Anderson Filter the used oil undergoes a cleansing, purifying treatment identical to that of the refiners. It comes from the Filter clean and pure, suitable for use on the finest bearings.

Look up your yearly consumption figures; consider the ever increasing prices of oil and the fact that you can save at least one half on every oil bill. Then write for the Anderson catalogue and prices. This is an economy of too great importance for you to overlook. Write to-day.

The V. D. Anderson Co.
West 96th Street, Cleveland, Ohio

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

D.K.McLaren's

Genuine British Oak Tanned

Leather Belting

Genuine Oak

Genuine Oak

Good Belting Is Not a Matter of Chance

That most important feature of a belt —dependability—is not secured by any haphazard method. Each detail contributing to its manufacture must be as nearly perfect as possible.

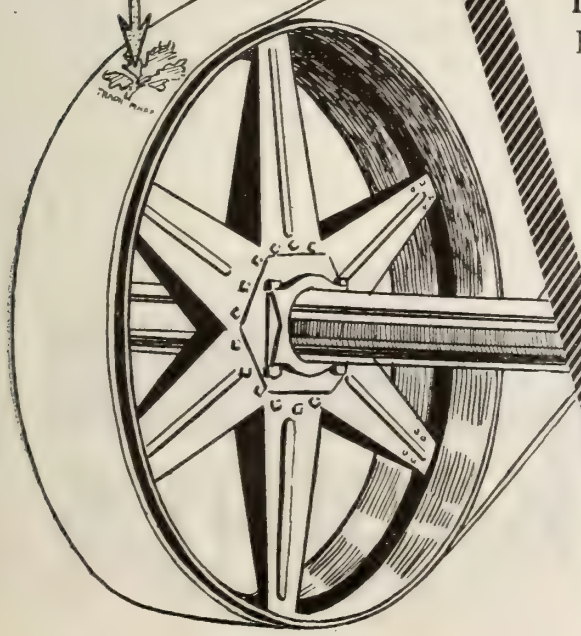
Consider these factors of D. K. McLaren's Belting.

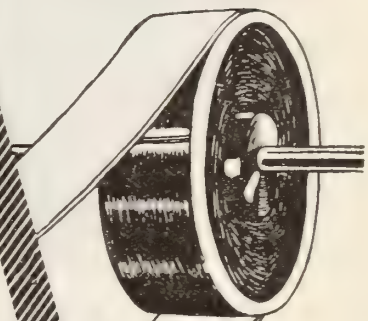
The Hide—Selected from the **backs** of the choicest steers. The back is the strongest part.

The Tanning—Genuine British Oak tanning by skilled workmen impart to the leather that mighty toughness and flexibility characteristic of D. K. McLaren's Belting.

The Result—A belting that can be depended upon at all times—a belt with minimum stretch and minimum slippage.

A Guarantee that is on every piece of D.K.McLaren's High Grade Belting.

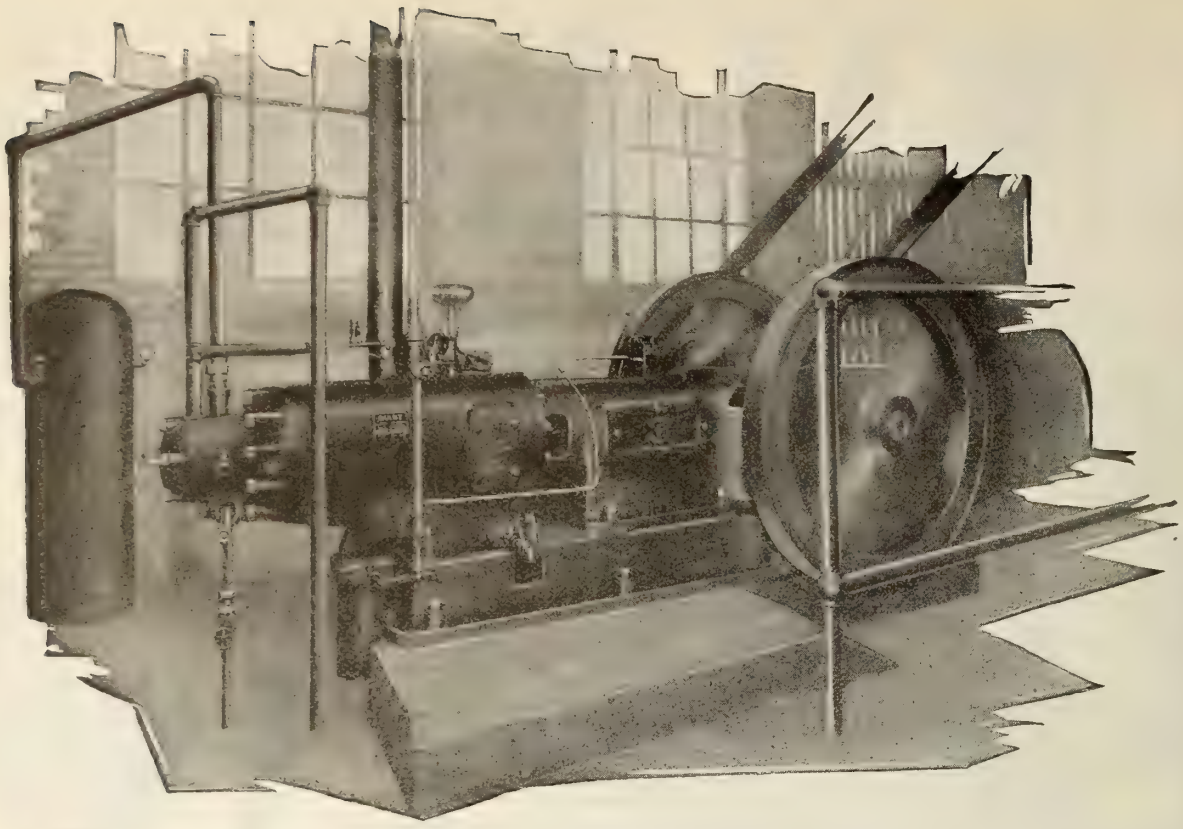




D·K·McLAREN LIMITED

351 St. James St., Montreal, P.Q.

Toronto, Ont., 194 King Street W.
Vancouver, B. C., 334 Cordova Street W.
St. John, N. B. 90 Germain Street



Giant oil engines pay for themselves

GIANT Oil Engines cut down monthly power bills sufficient in most cases to return their initial cost within a short time.

The cost of oil for fuel is low. Giant Oil Engines burn most efficiently the lower grades of low-cost fuel oil.

Through automatic regulation they prevent waste of fuel and power and eliminate the human factor in obtaining power efficiency.

Their sturdy, simple construction—free from valves, magnetos, carburetors, wiring and other complicated devices—prevents breakdowns and the expense of frequent replacements.

Power costs of ½ to ¾ cent per horse power hour are common amongst Giant Oil Engine users.

Performance records are available showing the dependability and operating economy of Giant Oil Engines under service conditions similar to yours.

Ask for bulletin.

Giant Semi-Diesel Oil Engines are built in capacities from 12 to 200 H. P., both single and duplex types. They embody such important features as box-type crosshead construction, hot liner ignition, and totally enclosed frame and automatic lubrication.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN-36-H

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

GIANT ENGINES

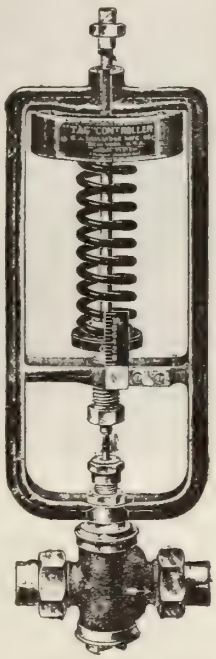
Dependable Power at *Less Cost Per Hour*

No Overtime For Night Work

Any machine operated by power, works best and most economically at a certain definite pressure.

This pressure cannot be regulated by a hand valve, because a hand valve is not suitable—it's too uncertain.

A TAG Self-Operating Pressure Controller on the supply line, will maintain the desired pressure night and day, as long as the power is on.



It needs no care and attention. It is absolutely automatic. You merely set it and leave it alone. You can go away and forget it.

It differs from human labor, in working just as well when the foreman is absent, as it does under the foreman's eye. It works over-time all night, if necessary—without protest, without over-time pay.

In fact, it pays its own wages by reducing direct labor cost and by economy of power and fuel.

Bulletin PP-388 explains

C.J. TAGLIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark
Reg. U. S. Patent Office

No Stoker is Better Than its GRATES

MURPHY AUTOMATIC FURNACES

Back of every feature of MURPHY GRATE construction are *many* sound reasons. Consider how these features save you dollars—in fuel—in labor—in maintenance.

The long—narrow—but deep sections give eighteen to twenty-eight square inches of cooling surface to every inch of exposed grate surface.

The liberal air space (47% to 52%) gives double the capacity of the boiler "without one penny for draft."

The correct proportion and distribution of ribs on the stationary grates, combined with the greatest accuracy of machine moulding have solved the sifting problem. The continuous movement of the ribless grates 3/4" above and 3/4" below the surface of the stationary grates—breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free—and advances the ash gradually to a point where it is removed by the clinker grinder. It is this action that gives the Murphy Furnace the faculty of ***burning anything that has heat in it.***

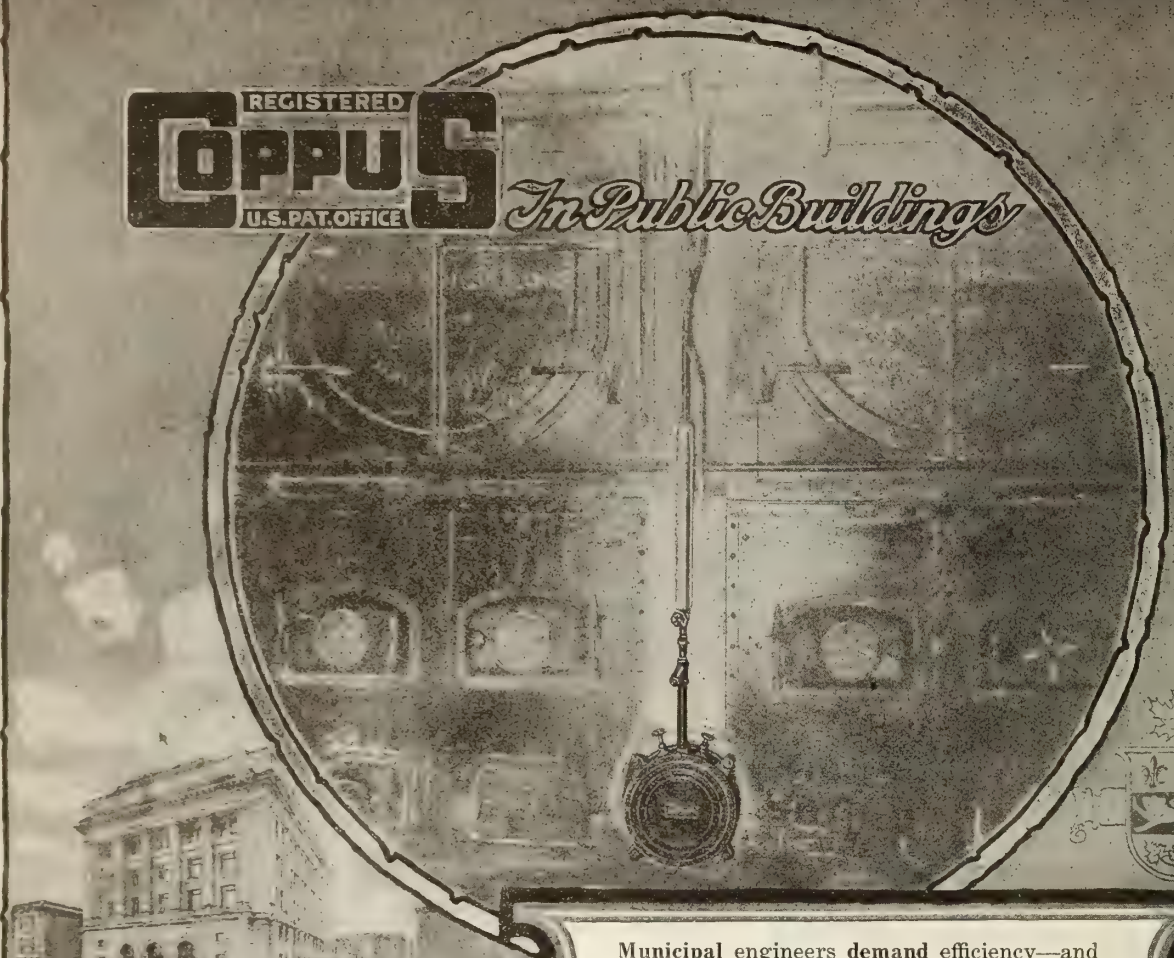
Yet with all these advantages, the Murphy Grate of to-day is built to the same policy that has characterized every improvement First, to make all parts standard; second, to make every piece interchangeable; third, to advise users of new developments so that they may keep their equipment up to date—and operating at top notch efficiency.

For information on the Riley Underfeed Stokers for large boilers, see February 5 advertisement or send for Riley Stoker catalog HR-6.

MANUFACTURED EXCLUSIVELY BY

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

REGISTERED COPPUS U.S.PAT.OFFICE *In Public Buildings*



Municipal engineers **demand** efficiency—and **insist** on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the **highest** standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save you money." Write for Blower Catalog.

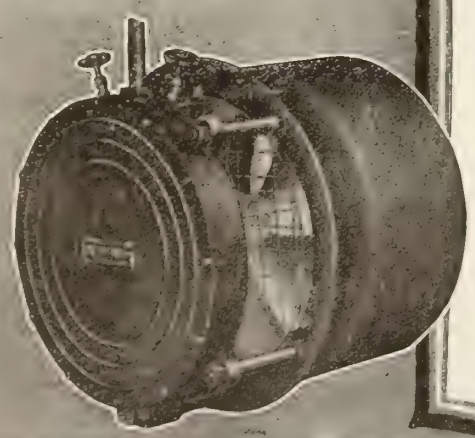
"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

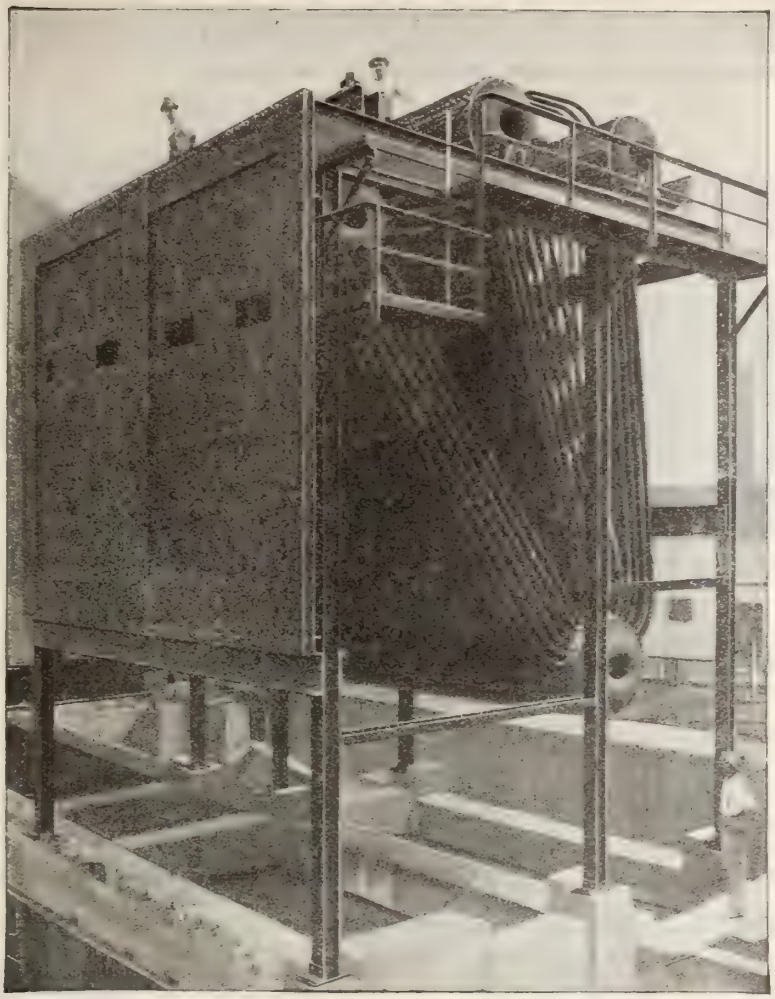
Mfrs. of COPPUS Turo Feed Pumps and COPPUS Power Turbine.

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.



COPPUS TURBO BLOWER



Connelly (Patented U.S. & Canada) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of circulation and deliver steam superheated to from 5 to 10 degrees Fahrenheit.

Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no hand-holes, free from joints.

All parts easily accessible for cleaning, both internally and externally.

Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. LEONARD & SONS LIMITED

Head Office and Works : LONDON, Canada

Branches:

1790 St. James St., Montreal, Que. 62 Water Street, St. John, N.B.

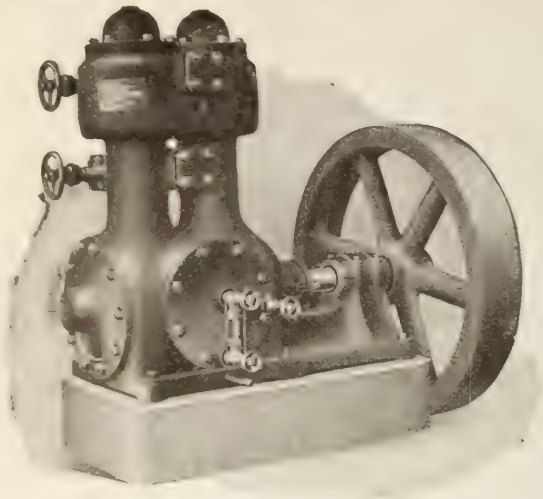
Agents:

E. J. Philips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning Street, Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave Street, St. John's, Nfld.

ESTABLISHED 1834

LEONARD

Mechanical Refrigeration



Reliable--Beneficial

THE many benefits common to all users of MECHANICAL REFRIGERATION, should make it a valuable adjunct to **your** business.

The uniform temperatures it provides have a better holding effect on the product in storage than ice, because the temperature produced by ice is not uniform, varying with the amount of ice in the refrigerator.

MECHANICAL REFRIGERATION permits the maintenance at all times of any temperature desired in the refrigerators or cold storage rooms, whereas you can not always get ice just when you need it, and a delay of a few hours often means a loss through deterioration of the product in storage.

If interested in MECHANICAL REFRIGERATION, a request for information and prices will receive our prompt attention.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative :

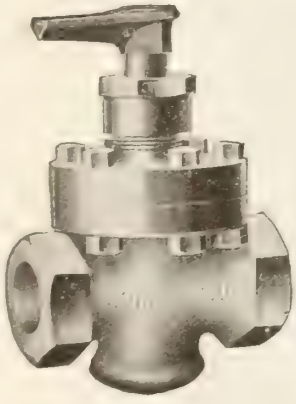
Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St

HOMESTEAD

Quarter-Turn Valves

For All Classes of Service



Whenever the duty is exceptionally severe and frequent opening and closing is required insist upon Homestead **Quarter Turn Valves.** They are the "last word" in valve efficiency. A quarter-turn closes Homestead Valves tight — a quarter-turn opens them to a straight-way unobstructed flow.

Tightness is absolutely assured by a patented wedging cam that automatically forces the plug downward in closing and instantly releases it again when the handle is turned to open the valve.

Homestead Valves embody the highest quality workmanship and material and will stay tight under any specified pressure up to 5,000 lbs. Made in two, three and four way types with semi-steel, brass, or cast steel bodies.

The Homestead Way is the only way. Investigate!

Homestead Valve Mfg. Company

Homestead, Pa. Works: Homestead

Make it Easier--

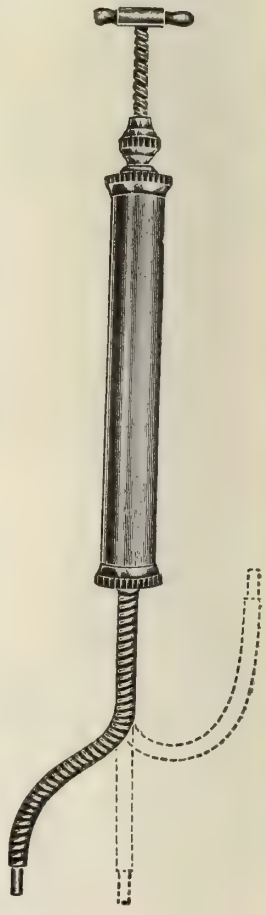
ALL-WAY

Flexible Spout Grease and Oil Guns

Make it easy to refill the most out-of-the-way gear cases or transmission as the flexible spout can be bent to any desired angle. The Cleaning Device at the end of the **"ALL-WAY"** spout reduces cleaning time and oil wastage to a minimum. The **"ALL-WAY"** gun is especially useful and handy in filling lineshaft hanger reservoirs.

If your dealer cannot supply you, write us.

We also manufacture the well-known "ALL-WAY" Oil Can. Saves you 50% of your oil bill.



The Allway Oiler Mfg. Co.

196 KING STREET WEST
TORONTO, ONT.

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

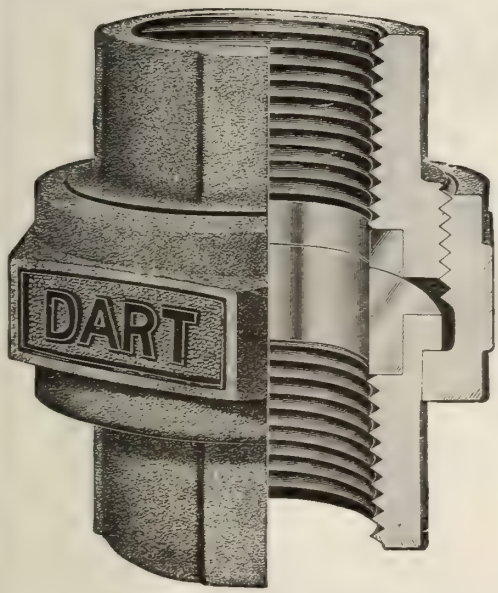
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal



Bronze
to BRONZE at the Joint
(Both Face and Seat)

No Deterioration Here

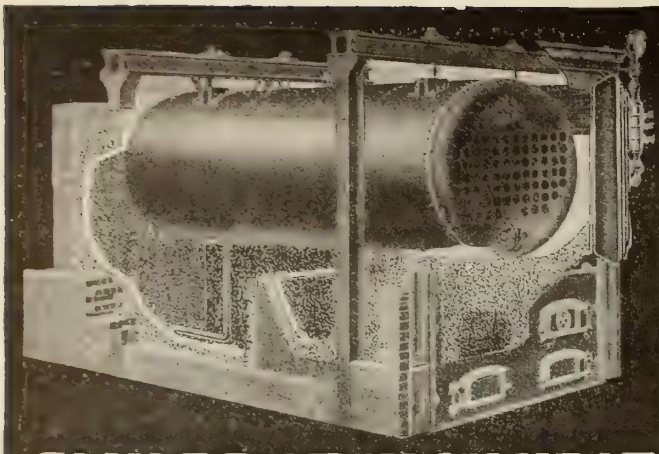
Make Your Next Order

DART UNIONS

They Are Really Economical and Trouble-proof

No Upkeep Cost
No Replacement Cost
No Loss From Leaks

Manufactured by
Dart Union Co. Limited, Toronto



SMILES AT HIGH HEAT

Boiler furnace linings moulded into place forming a solid, one-piece monolithic lining, will withstand the variations and extremes of heat under continuous service, when the proper lining material is used, viz:—

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

The result of twenty years of scientific and practical experience. Only those refractory materials that are of tested quality and purpose are used, and these years of experience have produced a most generally satisfactory lining material. Not theoretically but under actual everyday conditions.

There is only ONE Plastic Fire Brick and it comes to you in barrels in a moist plastic condition, ready for use. Any intelligent person can do the work, no special tools, forms or skill is required.

Costs less than fire brick or special blocks. is always available and will outlast other linings.

Write for our informing pamphlet, it is worth having in your file whether you need lining material now or not.

Order in advance of your need on account of slow freight delivery.

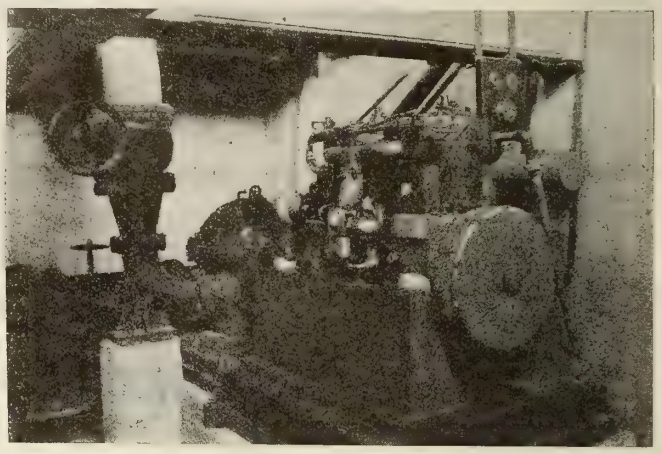
Betson Plastic Fire Brick Co., Inc.
P. O. Box 386—6, Rome, N. Y.

Canadian Distributors:
International Chemical Co.
44-6 Lombard St.
Toronto, Ont., Canada

Shipment F.O.B. nearest warehouse in our new substantial "Yellow-Top" barrel.

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

The expense of maintaining forty pounds of steam for emergency can be practically cancelled by installing a high speed Sterling gasoline engine to operate your centrifugal pumps.

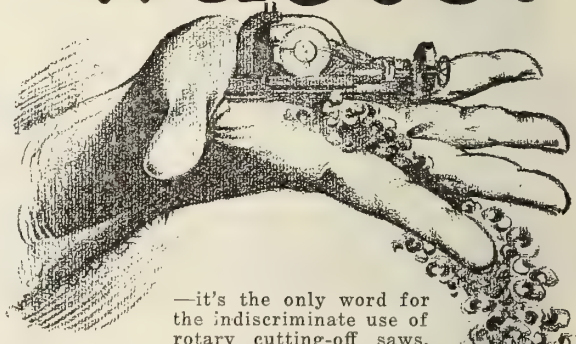


Four cylinder 100-H.P. Sterling, direct connected to Dayton-Dowd 1250-G.P.M. pump, speed 1350-R.P.M., at Sorel, Que., for stand-by service as a protection against breakdown.

The cost of a Sterling as emergency power for pumps, or generators, is so low that it is false economy to be without the protection they afford. **Catalog on request.**

STERLING ENGINE CO., Dept. C4, Buffalo, N.Y.
12 to 300 H.P., Speeds 400 to 1600 R.P.M.

-waste!

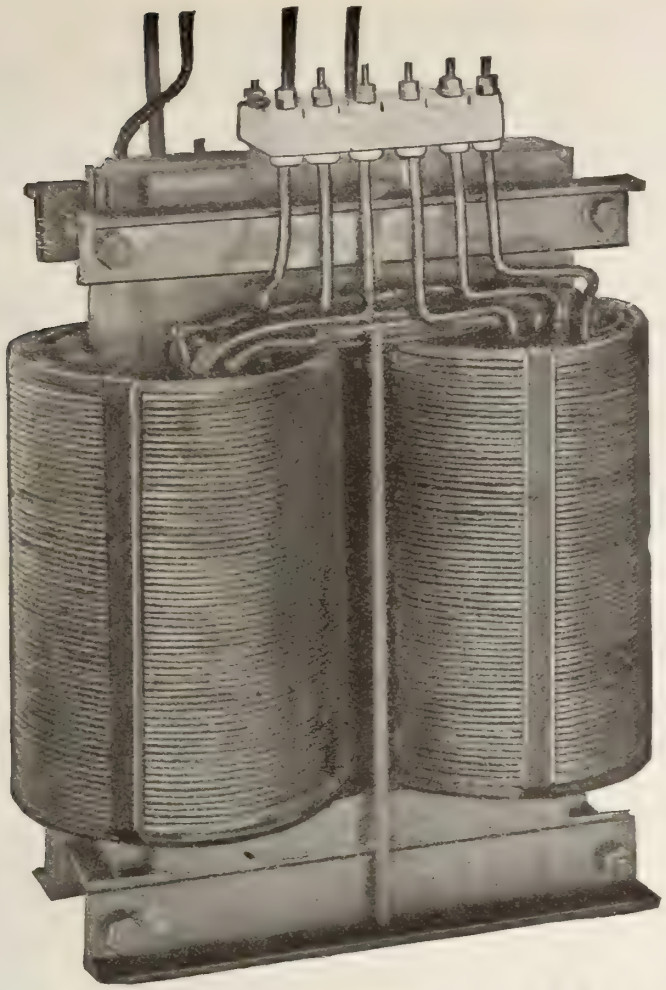


—it's the only word for the indiscriminate use of rotary cutting-off saws. The heaviest Starrett Hack Saw is but .065 inch thick. Compare its "kerf" with that of a half-inch rotary, often used for the same work. Send for free copies of the Starrett Hack Saw Book and Catalog No. 21 "CD."

You need the Starrett Hack Saw Chart — sent free on request

The L. S. Starrett Co.
The World's Greatest Toolmakers
Mfrs. of Hack Saws Unexcelled
Athol - Mass.
42-55

Starrett Hack Saws



CANADIAN CROCKER-WHEELER
New Service Transformers

Embodying—

True core type construction with cruciform section.

Terminal Boards specially designed with large creepage surfaces.

Circular coils—the strongest known construction.

Coils with large oil ducts, liberal clearance and entirely surrounded by oil.

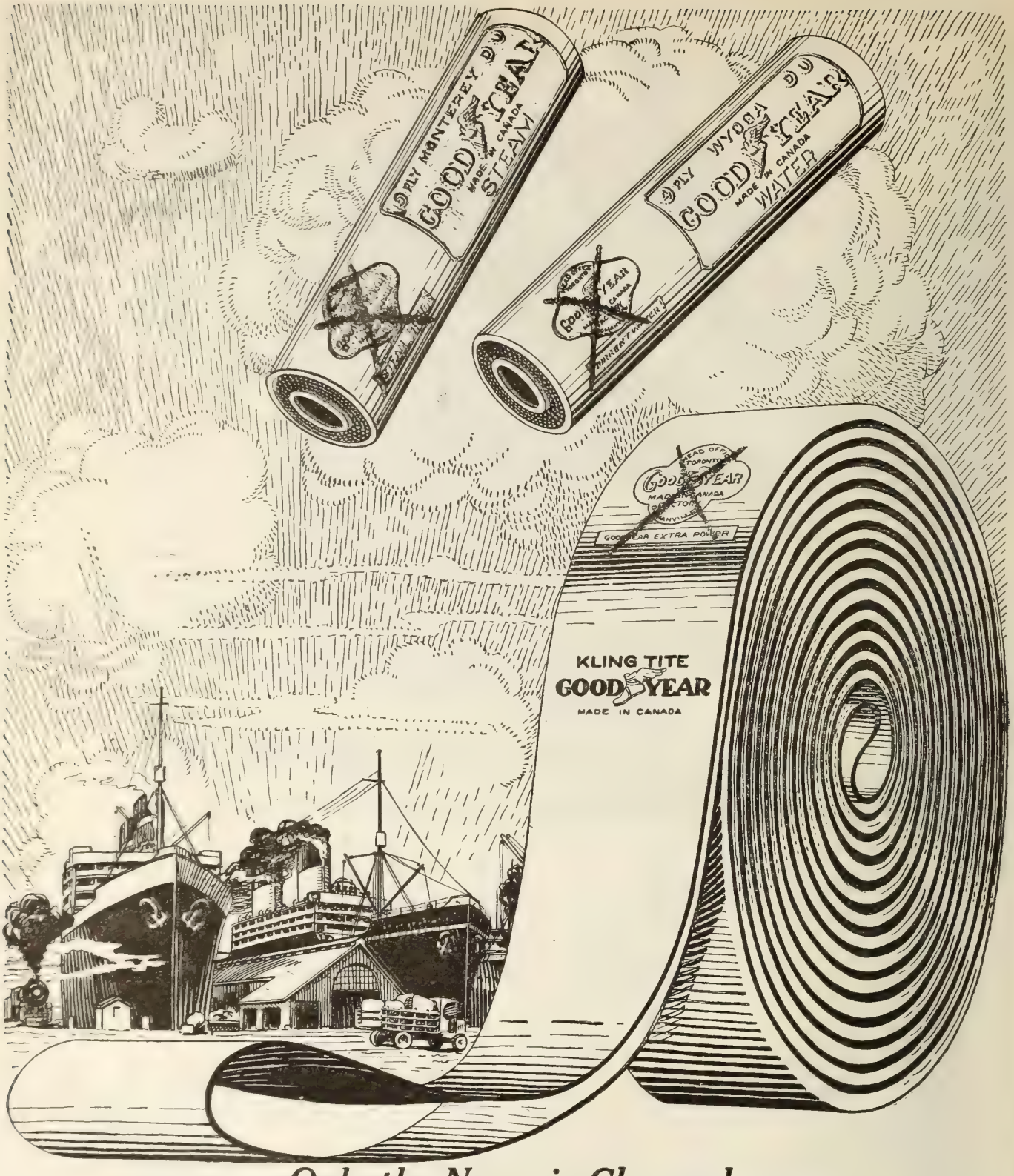
Low magnetising current.

Light welded steel tanks.

Obtainable Through Our Houses

Northern Electric Company
LIMITED

MONTREAL HALIFAX TORONTO LONDON WINNIPEG CALGARY VANCOUVER
QUEBEC OTTAWA HAMILTON WINDSOR REGINA EDMONTON



Only the Name is Changed

GOODYEAR

MADE IN CANADA

KLINGTITE BELT

(The New Name of EXTRA POWER BELT)

World-Wide Demand for Goodyear's Quality of Belting and Hose Makes Advisable Some Changes in Brand Names

Example—GOODYEAR { *formerly*—"Extra Power" / *now* —"Klingtite"

THE most widely known belting in Canada to-day is "Extra Power."

Now you will buy this same belting as Goodyear Klingtite belting —"Klingtite"—a name adaptable to world-wide use.

In our sales messages you will read of Goodyear Klingtite instead of Goodyear Extra Power.

Our Belting men will talk to you of Goodyear Klingtite instead of "Extra Power."

The familiar brand names of Goodyear belting, hose and packing have been changed so that each of these products may be called by the same name in Australia, Europe, South Africa, India, Japan, China and other countries, as in Canada.

The new brand names are such that they can be used and understood in practically every language and country without change.

Some of the former names designed and reserved for Canadian use do not lend themselves to the complication of languages and conditions prevailing in some of these foreign countries.

Goodyear Belting, Hose and Packing, made in Canada, have become products of world-wide sales.

You will welcome the development of this phase of our business because it means the building up in Canada of another world-wide manufactory. It means increased demand and prosperity for Canadian workers. It means economy and service for you.

Particularly to you, it means that efficient engineers and factory superintendents the world over endorse your choice when you secure belting, hose and packing for your plant.

Phone, wire or write the nearest Goodyear branch for a man trained by Goodyear in belting, hose and packing problems to call on you. No obligation.

The Goodyear Tire & Rubber Company of Canada, Limited

Branches:—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary Edmonton and Vancouver. Service stocks in smaller cities.

Only the Name is Changed

GOODYEAR

MADE IN CANADA

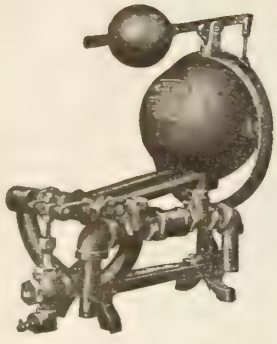
KLINGTITE BELT

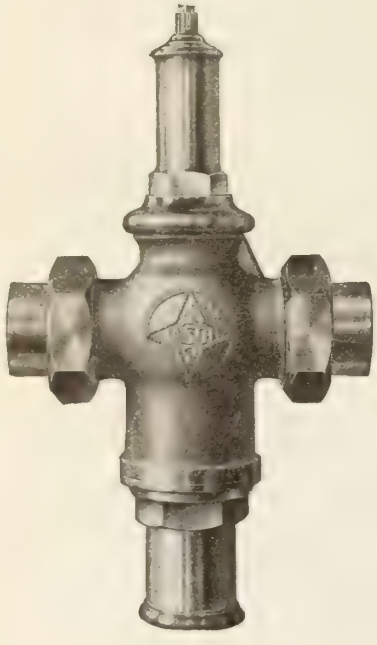
(The New Name of EXTRA POWER BELT)

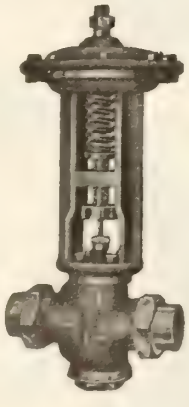
Mason Power Plant Equipment

QUALITY

SERVICE *RELIABILITY*







The splendid reputation of MASON POWER PLANT EQUIPMENT is not the result of an accident, but the expected outcome of thirty years of persistent effort backed by large capital and superior manufacturing facilities.

They hold the FIRST place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the MASON. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend on these devices working in many critical locations and find them satisfactory.

MASON equipment includes the following well-known lines:

Mason Reducing Valves
Mason Pump Pressure Regulators
Mason Balanced Valves
Mason Strainers
Bundy Steam Traps
Bundy Oil Separators
Stratton Steam Separators
Reilly Feed-water Heaters
Reilly Evaporators
Reilly Distillers
Reilly Feed-water Filters
Republic Flow-meters
and other high-grade devices.

We shall be glad to mail you any catalogues that you may be interested in

The Mason Regulator & Engineering Company, Limited

135-153 DAGENAIS STREET (ST. HENRY)
MONTREAL

ROOM 5, 145 WELLINGTON STREET WEST
TORONTO

Jones

"AC"

Automatic Cleaning Stoker

Save Coal!

—your Duty to Canada and Yourself

OF THE seven million tons of coal used last year by leading Canadian industries and public utility plants, one million tons could have been saved by the application of scientific methods of combustion.

1,000,000 tons of coal saved in Canada in one year!

20,000 coal cars released for other service!

Your Part

in Eliminating Canada's Annual Coal Waste of a Million Tons

What is your share of Canada's excessive coal bill? One seventh of the coal consumed by industrial Canada in 1919 could have been saved.

As a Canadian power user—a part of Canada's industrial backing—you owe it to the nation to assist in abolishing this preventable waste.

And as an engineer, plant owner, or director you owe it to yourself and your organization to save every pound of fuel that can be saved—particularly so to-day, with coal prices going constantly higher and the supply of coal inadequate to meet domestic demand.

Twenty million tons of coal were imported from the United States in 1919. This could have been reduced to nineteen million.

Canada's preventable fuel waste is, of course, largely the result of improper stoking.

And since hand firing is the commonest form—although by no means the only form of improper stoking—this abnormal fuel bill is largely traceable to hand firing.

Is your plant hand fired? Is it incorrectly stoker fired?

No other single step you can take could possibly rival the importance of installing the right kind of stoker in your plant—if you have Canada's interests and your own interests at heart.

The announcement on the opposite page will be of vital interest to Canadian power users:

Pays for

Itself

This Greatly Expanded Engineering Organization Will Help You

The Jones Under-Feed Stoker Company, Limited, has been reorganized, and its name changed to the Under-Feed Stoker Company of Canada, Limited. The following are the officers and directors of the Company:

President: Lloyd Harris, late Chairman of the Canadian Trade Mission, London, England; President Russell Motor Car Ltd.; President the Under-Feed Stoker Company of America.

Vice-President and General Manager: S. A. Armstrong, Vice-President and Managing Director of the Under-Feed Stoker Company of America.

Vice-President and Secretary: James L. Ross, Barrister, etc., Secretary of the Under-Feed Stoker Company of America.

Directors: T. A. Russell, President Willys-Overland Ltd.; Vice-President Russell Motor Car Ltd., and Director of the Under-Feed Stoker Company of America.

A. E. Holmested, Barrister, etc., and Director of the Under-Feed Stoker Company of America,

H. J. Fuller, President Canadian Fairbanks-Morse Company, Ltd.

David Fasken, K.C., President Excelsior Life Insurance Company.

This Directorate and reorganization makes available for all industrial Canada the engineering experience and development of mechanical stokers of The Under-Feed Stoker Company of America, and The Under-Feed Stoker Company of Canada, Ltd.

This Canadian Company has carried on business in Canada for the past twenty years. Its stoker equipment is manufactured in Canada, is sold for Canadian money at par.

This is the oniy stoker company doing business in Canada to-day that is qualified from the standpoint of equipment to handle any type of combustion problem presented.

Jones Stokers vary in size and type from what is known as the Jones Standard Stoker, manually cleaned, to the heavy duty "A-C" Stoker for the largest type of power plant and boilers.

Standard Stokers may be furnished with side cleaning astachments, eliminating the manual training methods. A heavy-duty side cleaning stoker is also furnished fo. boilers from 250 h. p. to 500 h.p. rating.

Before Paying Your Next Coal Bill, Read the Next Page

Then pays JONES STOKER **Dividends**

Getting Down to Figures

THESE comparative figures show how the Canadian manufacturer can conserve coal and make money for himself by equipping his plant with Jones Stokers.

Boiler Plant consisting of Six 250 h.p. Boilers:

Assuming 5 boilers operated for 24 hours a day, 300 days a year, 1 boiler held in reserve:

Two shifts of 12 hours—
Labor at 50c an hour
Coal at $6.00 a ton

Cost of installation of Jones Stokers, $17,000.00.

Annual Cost of Hand Firing

Labor: 5 men per shift . .	$18,000.00
Coal: 4½ tons per B.H.P.	121,500.00
	$139,500.00

Annual Cost of Stoker Firing

Labor: 3 men per shift. .	$ 10,800.00
Coal: 12% saving.	106,900.00
Depreciation: 10%.	1,700.00
Repairs: 5%.	850.00
	$120,250.00

Capacity of Plant increased from 50% to 100%.

Additional saving made possible through burning of cheaper grades of coal.

Annual Saving—Stoker Firing over Hand Firing. . $19,250.00
Return on Investment . . . . . 113 per cent.

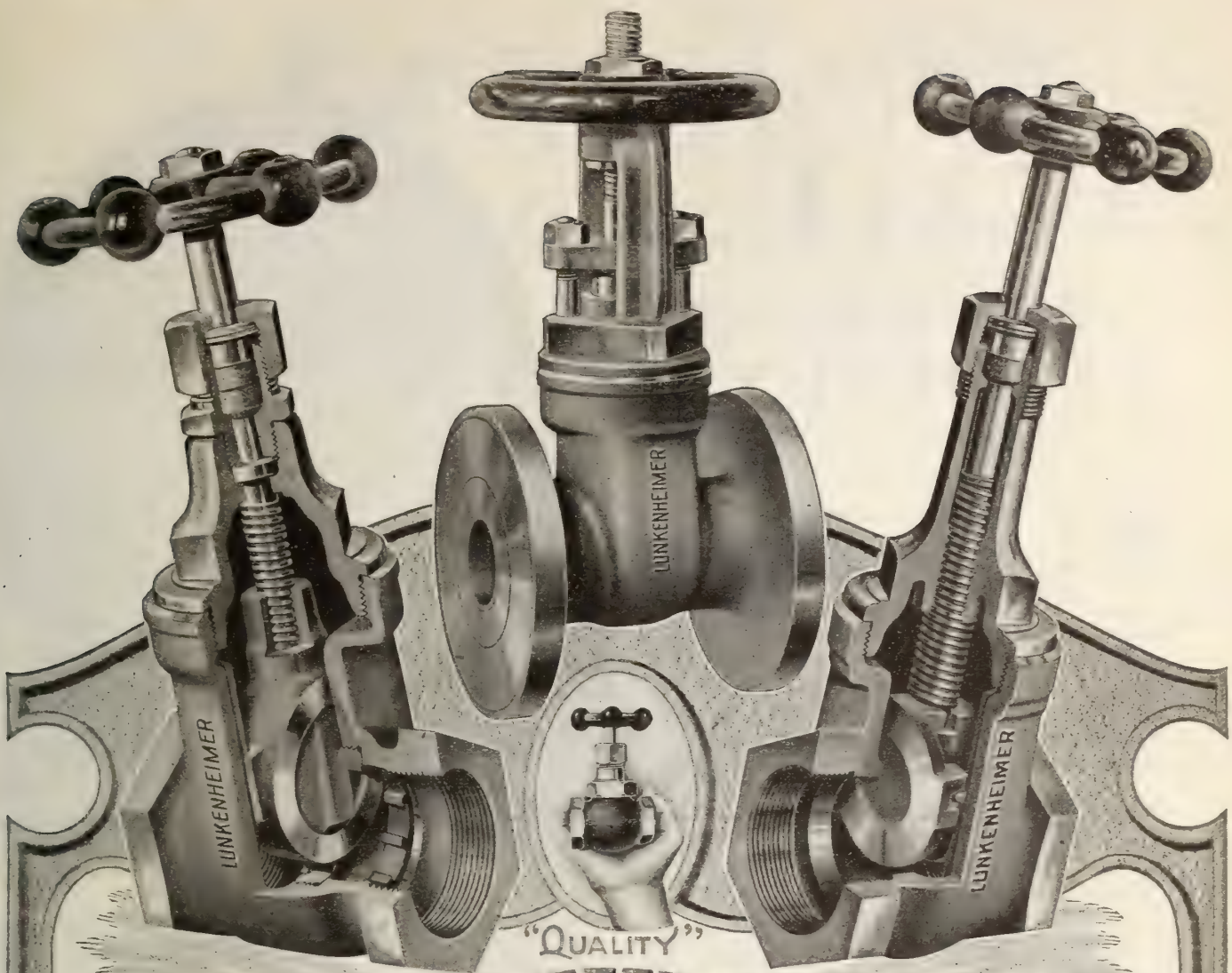
With the engineering service of this company at the disposal of the Canadian manufacturer, can he hesitate for one moment to call for assistance in solving his combustion problems?

Write for Extensive Catalog

The new Jones Catalog goes into all the details of high duty stoker firing. Write for your copy.

The Under-Feed Stoker Company of Canada, Ltd.

81 Victoria Street
TORONTO



"QUALITY"

LUNKENHEIMER BRONZE GATE VALVES

have full straightway opening; are double seated and will take pressure from either end.

Bodies are heavy to resist pipe strains and the valves seat tight without undue pull on the handwheel.

The DOUBLE-DISC type has a ball and socket bearing between the discs, making them self-adjusting, and the discs are accurately guided by ribs in the body. Sizes ¼ to 3 inches, inside screw for working steam pressures up to 150 pounds.

In the WEDGE DISC type, the seats are finished to the exact taper of the disc faces and all parts are renewable, including the SEAT RINGS on sizes one inch and larger. Made in sizes ½ to 3 inches, inclusive, with inside screw and 1 to 3 inches with outside screw and yoke for working steam pressure up to 200 and 300 pounds.

The material and workmanship are of that high order which characterizes all Lunkenheimer Products.

Specify LUNKENHEIMER and insist on having the genuine.

Distributors of Lunkenheimer Products situated in every commercial centre.
Write for descriptive Booklet No. 574--D.C.

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

New York Chicago CINCINNATI Boston London

11012-7-43

WAIT STEAM TURBINES

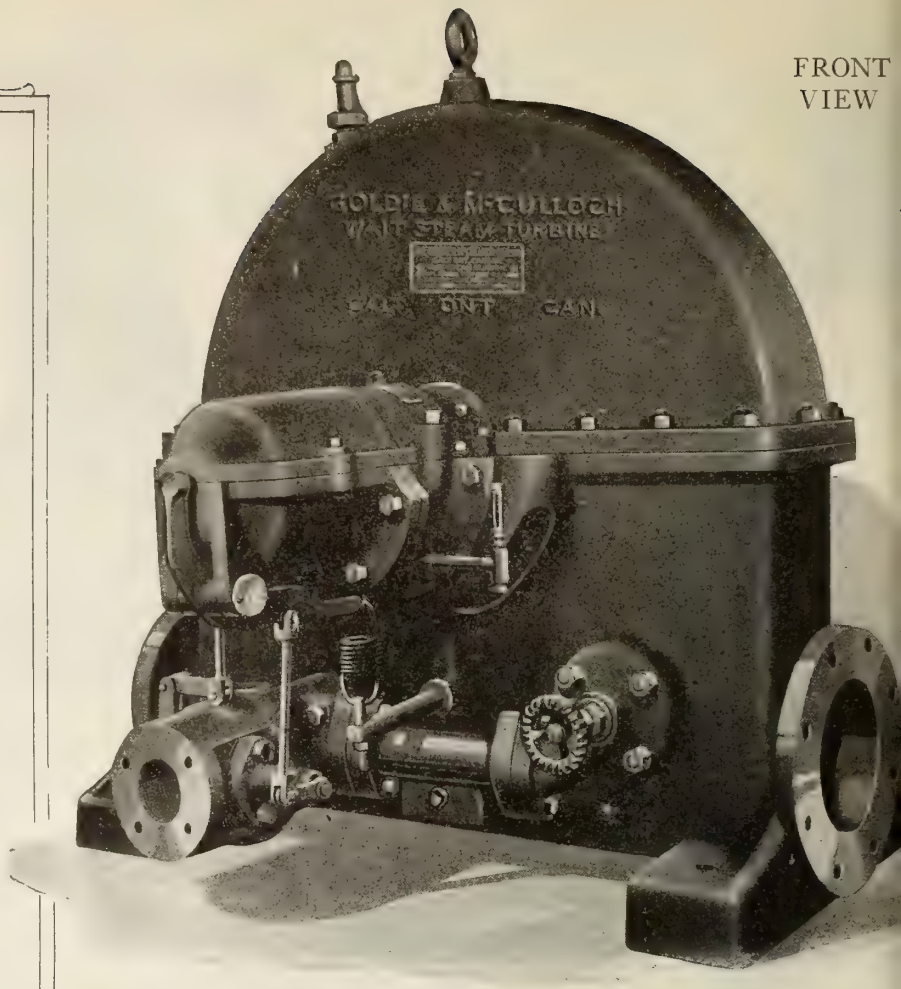
The Acme of Perfection

MANY recent improvements in detail by skilled investigators have resulted in the G. & McC. Co. "Wait" Steam Turbine reaching a high point in efficiency—it is in fact recognized by leading engineers as the acme of perfection in steam turbines. Some of its leading features include in addition to high efficiency—simplicity, ruggedness and economy of operation.

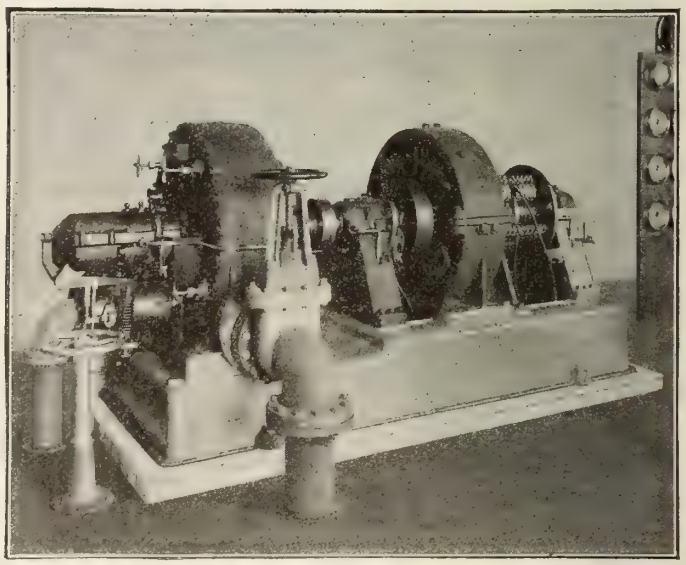
Points of this ***G. & McC. Co.*** *Machine that should be remembered are:*

—The Turbine is entirely automatic.
—No oil or grease cups.
—Stuffing boxes and glands, seldom require attention.
—Emergency governor and valve are entirely separate from main governor and valve.
—Interior may be easily inspected.
—Self-lubricating; dust proof; dirt-proof.
—Speed can be changed while running.
—LOW RUNNING EXPENSE AND COST.

Dependable Power Equipment



FRONT VIEW



Goldie & McCulloch "Wait" Steam Turbine at St. Boniface Hospital, Winnipeg, Man.

The Goldie & McCulloch Co., Limited

Head Office and Works: GALT, Ontario, Canada

Toronto Office: Suite 1101-2, Bank of Hamilton Bldg.

Western Branch: 248 McDermott Ave., Winnipeg.

Quebec Agents: Ross & Greig, 400 St. James Bldg., Montreal.

British Columbia: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 Canada, $2.00 per year; U.S. $2.50 per year. Published Semi-monthly

Air Pumps for Condensing Equipment

In This Paper Read Before the American Society of Mechanical Engineers, the Writer Discusses Past and Present Types—The Leading Features Are Described, with Special Attention to the Steamjet Ejector.

By FRANK R. WHEELER

THE past few years have brought about decided changes in three component parts of a steam power plant:

(a) The steam turbine has replaced prime movers of the reciprocating type;

(b) Mechanical stokers of fuel have increased boiler efficiency and ratings;

(c) Improved condensing equipment is now used which will maintain vacua of 29.5 in. referred to a 30-in. barometer under operating conditions and with proper water temperatures.

The improvement in condensing equipment is primarily due to the better designs of air pumps adopted and to the radical changes and innovations that have been introduced since 1914, and the following review, dealing with past and current practice in air-pump design and selection, is submitted in the hope that it will prove of interest.

Classification of Air Pumps

2. Air pumps may be classified as follows:

- Displacement
  - Wet-vacuum pumps, handling liquid and vapor
    - Simple, 3 valve decks
    - Edwards
    - Rotrex
    - Mullan
  - Dry-vacuum pumps
    - Simple
    - Two-stage
- Impulse
  - Rotary
    - Leblanc
    - A.E.G.
    - Roturbo
    - Thyssen
    - Weir
  - Ejectors
    - Water
      - Koerting
      - Kinetic
      - Muller
    - Steam
      - Radojet
      - Evacter
      - Leblanc
      - Briguet
      - Occluder

As most of these types are well-known to engineers, but little attention will be given to the older designs.

Wet-Vacuum Displacement Pumps

3. "Wet"-air pumps have proven their merit for more purposes and duties than is often realized, and are to-day to be recommended and installed with a clear conscience. For a simple power station or a small unit up to, say, 2,000 kw. capacity the question of style and trend has often influenced the selection of a more complicated system. Improvements have been made in the better-known pumps of this class so that volumetric efficiencies have been materially improved and power consumption reduced.

4. Succeeding the original bucket-type pump with three valve decks, the Edwards air pump, the principle of which was described in 1845* by Bodmer, was introduced into this country in 1900 by Mr. C. H. Wheeler, and is in general the best-known pump with wet-vacuum type. It is a vertical-piston displacement pump with suction ports in the cylinder wall which are uncovered by the piston at the bottom of the stroke, a vacuum being produced in the cylinder barrel by the downward movement of the piston. Upon the suction ports being uncovered by the piston the pressure in the cylinder barrel and the condenser is equalized, the condensate entering the pump with the vapors. The upward movement of the piston closes the ports and compresses the entrained air and vapors to atmospheric or discharge pressure and discharges the mixture through valves in the head.

5. The horizontal suction valveless pump had also been developed, and in this country as the Bailey pump preceded the designs of Blake, Knowles, and Mullan. These pumps and the later improved designs, like the Rotrex, are of the "wet" type, that is, removing bath condensate and vapors in a single cylinder. The chief advantages of these types are:

(a) Low power consumption;

(b) Positive action and stability, and

(c) Ability to handle excessive air leakages.

6. While these later designs as represented by the Rotrex and Edwards are still excellent pumps for units up to 1,500 kw., for larger units it is necessary that the rotative speed be reduced, in which event they become both cumbersome and expensive and take up a large amount of space. The volumetric efficiency of these pumps varies from 60 per cent. at three inch partial air pressure, to 18 per cent. at 0.5 in. partial air pressure, and since they handle both the water of condensation and vapors, at high vacuum the partial air pressure soon becomes very low unless the condensate is refrigerated by flooding the lower banks of tubes in a surface condenser.

7. On account of the distinct advantages of this type, however, and particularly where the pump drive is combined with the circulating water pump, the writer feels that the merits of these improved old-time designs are often overlooked, especially for units up to 1,500 kw.

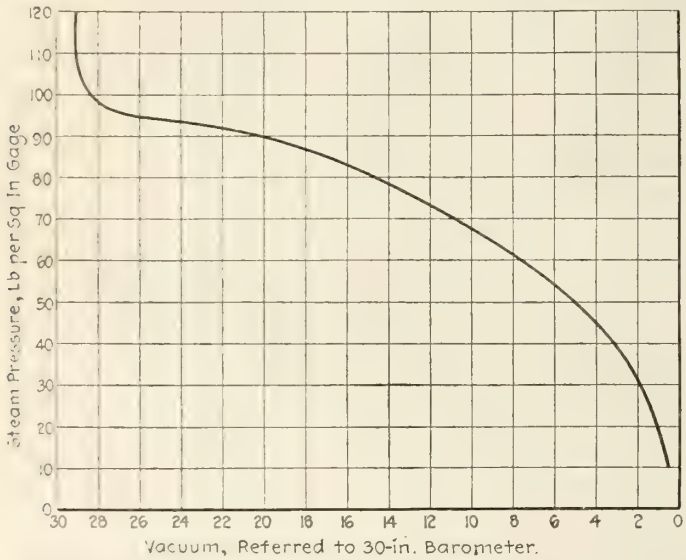
Dry-Vacuum Displacement Pumps

8. The next development was the separating of the handling of condensate and vapors, introducing what is commonly known as the "dry-air" pump. Wet-vacuum pumps of the type previously described were first used with a small quantity of water admitted for sealing purposes, a separate pump being provided to remove the condensate. Later the dry-vacuum pump made with small clearances and handling air only appeared, and this type has the same general advantages as the "wet" pumps but with better volumetric efficiencies. With improvements like flash ports, introduced by Wellner, to momentarily connect the clearance space at the end of the compression stroke with the vacuum side of the piston, both suction and discharge valves being closed, and using two-stage pumps with double and single cylinders, this type has held its own in the demands for high vacuum and increased sizes. And, except for its complications, the number of moving parts, maintenance, size, space requirements, etc., its use cannot be criticized.

9. The increase in the size of turbines coming into general use, however, together with the continuous demand for higher vacuum, called for dry-air pumps of cumbersome size and excessive cost, and the solution of this problem seemed to point to an ejector air pump of some form, using water as the motive fluid.

Hydraulic-Entrainment Air Pumps of the Rotary Type

10. In 1862 Christian Schiels, of Oldham, England, invented a hydraulic-entrainment air pump† which expelled the air from a condenser by combining or entraining it with hurling water in its passage through a fan or centrifugal pump. The necessary water pressure was provided by means of a high-speed rotary device and this, together with the relatively small space required and ability to maintain a high vacuum, offered such desirable features that, when the demand had exceeded the limitations of the dry-air pump, development came very rapidly. These pumps took two general forms. In one the air is entrained in the same chamber containing the rotating element, this type including a design of Leblanc's, manufactured by the Westinghouse Companies, which has given excellent results and is so well-known that a detailed description is not necessary. The A. E. G. pump is a modification of this type of pump and operates on almost the same principle.



VACUUM OBTAINED WITH SMALL-SIZED EJECTOR OF RADOJET TYPE WITH CONSTANT CAPACITY AND DECREASING STEAM PRESSURE.

11. The Hydrovac is another pump operating on the principle of entraining alternating slugs or layers of air and water in a combining element. The Thyssen pump performs its function by entrainment only, a centrifugal impeller discharging a thin sheet of water across a combining chamber into an annular diffuser, air being admitted to come in contact with both sides of the water sheet.

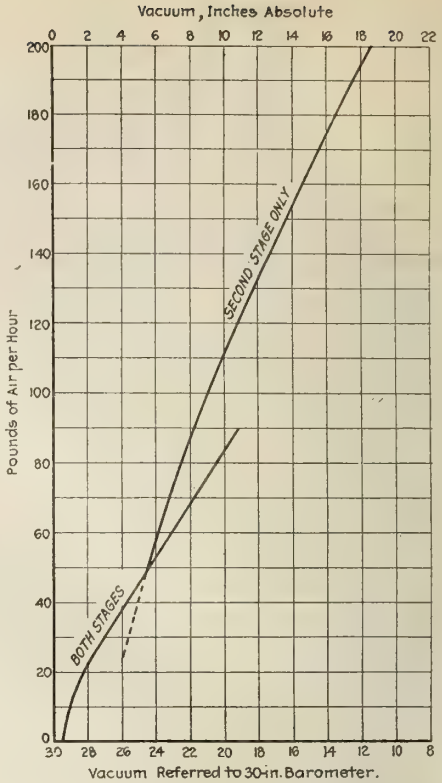
12. The Roturbo pump operates on a similar principle, except that numerous jets of water are discharged from a revolving pressure chamber across a combining chamber, and the resultant water and entrained air are collected in a revolving fan and directed into an annular diffuser and volute.

13. There are also numerous other designs of hydraulic-entrainment air pumps of the rotary type, such as the Globe-Johnson, Weir, and others, nearly all of which are subject to the same limitations.

Hydraulic-Entrainment Air Pumps of the Ejector Type

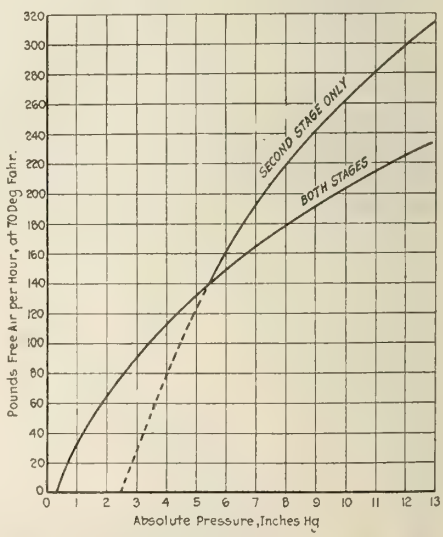
14. The other type of hydraulic-entrainment air pump is that in which the entrainment or compression of the air is performed in a part of the apparatus entirely separate from that producing the pressure of the hurling or entraining water. These pumps follow the simple ejector principle, using single or multiple jets of water discharging into a combining cone or diffuser and entraining the air due to the high velocity of the water jets. The Koerting ejector is the best known of this type, the water being supplied from an exterior source and forced through a number of nozzles into a combining cone or diffuser. These pumps serve their purpose best when combining the function of an air pump and a condenser, as then the steam condenses immediately on coming into contact with the water, increasing the effective head on the water nozzles and consequently the water velocity and entrainment. Under favorable conditions this type will be found satisfactory, its limitations being the amount of water that must be pumped and the necessity of keeping the nozzles thoroughly clean; for the pump must have water, and as it has very definite limitations in its air-handling capacity, it becomes very unstable when called upon to handle air in excess of the designed quantity. There are several modifications of this type of pump in use abroad, as represented by the Kinetic and others.

15. These water ejectors are occasionally used in series with some form of a steam jet which acts as a booster, and they usually take their water supply from a small centrifugal pump connected in parallel with the circulating system. The Muller or Worthington pump is a distinct design in that the jets are discharged from a rotating element into the diffuser, assuming a helical form with a decreasing pitch. The air is entrained and trapped between these jets and compression in the diffuser is aided by the decreasing pitch of the helically shaped jets of water.



VACUA OBTAINED WITH TWO-STAGE RADOJET EJECTOR WITH VARYING VACUA AND CONSTANT STEAM PRESSURE.

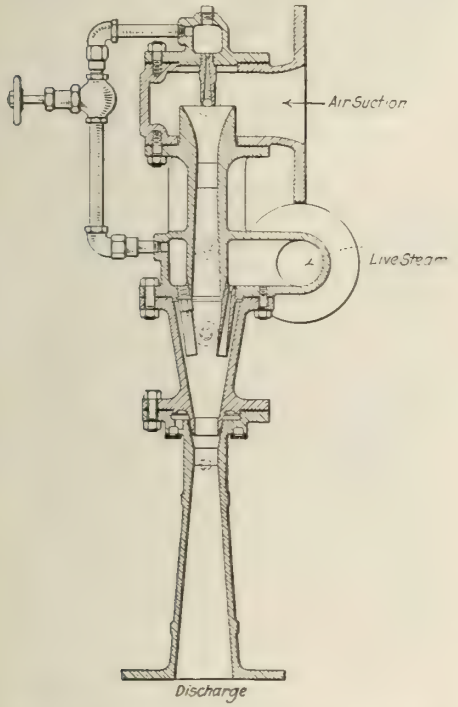
16. In general, the power required by a hydraulic-entrainment air pump is 40 per cent. greater than that for a rotary dry-air pump of the same relative capacity and the air-handling capacity is subject to strict limitations at moderate vacua; consequently these types cannot be counted on for overloads or unusual demands. The former is due to the



VACUA OBTAINED WITH ANOTHER TWO-STAGE RADOJET EJECTOR WITH VARYING

power required to move the necessary hurling water against a fixed discharge head, and the latter to the limiting weight of air that can be entrained by a fixed quantity of water. The volumetric efficiency of the dry-air pump falls off very rapidly at high vacua, due to the rarefied air to be handled in a fixed cylinder volume, through fixed port areas, and to the detrimental effect of the smallest clearances. The hydraulic pump is not so seriously affected; in fact, it improves in capacity at high vacua.

17 The hydraulic-entrainment type of pump has given complete satisfaction in performing the function demanded of an air pump, i.e., removing air and vapors from the condensing chamber and maintaing as low pressure as is consistent with circulating-water temperatures. But against the many advantages and satisfactory performances must be balanced the disadvantages. Hydraulic air pumps, using water as their



SECTIONAL VIEW OF LIBLANE EJECTOR.

working medium, are subject to erosion, and on account of the necessarily small passages, or sharp edges of vanes, presented to the water, must have clear, clean water of the falling off in capacity and efficiency is very rapid. In most cases these essential requirements necessitate a tank for the hurling water, screens and incidental attention thereto. And on account of the simplicity of the apparatus when compared with the rotary dry-vacuum pump, the admitted hgih power consumption has been accepted as a necessary evil and provision made to equalize the heat balance by providing electric drive for other auxiliaries.

Steam-Jet Ejector Air Pumps

18 The ejector principle is an old one, the use of steam as a medium and applied as a vacuum pump having been patented in England in 1868, but for high-vacuum service the ejector pump has not been in general commercial use in this country until the last three years. It is now, however, a definite engineering and commercial success, one manufacturer having actually delivered ejector pumps to serve over 4,000,000 h.p. of prime movers.

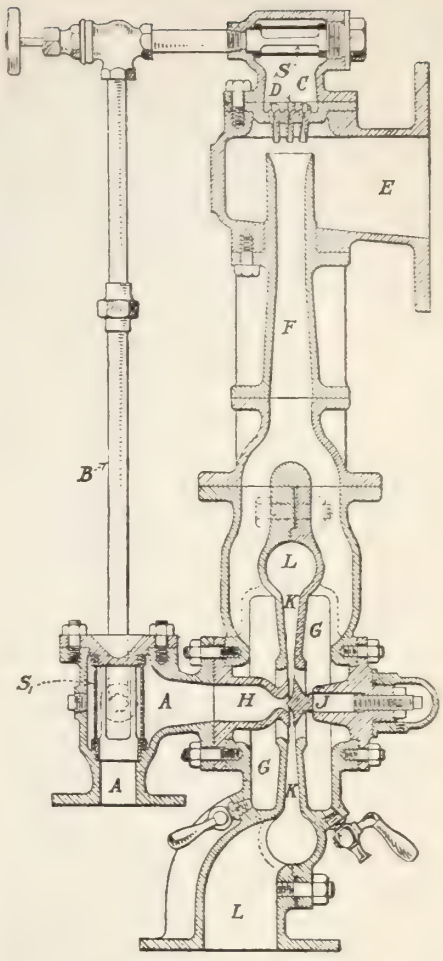
Advantages Claimed for the Ejector Air Pumps

19 Before outlining the development of the ejector air pump, the reason for its adoption may be considered by reviewing the advantages claimed for it, namely,

a Extreme simplicity
b No maintenance or attention
c Reliability and flexibility
d Stability
e Minium space and weight
f Low steam consumption, high efficiency.

20 The first advantage enumerated, while the most important, may be passed over as obvious. The second advantage results from the fact that there are no moving parts to wear out. The parts subject to wear are steam nozzles and diffusers, and the medium used is the same as used in the turbine; therefore the life of the pump, as far as its wearing qualities are concerned, should be as long as that of the nozzles of the turbine it serves. Because there are no moving parts to oil or adjust, the only attention required is that of opening and closing the valves controlling the pump.

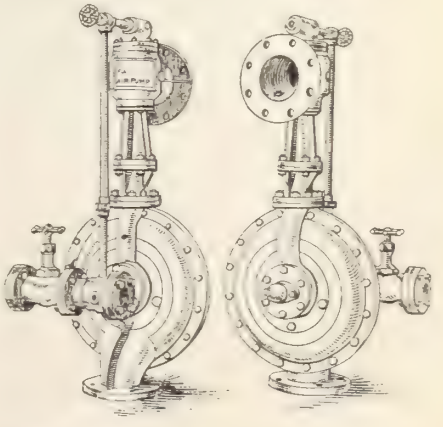
21 The third advantage claimed is one that will carry the most weight with engineers in charge of power production, because with them continuity of service is of first importance. As is well known and shown later, the air leakage varies greatly and provision must be made for leakages largely in excess of those expected with good operation. With other types of air pumps than those being considered, particularly rotary dry-vacuum pumps, it is usual to provide a pump large enough for maximum requirements and operate at reduced speed or displacement. This has the serious objection of making the entire unit dependent on a single air pump operating inefficiently. With ejector-type pumps, on account of their small size, weight and space requirements (no foundations being required), the total estimated air-removal capacity can be provided by two or more units, one or more of which can be operated as required, thereby providing maximum efficiency and insurance against shut-down. And the size of units can be so selected that one only is sufficient with a tight condensing system. Another desirable feature is that the necessity of using a second pump is an indication that unusual air leaks exist, and a third advantage is the maximum steam economy resulting from only as many pumps being used as are actually required. The adoption of ejector air pumps by the navies of the United States and France and by the United States Emergency Fleet Corporation supports this third claim.



SECTIONAL VIEW OF RADOJET AIR PUMP.

22 As to stability, while engineers have raised the question in regard to the single-stage water or steam ejector, attention may be called to Fig. 1, which gives test results of a small-size two-stage ejector to the Radojet type with constant capacity and decreasing steam pressure. Figs. 2 and 3 show variations of capacity of two sizes of these ejectors with varying vacua and constant steam pressures. Similar results are regularly obtained in operation of priming pumps, also with pumps attached to other than condensing equipment.

23 The fifth claim is clearly demonstrated by the following comparative figures for weight and floor space re-



EXTERIOR VIEW OF RADOJET AIR PUMP.

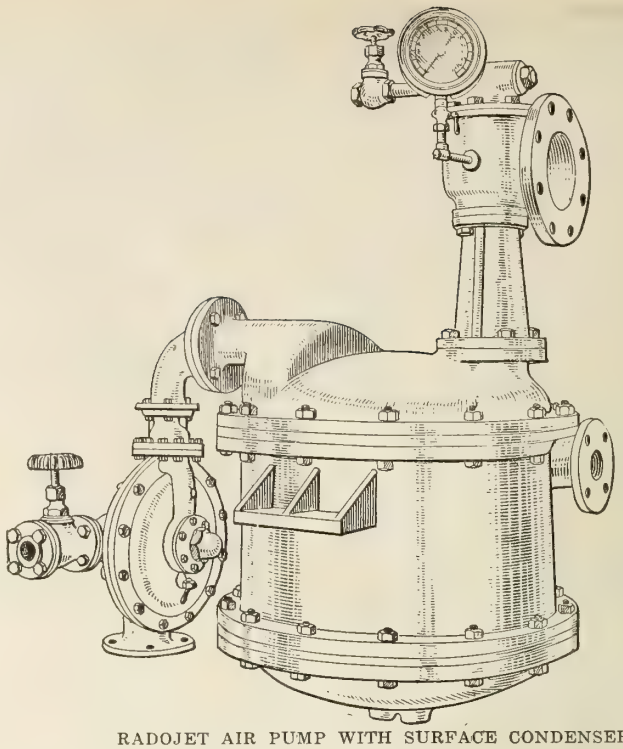
quired by three types of pumps for use with a 7,500-kw. surface condenser:

Type of Pump	Floor-space	Wght. lb.
Rotary dry-vacuum	10′ x 22′	31,000
Hydraulic	5′ x 10′	6,300
Ejector	1′ x 1′	450

24 The sixth claim requires the most consideration because it leads the list of disadvantages put forth by the few who have opposed the use of ejectors. Based on wasting all the steam used by the air pump (and the writer does not know of a modern power plant designed on this basis), it is freely admitted that the ejector requires more steam than the rotary dry-vacuum or wet-vacuum pump. If there is a case where all the steam used by the air pump cannot be used in heating feedwater, intercondensers can be used between the stages, resulting in a steam requirement less than that of the rotary dry-vacuum or wet-air pump. This alternative, however, requires some investigation. The operating steam in passing through the nozzles does work in entraining and accelerating the velocity of the air, and increases its temperature and compresses it. There is a small amount of heat lost, due to friction through the diffusers, which may be considered negligible. Excepting this the whole of the heat in the steam is available for heating boiler feed-water, the heat in both the steam and air doing useful work. With a 10,000-kw. surface-condensing equipment the condensate would be raised approximately 10 deg. by this means. Compare this now with the rotary dry-vacuum pump, hydraulic pump and ejectors with intercondensers. With the first the heat imparted to the air by compression (dry air at 60 deg. Fahr. compressed from 2 in. absolute pressure to atmospheric pressure has a final temperature of 680 deg.) is transmitted to the jacket or hurling water and wasted, as is the heat imparted to the hurling water in hydraulic air pumps.

25 With the intercondenser ejector approximately 30 per cent. of the total steam is used in the first stage and is seldom conserved. With jet intercondensers of the Briguet type, where air is admitted into the suction of the second stage, the operation is further complicated. Another objection to the intercondenser type is that the condensed steam from the first-stage nozzles must be removed from a chamber under vacuum, and the system is further complicated by cooling-water lines to and from this intercondenser. When a thermal efficiency of 90 per cent. and over is obtainable, and that with a total steam consumption that need not exceed 1 per cent. of the total steam used, then the claim seems established.

26 As a general rule, for plants of ordinary size (excluding units of 20,000 kw. and over, where better results are obtainable), it may be said that with ejectors without intercondensers less than 1 per cent. of the total steam consumption is required for surface condensers, and from 2½ to 3 per cent. for jet condensers; for intercondenser ejectors the percentages are approximately one-half these values.



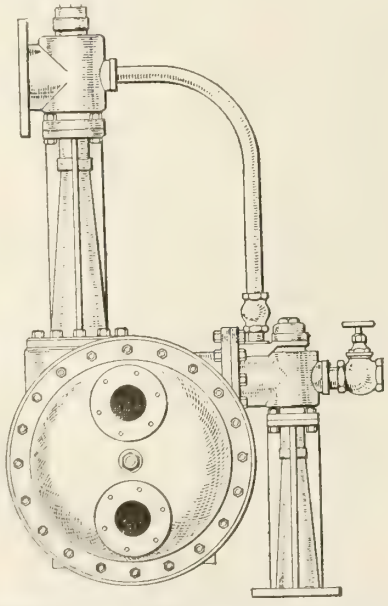
RADOJET AIR PUMP WITH SURFACE CONDENSER.

27 In 1903 Parsons brought out his steam-ejector vacuum augmenter, which was one of the first commercial uses of the steam-jet ejector as an exhauster of air under high vacuum. While it dealt with vapor, at low partial air pressures, the compression was only one or two pounds and therefore it is not comparable with modern pumps.

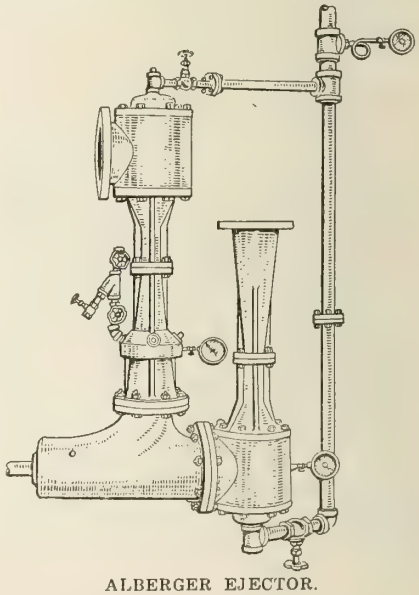
28 Parsons' application is to withdraw the vapors from the condenser and compress them 2 to 4 in. abs., condensing the steam used in an auxiliary condenser and discharging the compressed vapors into the suction of the wet pump which operates against a reduced vacuum by reason of an artificial head of condensate being provided.

29 One of the early developments of the ejector using steam jets in series for high vacuum was by Leblanc for his refrigeration system. He was able to obtain an absolute pressure of 0.05 in. Hg, and later applied his design to air pumps for condensers with marked success, although the Westinghouse Company, the licensees in this country, have confined their installations to marine use. The general design is shown in Fig. 4.

30 This ejector has a single nozzle in the first stage which entrains the air and compresses it in the diffuser, from which it is discharged into a mixing chamber where it comes in contact with



WHEELER CONDENSER AND ENGINEERING COMPANY EJECTOR.



ALBERGER EJECTOR.

the steam from a large number of nozzles of the second stage, the steam and air from the first stage being entrained and compressed to atmospheric or discharge pressure in the second diffuser.

31 It is well known that ordinary single-stage ejectors work best and are most stable when the compression ratio is approximately one to seven, and it is for this reason that two stages are always employed in steam-ejector air pumps. The ratios of compression in the two stages should be kept as nearly equal as possible, although for maximum economy over varying loads it is found in practice that the best results will be obtained by making the ratio of compression in the first stage equal to or greater than that in the second stage. It can be shown that for maximum efficiency in the utilization of kinetic energy of the motive fluid the ratios of the weights of fluid compressed and motive fluid used should be as nearly equal as possible. This, however, is a condition which a few experiments with steam ejectors will show unattainable.

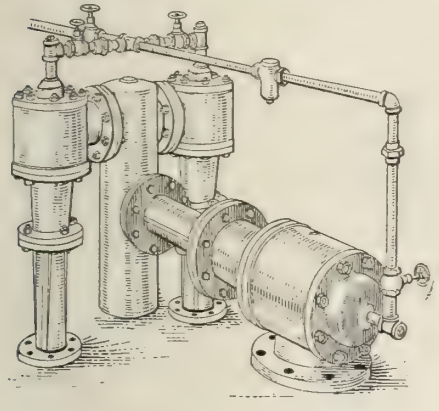


FIG. 10 CROLL-REYNOLDS EJECTOR

32 As has been mentioned before, hydraulic air pumps operate almost entirely by use of the kinetic energy of the motive fluid. The entrained water vapor carried over with the air condenses on coming in contact with the water and uncondensable vapors are entrained, either between sheets or with small globules of water and compressed by kinetic energy in the diffuser.

33 The action in a steam ejector is somewhat different, where there is a fluid to be compressed, moving at a very low velocity, which must be acted upon by steam issuing from nozzles at velocities varying from about 3,000 to 3,500 ft. per sec. It is quite evident, then, that the operating steam must entrain the air by friction, and also that a maximum entraining surface of the operating steam is of prime importance.

34 This means that either a number of small cylindrical nozzles must be used, or some special form of nozzle be substituted to give a greater superficial area per unit of steam used. This is of most importance in the second stage, where 70 per cent. or more of the steam is used, and may be accomplished in any one of three ways. The first method, that of using a large number of small nozzles, is objectionable on account of the difficulty of obtaining effective entrainment with the nozzles in the center of the group. And where the nozzles are placed concentrically or surrounding the first-stage diffuser, only half of the exposed steam area is effective.

35 In the second method a concentric steam nozzle is employed. This nozzle is sensitive to pressure fluctuations and exposes only a small portion of its superficial steam area to contact with the air.

36 In the third method, using a single steam nozzle in which an adjustable nozzle point spreads out the jet and causes it to flow radially as a thin sheet of steam, the air is entrained on both sides of the sheet and compressed in a radial diffuser surrounding the nozzle. This is the general form of the Radojet air pump illustrated in Figs. 5 and 6.

37 Referring to Fig. 5, steam is admitted from the boiler to the strainer cage *A*, a part being passed through the pipe *B* and strainer *S* to the first-stage nozzle chamber *C*. The steam expands in the nozzles *D* and passes across the suction chamber *E* at a velocity of approximately 3,000 ft. per sec., entrains the air and the vapors from the condenser and compresses them in the diffuser *F* to a higher absolute pressure. The mixture of steam and entrained vapors passes into a double passage *G* so arranged as to come into contact with both sides of the sheet of steam, and issues radially from the second-stage nozzle. Steam is simultaneously delivered through strainer S_1 and nozzle throat *H* to contact with the nozzle point *J*, which spreads the steam radially into a thin sheet issuing at a high velocity and passing across the mixing chamber *G*, entraining the commingled air and steam (or the air only, where an intercondenser is used) and carrying them into the annular diffuser *K* where the mixture is compressed to atmospheric or discharge pressure and then discharged through the volute and opening *L*.

38 From 70 to 90 per cent. of the total steam used passes through the second-stage nozzle. The thin sheet of steam issuing radially from the adjustable nozzle point *J*, by having both sides of the sheet in contact with the air to be entrained, exposes the maximum surface possible for entrainment and secures for this design the highest efficiency and economy. The nozzle point *J*, being adjustable, permits of varying the cross-section of the nozzle passage and changing the expansion ratio of the steam. This is a factory adjustment and made to secure the maximum efficiency of each individual pump. The first-stage nozzles and both diffusers are made of bronze and the second-stage "Radojet" of special steel. The parts described show absolutely no wear or erosive effect in service.

39 Ejectors with and without intercondensers are now made by practically all of the condenser companies, various designs being shown in Figs. 7 to 10.

40 Fig. 7 shows a Radojet pump with a surface intercondenser. Two or more pumps can be mounted upon a single surface condenser, division walls being made in the steam boxes so that each pump may be operated independently. These individual pumps may vary slightly in size so that different combinations of air-removal capacities can be obtained. Such an arrangement is now being followed with a 30,000-kw. installation at Detroit.

Selection of Air-Pump Capacities and Sizes

41 The selection of air-pump capacities and sizes has always been shrouded with considerable mystery and the methods to employ should be given more publicity. Air is admitted to the condensing chamber in three ways:

a From leaks in the system, under vacuum
b From entrained air in the boiler feedwater carried over with the steam, and
c From entrained air in the injection water (in jet or barometric condensers only).

42 The sizes of air pumps to use with surface condensers, where only *a* and *b* in the preceding paragraph apply, will be considered first. The early air pumps were of the wet type, and textbooks and handbooks of not many years ago gave a rule that the displacement of the air pump should be a function of the low-pressure cylinder displacement. And on this basis, or on the proportions of a successful installation, most air-pump sizes were then selected. Later a rule making the displacement a function of the volume of condensed steam was very generally used and proved to be very satisfactory. This called for ratios of swept displacement of the air-pump cylinder to the volume of condensate of:

20: 1 for 26 in. vacuum
20: 1 for 27 in. vacuum
40: 1 for 28 in. vacuum
53: 1 for 29 in. vacuum.

For rotary dry-vacuum pumps of good design the ratio of displacement to volume of condensate for 28 in. vacuum seldom exceeds 35 to 1.

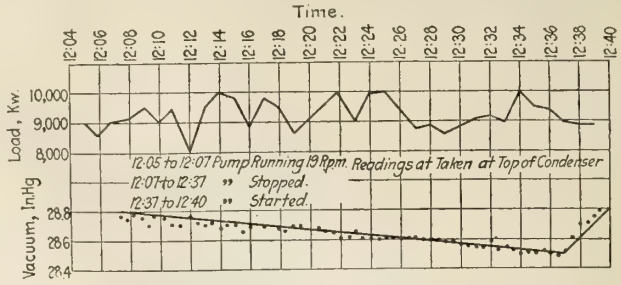
43 The introduction of ejector pumps using water or steam required that some other method of selection be used. And the adaption of ejector and entrainment-type air pumps and the general use of large units also called for a more accurate method of selection of sizes. For a number of years experiments and investigations have been made on the effect of air leakage on vacuum, heat transfer, etc., all of which have indicated that the presence of only a small amount of air has a very detrimental effect. The relative coefficient of heat transfer as referred to steam was shown

by Josse, to be 1 to 700. This caused the large operators to introduce periodic tests of their condensers for air leakage, which was accomplished by discharging the rotary dry-vacuum pump into a gasometer.

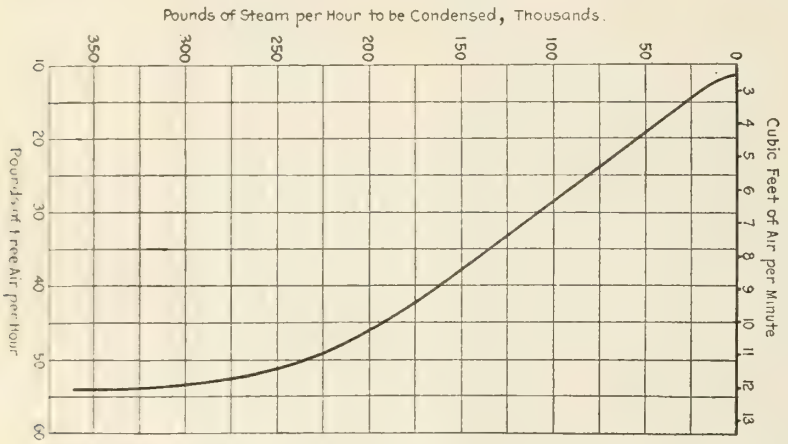
44 These periodic tests showed some unexpected results: That a 30,000-kw. unit need not necessarily have a greater air leakage than a 20,000-kw. unit, and that it was possible to keep air leakage to extremely low quantities, dependent (*a*) on the care exercised in installing the condensing equipment and (*b*) on the care in operation, or rather the willingness of the operating engineer to go after small leaks. That a system can be made practically air-tight can be demonstrated by shutting down the air pump while the unit is under load, Fig. 11 showing results as reported on a 10,000-kw. unit at the Boston Elevated Station. Here a drop of only 0.30 in. Hg in 30 min. indicates that there was very little entrained air in the steam and practically no air leakage.

45 The purchaser of a condensing equipment insists that the manufacturer guarantee the vacuum, but with his inquiry, in which he specifies the amount of steam to be condensed, water temperature, etc., he neglects to state how much air he intends shall be allowed to leak into the system. And the writer contends that this is almost as important a factor as the quantity of steam. For this reason the condenser manufacturer is compelled to do a great deal of "educated guessing." We know that with the ordinary system, using open feedwater heaters, the amount of air mechanically entrained in the feedwater is reduced to 1 per cent. or less. Orrok[1] showed reductions of entrained air from 4.325 per cent. in raw water to 0.931 per cent. in the heater. The air quantity from this source is in direct proportion to the quantity of steam condensed. Leakage through glands, joints, connections and the materials of which the condenser and the low-pressure stages of the turbines are made, is a function of its size and tightness. Assuming the same care in manufacture and make-up, then size also is a function of quantity of steam condensed and we may assume total air leakage as a factor of the quantity of steam condensed.

46 In arriving at our figures there are some very uncertain factors to be taken into consideration: Shall we assume the best operation possible, weekly tests for leaks, etc., or the operation of a shiftless attendant satisfied with a spring gage? Inasmuch as the manufacturer is interested in the prosperity of his customer, he assumes the former, and to be sure of his own guarantee, provides for the latter. It is generally known that under good operative conditions the speed of a rotary dry-vacuum pump can be cut to one-half its rating, and that there are other times when the full capacity is needed. It is therefore excellent practice to supply air pumps of capacity in excess of the anticipated requirements.



CURVES SHOWING EFFECT OF SHUTTING DOWN THE AIR PUMP WHILE UNIT IS UNDER LOAD.



ESTIMATED QUANTITY OF AIR TO BE REMOVED FROM SURFACE CONDENSER WITH TIGHT SYSTEM AND GOOD OPERATION.

Dry-Air Leakagae in Surface-Condensing

47 Based on a *tight system and first-class operation,* the amount of *dry*-air leakage to be expected with surface-condensing equipment is shown in Fig. 12. It should be noted that this is dry air and is less than the capacity to be provided by the air pump, because in passing through the condenser this air becomes saturated and the air pump must remove with the air an amount of water vapor dependent on the pressure and temperature of the mixture.

48 It will also be noted that the air-leakage curves in the figure are indicated in pounds of air per hour. This is done because a pound of air is a definite thing—a cubic foot of air must be specified as to temperature and pressure to have a definite meaning. To those accustomed to thinking in terms of cubic feet the approximate relation of 4.5 lb. of air per hour to 1 cu. ft. of air per min. at 70 deg. fahr. and atmospheric pressure, will be of some assistance.

49 According to Dalton's Law, the total pressure in the condenser is the sum of the partial vapor pressure corresponding to the temperature of the mixture, as taken from the steam tables, and the partial air pressure due to the air or other gas present in the condenser. The volume of the air is directly pro-

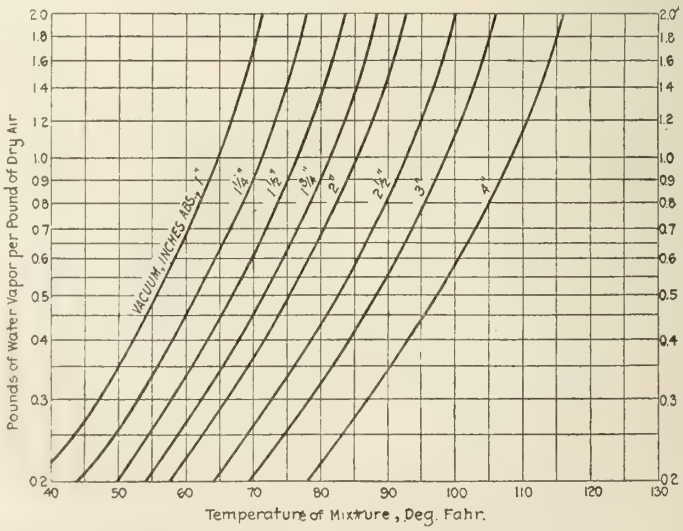
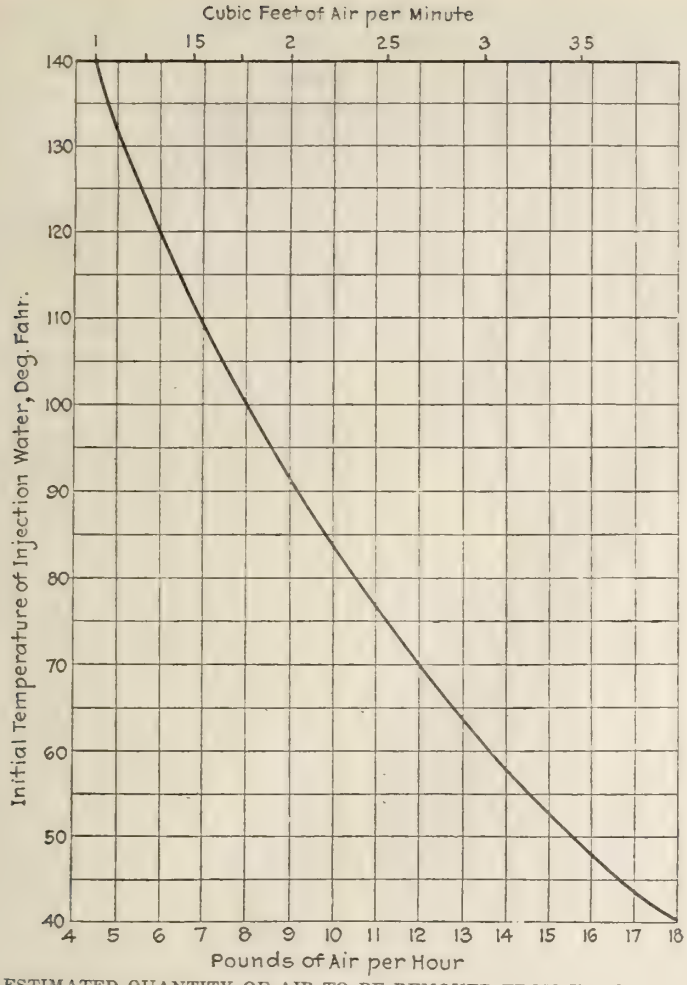


CHART SHOWING WEIGHT OF WATER VAPOR THAT MUST BE REMOVED FROM A CHAMBER CONTAINING WET AIR AND VAPOR TO REMOVE ONE POUND OF DRY AIR AT DIFFERENT TEMPERATURES AND PRESSURES.



ESTIMATED QUANTITY OF AIR TO BE REMOVED FROM JET OR BAROMETRIC CONDENSER PER 1,000 GALLONS INJECTION WATER PER MINUTE.

portional to its absolute temperature and inversely proportional to its pressure; therefore, if the mixture of air and water vapor in a condenser is cooled, the total pressure, or vacuum, remaining the same, the vapor pressure is reduced and the partial air pressure increased, with corresponding changes in volume.

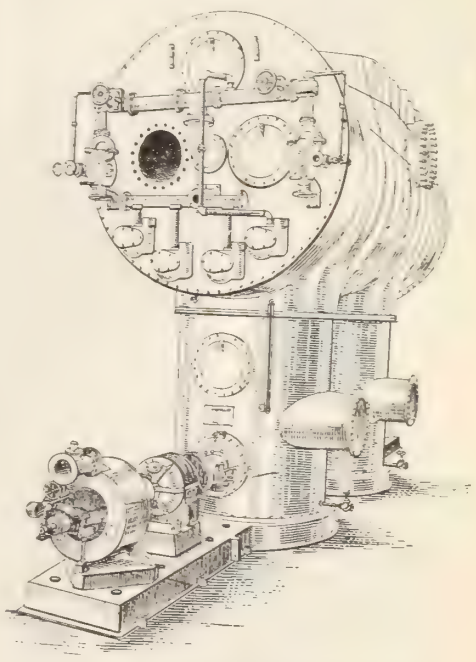
50 For example, 1 lb. of a mixture of air and water vapor at 80 deg. fahr. and 2 in. absolute pressure as extracted from a condenser would be composed of 0.595 lb. of air and 0.405 lb. of water vapor. Let this mixture be taken from a colder part of the condenser so that its temperature is reduced to 70 deg. fahr., and the relative weights will be changed to 0.724 lb. of air and 0.276 lb. of water vapor; or, to do the same effective work an air pump with a displacement only 0.595/0.724 or, approximately, four-fifths as large would be required. The problem may also be considered as the determination of the total weight of saturated mixture that must be removed from a condenser to extract 1 lb. of dry air, and Fig. 13 has accordingly been plotted to show the weight of water vapor that must be removed from a chamber containing saturated air and vapor to remove 1 lb. of dry air at different temperatures and pressures. These factors must be used in conjunction with Figs. 12 and 14.

51 For example, assume a 10,000-kw. surface condenser condensing 140,000 lb. of steam per hour, with circulating-water temperatures of 60 deg. in and 74 deg. out, a vacuum of 1.5 in. abs. being maintained.

52 From Fig. 12 it is seen that the expected dry-air leakage with a *tight system and with good operation* is 36 lb. per hour. Under these conditions and with good design the temperature of the mixture going into the air pump should not exceed a mean of the circulating-water temperatures, or 67 deg. with a vacuum of 1.5 in. abs. Fig 13 shows that in order to remove 1 lb. of air it is necessary to remove 0.5 lb. of water vapor. Therefore the air pump must have a capacity of 1.5 × 36 or 54 lb. per hour of a mixture of air and vapor at a pressure of 1.5 in. abs. to take care of a leakage of 36 lb. of dry air. Now this capacity is selected on the assumption of a tight system and good operation, and does not provide for emergencies. The usual way to provide for emergencies, unusual operating conditions and excessive air leaks is to select a larger pump and operate at reduced capacities, but the better way by far is to select two pumps of minimum size as indicated from capacity curves. There are several good reasons for this: A spare pump is provided as an insurance against shutdown; maximum economy of power is obtained; and the necessity of the use of both pumps is an automatic indication of excessive air leakage. The steam ejector being so small and not requiring foundations, lends itself most admirably to this selection and can be used in two or as many more units as are desirable, to provide for fractional loads and maximum economy.

Selection of Air Pumps for Jet and Barometric Condensers

53 In selecting an air pump for a jet or barometric condenser, capacity must also be provided for the entrained air and gases which enter with the injection water and immediately expand to the pressure being maintained in the condenser. Here we have a very uncertain item, for cold water will hold more air than hot water, and water flowing over leaves and decayed vegetable matter absorbs CO_2. The air content will be different in the water of a spray pond or a still lake, or of a slow-moving river or a mountain stream, and will vary under ordinary conditions from 1 to 5 per cent. by volume. The quantity of air admitted into the condensing system with the injection water is greatly in excess of that entering with the steam and air leaks, and a considerable quantity of air passes out of the system through the water-removal pump or down the tail pipe by entrainment. This latter quantity is sometimes as large as 40 per cent. of the total and seldom less than 20 per cent. It is therefore assumed that the air admitted with steam and by leaks in the system passes off with the injection water, and air-pump capacity is provided only for the air entering with the injection water. Taking all these variations into consideration, *dry*-air-re-



1500 K.W. JET CONDENSER WITH FOUR RADOJET AIR PUMPS.

moval capacity for either a low-level jet or barometric condenser should be provided as shown in Fig. 14, using as before the factors the factors from Fig. 13.

54 In this case it is advisable to select two or more pumps so that the total capacity is that obtained from the curve. The ejector pump lends itself to the best advantage in this selection and provides flexibility and economy when the air entrained in the injection water is not as great as anticipated.

55 To illustrate the selection of an air pump for a low-level jet condenser, assume a 7500-kw. unit condensing 110,000 lb. of steam per hour and maintaining a pressure of 2 in. abs. when supplied with 9,000 gal. of injection water per min. at 70 deg. Fahr. Fig. 14 shows that we can expect to remove 12 × 9 or 108 lb. of air per hour from the condenser. Assuming the mixture going to the air pump has a temperature of 75 deg., it is seen from Fig. 13 that with this temperature and a pressure of 2 in. abs. it is necessary to remove 0.49 lb. of water vapor in order to remove 1 lb. of air. Therefore the air pump must have a displacement of 1.49 × 108, or approximately 160 lb. of mixture per hour at 2 in. abs. To provide this capacity in a single unit would require inefficient operation at partial loads, or when the air leakage and content in injection water is not as great as provided for. To use two or more units is also better practice, as then the entire equipment is not dependent on a single air pump. Fig. 15 shows a 15,000-kw. jet condenser provided with four Radojet having a total capacity obtained as indicated in the foregoing example.

56 Most steam-ejector air pumps have their nozzles designed for a fixed initial and back pressure, a pressure-regulating valve being installed in the steam supply line to automatically take care of boiler fluctuations. The maximum back pressure usually specified is 0.5 lb. gage, but this may be increased to a maximum of 3 lb. by increasing the initial steam pressure at some sacrifice in steam economy. Ordinarily, steam-ejector air pumps should be exhausted under water into a surge or feed tank so that the entire heat in the steam and air can be utilized, and the entrained air passed off through a vent. The exhaust can be into an open feedwater heater without detrimental effect, provided the heater is thoroughly vented, and also can be piped to any reasonable distance, provided pipe sizes are so selected as not to produce excessive back pressure. If the exhaust discharge is above the air-pump exhaust opening a barometer trap should be provided at the lowest point of the exhaust line, and of such length as to balance the predetermined back pressure. And a check valve should always be installed in the exhaust line from each ejector.

57 There is nothing to get out of order, to oil, or to adjust about this type of pump, and if the screens and nozzles are inspected and cleaned occasionally, the owner of a condenser equipped with steam air ejectors can be excused for exclaiming, "Why didn't some one think of this before?"

Sold Outfit.—The Hanson Van Winkle Co. have just sold to the Kelsey Wheel Co., of Walkerville, a large generator plant, including a 2,000 amp. dynamo, which they are using for electro-plating automobile wheels and accessories.

Chatham's Water.—At a meeting of the Chatham Water Commissioners it was decided to submit a referendum to the ratepayers of Chatham at the earliest possible moment asking them to decide between Lake Erie and the River Thames as the permanent source of a civic supply of water, with the understanding that the city council will apply to the Railway and Municipal Board for permission to issue debentures for raising money to carry into effect the scheme selected.

Sold Property.—The Gurney Foundry Company have sold No. 740 and 742 Yonge Street, Toronto, but as yet the name of the purchaser is not disclosed. The sale price is reported to be around $90,000 and the lot has a frontage of 33 feet by a depth of 325 feet to Balmuto Street.

Selling Stock.—The Dillon Crucible Alloys, Ltd., are advertising in the Welland paper, giving to citizens an opportunity to buy a small block of stock, which will pay dividends of not less than eight per cent., at the price of $100 per share, cumulative preferred, with bonus of 50 per cent. common at $5 per share; for instance, $1,025 would buy ten shares preferred and five shares common.

Welding is Steadily Gaining Favor in Boiler Industry

By ARTHUR MALET

THERE is no question but that welding in general and oxy-acetylene welding in particular is steadily gaining in favor in the boiler industry, as is evidenced by the number of shops in which its use is gradually being extended in regular production.

This interesting statement is made by the above author in a recent issue of Acetylene Journal; and he goes in the following manner: .

Although it has been condemned by some individuals, the causes of failures of oxy-acetylene welding are generally traceable to the inexperience or poor workmanship of the operator. To become a good welder or to be efficient in any line of work, it is necessary that a man must like that work and try his hardest at all times to produce the best results of which he is capable.

In the case of oxy-acetylene welding, the operator must study the action of the metal when subjected to the intense heat produced by the flame and understand why the welding progresses as it does. He must watch his flame and keep it neutral and be sure that he is actually welding and not simply sticking the metal from the filler rod on to the piece being welded. He must learn how to handle his torch and the filler to the best advantage. He must also be a cold-blooded sort of chap to be able to stand the intense heat in which he must sometimes work if he is welding a piece surrounded by a bed of red-hot coals, as happens when preheating is necessary.

In the shops where the writer is located the torch is put to every possible use in the work. In its cutting capacity it is used to burn out all staybolts and old sheets and to cut all rivets. If the operator is careful, he can bevel the sheets to be welded with the cutting torch and save time and labor that would be required to do the same work with a chisel and air hammer.

Ash pans are in a great many cases welded now and seem to give as good service as pans with angle irons and rivets. In building up ash pans the pieces of plate may be riveted to the casting before or after welding. The sides of the pan are held together at the top by a wire clamp. Before the welding is started, thin wedges are driven between the edges of the plates, forcing them apart about ¼ inch.

All tool boxes used by the engine crews are welded. These boxes are built up of No. 12 gauge sheet iron and are 18 inches long, 8 inches wide and 8 inches deep. Welding is done from the inside, the outside edges being smoothed after the operation is completed.

The great speed that can be accomplished in doing any of this shop work by means of welding is very much in favor of the process.

Recently it was necessary for the men in the shop to put a patch in the left back mudring corner of an engine. The patch was to cover an area which included two staybolts, eight mudring rivets on the door sheet, and three mudring where it lapped on to the side sheet, and three rivets in the running seam. It took just eight hours for a boiler maker, a helper and a welder to remove the old piece and weld the patch into place. All that remained after this was to drill the holes for the mudring rivets, drive the rivets, apply the two staybolts, and chip and caulk the patch.

Incidentally, the cutting torch was used to burn off the staybolts and the old sheet, as well as to preheat the patch when it was being laid up.

As yet we have not had to install any new side sheets or flue sheets, but probably will in the near future. When this becomes necessary we intend to try cutting out the top of the back flue sheet just below the braces and weld in a new top piece, as several of the flue sheets are badly worn in the tube area, but perfectly sound below.

Board of Trade Reports on Furnace Failures

C. E. Stromeyer, Chief Engineer of the Manchester Steam Users' Association (England), Discusses Some of the Features of These Reports

MY enquiry, in the 1916-17 Memorandum, into the strengths of shell plates suggested the desirability of reviewing the enquiry of 1899. I then dealt with 172 Board of Trade Reports. An additional number have come to hand since then, but by selecting only those cases in which the furnaces were not supported either by stays or cross tubes, the number has been materially reduced and the problem simplified.

It resolved itself into the two questions: Does the quality of furnace plates deteriorate in the same way as the quality of shell plates? and what is the weakening effect of local corrosion?

Forty Board of Trade Reports, which seem to throw light on these points, are contained in Tables III. and IV., and are fairly complete as regards essential details. Forty-eight other reports on the same subject are deficient in details and are enumerated further down. They include a few collapses, which are fairly complete as regards detail, but which seem to have been due to other causes than stated by the Board of Trade. Particular interest attaches to those cases, of which there are eight, in which the boilers had been subjected to hydraulic pressures without collapses taking place. These tables also contain a few cases of collapses of oval furnaces.

Unfortunately for the present enquiry, it is more difficult to deal with furnace plates than shell plates, because the theoretical bursting stress of a shell is also the ultimate tenacity as found with a testing machine, whereas the collapsing stresses of furnaces depend not only on the crushing strength of the material, but also on the ratio of plate thickness to furnace diameter and on its length. The most popular formula dealing with this relation is associated with the name of Fairbairn, who, it will remembered, made a number of tin-plate tube experiments while he was president of the Manchester Steam Users' Association. Those experiments threw much light on this complicated subject, but his formula and other similar ones have not been found quite satisfactory. Representing the test results by hyperbolas, as they do, necessarily demands limiting rules, because otherwise very short furnaces would appear to be infinitely strong and long furnaces would have no strength at all. A more comprehensive formula, which covers all lengths from nothing to infinity, which was suggested by me in 1899, has been found very useful, and serves as a convenient basis for the present enquiry:

$$S_H = 3 + \frac{13}{1 + \left(\frac{l}{t}\right)^2 \frac{1}{13{,}000}}$$

Here l and t are respectively the length of the furnace between supports and the thickness of the plate, both measured in inches SH is the compression in tons in the furnace plate at which collapse takes place. This formula has been slightly modified and simplified as follows:

$$S_H = 3 + \frac{13 \cdot 5}{1 + 3\left(\frac{L^2}{t^2}\right)}$$

L and t being measured respectively in feet and sixteenths of an inch. This formula, as will be seen by the three following cases, is in fair agreement with actual experiences, though they are unfortunately very few in number.

Board of Trade Report No. 314.—In this case the furnace did not collapse until the bursting pressure of the shell had been reached. This pressure of 212 lbs. was estimated from the boiler dimensions, a procedure which was justified by the fact that the riveted seams of the shell were found to have slipped before rupture took place. The furnace dimensions were 29 in. diam., 26.5 ft. length and ⅜ in. thickness. The stress at which the furnace should have collapsed according to the above formula was 3.16 tons per square inch. It actually withstood a 12 per cent. higher pressure of 3.57 tons.

Board of Trade Report No. 1,173.—This was a marine boiler which exploded while the safety valves were being adjusted to a pressure-gauge which was not in working order. The safety valves were found after the explosion and tested, and it was ascertained that they lifted at a pressure of 257 lbs. per square inch. As the valves were blowing at the time of the explosion, 257 lbs. was the bursting pressure. The furnaces were 34 in. diam., 6¾ ft. long., and the top plate thickness was 7-16 in., the bottom plates being ½ in. thick. The stress in the furnace plates at the time of the shell explosion was, therefore, 4.43 tons per square inch. Introducing the several values into the above formula, we find that the furnaces should not have collapsed until 6.57 tons per square inch had been reached. If, as is possible, the furnace plates had been reduced in thickness to ⅜ in. the stress would have been 5.16 tons at the time of the explosion, and the estimated probable collapsing stress 5.80 tons per square inch.

Board of Trade Report No. 2,349.—This was a Rastrick boiler with a vertical flue 38 in. diam., 3 2-3 ft. long between flanges, having 7-16 in. thick plates. The junction valve between this boiler and the steam pipes had been closed unbeknown to the engineer, who thought that the blowing of the safety-valves was due to a leaky seat. He, therefore, heavily overloaded the valve, which nevertheless continued to blow. With the help of the added weights, which were found after the explosion, it was estimated that the steam pressure under which the flue collapsed was 150 lbs. per square inch. Under this pressure the stress in the flue plate would be 6.51 tons per square inch. The stress estimated by the formula under which the flue might be expected to collapse was 6.03 tons per square inch.

These three cases are too few for the drawing of a very definite conclusion as to the correctness or otherwise of the formula, but they show that it can be used as a standard of comparison, to be modified in the light of the information collected in the present tables.

The furnaces in Tables III. and IV. gave way, due to local corrosion, and the important question to be considered is, does the general rigidity of the furnace as a whole determine the limit of stress under which the weakest section will give way, or does the strength of the furnace depend only on its weakest section? The problem is analogous to that of a strut with which furnaces have often been compared, the only difference between the two cases being that in a column the line of thrust between the load and the base is a straight line passing down the axis of the column, whereas in a furnace, which is really a complete arch pressed from all sides, the line of thrust is a circle passing along the centre line of the plate. Now it has been found for columns that up to a certain limit of load the column will always straighten itself again if through any accidental cause it may have been slightly bent. However, when the load exceeds a certain limit the column will not recover itself if accidentally bent, but will collapse completely. Similarly a cylinder will recover cylindrical shape if the external pressure does not exceed a certain limit, but will collapse under the slightest deforming influences if the external pressure exceeds that limit.

These conditions would not be changed by a local weakness such as a saw cut, in either the column or the cylindrical ring, except that, as the section at the saw cut is a reduced one, and the average stresses across the section are far more intense than the average stress, the limit for the load or thrust should be reduced in proportion to the reduction of the section. In other words, the permissible stress across the smallest section has to be determined by the average dimensions of the column or furnace. Thus, if the collapsing stress of a new furnace has been determined, the external pressure for a cylinder is fixed by this stress and by the thickness of the plate. If we saw-cut this plate on one side, the permissible

COLLAPSES OF CYLINDRICAL FURNACES OF VERTICAL BOILERS.

Board of Trade Report	Age of Furnace. Years.	Furnace. Diam. Inches.	Furnace. Length Feet.	Plate Thickness in 1/16 in. Original.	Plate Thickness in 1/16 in. Reduced for Age.	Plate Thickness in 1/16 in. At Fracture.	Probable Boiler Pressure. Lbs.	Stress at Fractured Section. Tons.	Collapsing Stress by Formula. Tons.	REMARKS.
73	15(?)	29	3·5	4·5	3·75	1·5	60	4·15	4·86	
73	15(?)	29	3·5	4·5	3·75	1·5	70*	4·86	4·86	*Steam test six months earlier. No collapse.
111	4(?)	32	3	4	4	0·25*	45	20·5	5·52	*3/16 in. at fracture is probably only a local weakness.
115	18 and more	35	5·5	6	5	3* mean	75	3·15*	4·46	*With a minimum thickness of 2/16 the stress would be 4·73 tons.
121	13(?)	21	2·2	4	2·75	1* bare	60	4·52*	5·31	*For a thickness of 3/16 the stress would be 6·03 tons.
127	3 to 8	22·5	3·9	5	4·5	2·5	95 or more	3·07 or more	5·08	
267	13	25·5	4·5	5	4·25	2	80	3·66	4·55	
267	11	25·5	4·5	5	4·25	2	100*	4·58	4·55	*Hydraulic test two years previous. No collapse.
269	15 and more	31	2	5	3·75	1	40 to (60)	8·88	6·66	
394	very old	42	4·9	6	4	1* mean	37	2·78*	4·23	*For a thickness of 3/16 the stress would be 4·16 tons.
524	23	27·75	4	5	3·75	1·5	20(*)?	1·33	4·21	*The working pressures were 75lbs. and 35lbs. respectively, both furnaces collapsed while under banked fires, and probably under working pressures and not under 20lbs. pressure as reported.
524	23	27·75	4	5	3·75	1·5	75	3·53	4·21	
562	10	32·75	3·7	5	4·5	1	20(*)?	2·33	5·23	
562	10	32·75	3·7	5	4·5	1	35	4·10	5·23	
551	16	24	3·1	4	3·25	1/20 in.	30* to (60)	3·12*	4·81	*30lbs. last seen on gauge. Collapse after stoppage of engine. At 60lbs., the usual working pressure, the stress would be 6·24 tons.
719	22	23·5	2·7	6	5	1/2*	50 to (80)	8·34	8·13	*1/32 in. at fracture is probably only a local weakness.
1143	20	32	4·7	6	5	1	56	6·40	4·84	
1431	24	25	3·2	6	4·75	1	55 to (65)	4·92	5·86	
1512	7 and more	21·5	2	5	4·5	1/2*	30(?)*	9·26	7·24	*3/32 in. at fracture is probably only a local weakness; 30lbs. pressure is a doubtful value. The report only states that the gauge pointer stood upright.
1643	23	27	2·4	5	3·75	1/2*	40	7·80	6·03	*1/32 in. at fracture is probably only a local weakness.
1643	23	27	2·4	5	3·75	1/2*	65	12·60	6·03	*Steam test sometime previous, where plate may have been thicker.
2020	12 and more	30	2·9	5	4·25	1/2*	42	8·90	5·81	*1/32 in. at fracture is probably only a local weakness.

The pressures in brackets are those to which the safety valves were loaded, but which were not used for estimating the stresses.

stress will not be altered, but, on account of the local reduction of thickness the permissible external pressure will have to be reduced.

A very interesting case, illustrating this point, occurred recently. A furnace had grooved very severely along both sides of the firebars, until the limiting collapsing stress, as determined by the uninjured portion of the plate had been reached, and then the two sides developed two very sharp, long bulges, the upper half of the furnace as a whole settling down about 1½ in. The rigidity of the uninjured portion prevented any general deformation, and the failure was due to a local excess of crushing stress.

The method of dealing with the reported collapses was, therefore, to estimate the actual collapsing stress at the locally reduced section where the final rupture took place, and to compare this with a collapsing stress estimated from the overall thickness of the furnaces as a whole. Here, however, a serious difficulty was encountered, which could easily be obviated in future Board of Trade reports, for in no single instance has the average thickness of the collapsed furnace been measured. The only available information is the original thickness and the thickness at the fracture. There are, unfortunately, a number of reports in which even no mention is made of the fracture thickness, in others the pressure has not been ascertained, and yet in others the collapses were not due to weakness or overpressure as stated in the report, but most probably to overheating. These imperfect reports are not included in Tables III. and IV. As, however, even these reports might be made useful, their number are here given. Incomplete reports: Short furnaces—No 149, 439, 601, 681, 771, 1,081, 1,136, 1,237, 1,297, 1,423; long furnaces—Nos. 58, 230, 326, 346, 362, 538, 547, 619, 791, 808, 864, 871, 1,066, 1,149, 1,601, 1,682, 1,825, 2,295. Overpressure generally due to inoperative safety valves: Short furnaces—Nos. 177, 276, 983, 1,211, 1,246; long furnaces—Nos. 117, 199. Overheating: Short furnace—Nos. 874; long furnaces—Nos. 230, 782, 859. Oval furnaces: Long—Nos. 1,152, 1,208, 1,292.

In the absence of information about the average thicknesses of plates in Tables III. and IV., it seemed at one time hopeless to continue this enquiry, but it was found that as a rule the estimated collapsing pressures for long furnaces, detailed in the upper portion of Table IV., agreed fairly well with the actual collapsing stresses. Now, in these cases the collapsing stress is not materially affected by the average thickness, and it was felt that by making some reasonable assumption as to general wasting in the course of years, the short furnaces in Table I. might also be harmonised with the formula. The first assumption that the average wasting was proportioned to the local corrosions, an assumption which it must be admitted is not generally correct, led to no satisfactory result, but better results were obtained when it was assumed that furnace plates are subjected to an annual loss of thickness. The most concordant results were arrived at on the assumption of a loss of 1-64 in. in five years, or about 1-320 in. per annum. Then, however, it was found that the second term in the expression for the collapsing stress, the term which might be said to take into account the supporting influence of end plates and stiffening rings, was carrying too much weight, and on halving its co-efficient from 13.5 to 6.75 reasonable harmony was established.

Tables III. and IV. have, therefore, been arranged as follows. Column 5 gives the original thickness of the plates in sixteenths of an inch; column 6 gives the thickness as estimated by deducting 1-64 in. for every five years of furnace life; column 9 gives the collapsing pressures as estimated from information about boiler pressure and minimum plate thickness. These details are sometimes not very reliable, and when as in Table III., Nos. 111, 719, 1,512, 1,643, 2,020, thicknesses of 1-32 in. and even of 1-64 in. are reported, one is inclined to assume that the surveyor has fixed on very small local wastings without mentioning the fact. These doubts are confirmed by the fact that in all these cases the apparent collapsing stresses are greater than those estimated by the formula. Column 10 contains the collapsing stresses as estimated by the formula

$$S = 3 + \frac{6.75}{1 + 3\ L^2/t^2}$$

The difference between this formula and the older one is an important one, and makes it appear that in practice short furnaces are weaker than experiments have indicated, and as here it is a question of safety it is advisable, until more reliable information comes to hand, to choose the one which gives the lower results of the two. On the other hand, whereas it is only right that large factors of safety should be used when applying the results of carefully conducted

COLLAPSES AT CYLINDRICAL FURNACES OF LONG BOILERS.

Board of Trade Report.	Age of Furnace. Years.	Furnace. Diam. Inches.	Furnace. Length. Feet.	Plate Thickness in 1/32 in. Original.	Plate Thickness in 1/32 in. Reduced for Age.	Plate Thickness in 1/32 in. At Fracture.	Probable Boiler Pressure. Lbs.	Stress at Fractured Section. Tons.	Collapsing Stress by Formula Tons.	REMARKS.
LANCASHIRE AND CORNISH BOILERS.										
63	32	39·5	25·25	7	5·75	2	15* to (35)	2·47*	3·11	*The pressure was probably higher than 15lbs. With 20lbs. pressure the stress would be 3·29 tons.
79	10	48	26	8	7·5	2	40·5	3·55	3·18	
200	24	30·5	14·25	5	3·75	2·5	65	2·83	3·15	
233	6 and more	31	15	6	5·5	1	70 to (152)	7·72	3·29	
307	8 & over	35	14	5	4·5	3	50* to (70)	2·08*	3·22	With 70lbs. working pressure, the stress will have been 2·91 tons.
521	10	43·5	30·2	7	6·5	4	52·5	4·08	3·10	
547	15	36	39·3	6	—	6	75	1·61	3·10	Plates not wasted.
909	20 and more	26	24·6	6	4·75	2	45	2·10	3·08	
921	35	19·5	5*	7	5·25	1	30 to (47)	2·10	4·82*	*The furnace ends in a cone, corrosion very general; estimated stress probably below 4·82 tons.
1233	18	24	11	4	3	3	79(?)*	2·26	3·16	*79lbs. is the estimate pressure if the weight was 4½in. from end of lever.
1466	35	24	12	6	4·25	1	35	3·62	3·28	
1534	25	26	14	6	4·75	1	42 to (60)	3·91	3·25	
1534	24	26	14	6	4·75	1	110	10·25*	3·25	*Hydraulic test of one year previous. Then the thickness was probably greater than 1/32in., and the stress less than 5·12 tons.
1574	12	37	14	6	5·5	2	47	3·12	3·33	
1596	14	28·75	14·2	6	5·25	1	35	3·60	3·30	
FLANGED FURNACE RINGS.										
1627	3	32·5	2·4	8	8	2	150	8·75	6·90	Fairly uniform wasting.
2235	13	33	3·5	7	6·25	¼* to 4	55	6·50*	6·37	*1/64in. is evidently very local. Stress estimated on 1/16in.
HAWKSLEY FURNACE.										
1438	20	36	3	6	5	2	43	2·77	6·37	
MARINE-TYPE BOILER.										
378	12	12·5	6·3	5	4·5	3	68*	3·67	3·98	*The safety valve was inoperative.

The pressures in brackets are those to which the safety valves were loaded, but which were not used for estimating the stresses.

laboratory tests to practice with all its unforeseen disturbing influences, comparatively small factors of safety may be employed when practical results, in this case actual explosions, are applied to practice.

Now it appears that the lowest results in Tables III. and IV., neglecting one or two extreme but doubtful cases, are only 30 per cent. lower than the above formulae, and if we reduce it to 70 per cent of its above value we have

$$S = 2 + \frac{4.5}{1 + 3\ L^2/t^2}$$

and we might say that if any furnace which did not comply with this formula had been removed in the past there would have been no collapses from weakness or overpressure during the last 37 years.

It is probable that if fuller information had been available, the conclusion might have been drawn that even higher pressures would not have resulted in collapses, but there is also the possibility that the conclusion might have been in the other direction, and it is, therefore, better, in judging of the safety of a furnace to make a further reduction of say 25 per cent. and then the formula would be

$$S = 1.5 + \frac{3.3}{1 + 3\ L^2/t^2}$$

These formulæ lead to higher working pressures than are at present customary.

The cases reported in Tables III. and IV. almost certainly include a fair number in which, in addition to wastings, the furnaces were weakened by some amount of overheating, due to scale, grease, and mechanical stokers, and it is, therefore, not likely that these influences will have a greater weakening effect than is represented by the formulæ.

One of the objects for which this enquiry was undertaken was to ascertain whether, in the same way as in shell plates, the steel or iron of which furnace plates are made deteriorates on the surface due to corrosive influence. If that were so, then in the long furnaces in which the second, or rigidity factor or the formulæ has practically no influence, the collapsing stresses should fall below three tons per square inch. As will be seen by Table IV. this is not the case, the average collapsing stresses being about three tons, which was the average value found with new experimental furnaces. Evidently, therefore, the old material is as good as the new as regards compression stresses.

It would not be advisable to dismiss this subject without drawing attention to the fact that the empirical formula, which fits the cases under consideration, does not agree with some of the conclusions arrived at by mathematical means.

Thus, if we look on the local wastings dealt with here as if they were longitudinal grooves in the sides of furnaces, it is evident that the line of thrust, which in the uninjured furnaces is a circle which passes through the centre of the furnace plate, will in the grooved furnace pass to one side of the centre of the reduced section and must produce bending stresses. Thus, if a ½ in. plate be reduced on one side by a groove ⅛ in. deep the maximum stress in the reduced section will be 2.67 times the average stress in the ½ in. plate. But this bending stress will tend to bulge the plate a little, thereby increasing the eccentricity and with it the stresses.

It would, therefore, be reasonable to suppose that a locally wasted furnace should be very much weaker than the ratio of the reduced thickness to the original thickness. There can, however, be no doubt that in the collapses here considered this influence is negligible, and need, therefore, not be taken into account.

Then also it can be shown mathematically that in the very long furnaces the resisting powers should vary inversely as the cube of the ratio—thickness divided by diameter. Experiments supporting this view have been made by Carman (University, Illinois; Bul. 1903, Vol. III) and by Stewart (American Society of Mechanical Engineers, 1906), but although this point was borne in mind while analysing the present cases, no indication that this ratio has any influence on the strengths of furnaces could be detected. Possibly another method of attack may confirm these theories, and it is hoped that the data contained in the present tables may be useful for this purpose.

The vexed question of the strength-value of cross tubes in donkey boilers also came under review. Thirty-four reports (see Table V.) contained sufficient details for estimating the collapsing pressures. Cases in which the firebox plates had wasted away to less than 1-16 in. were not included in this summary, which is arranged according to thickness of plates. No collapses were recorded of welded fireboxes, so that it would seem that when, as certainly happens, welded fireboxes give way, they do not as a rule tear. The tables contain particulars of three collapses of steel fireboxes; this is too small a number on which to base a definite conclusion, but it will be seen that for this material the collapsing stresses are below the average, and it is, therefore, not desirable to credit steel fireboxes as be-

Collapses of Cylindrical Furnaces with Cross Tubes.

Report No.	Date of Build	Date of Explosion	Age. Years	No. of Cross Tubes	Height Ft.	Height Ins.	Diam. Inch	Material	No. and Type of Riveted Joints	Thicknesses New	Thicknesses Present	Collapsing Pressures Lbs.	Collapsing Stresses Tons	REMARKS
FURNACES REDUCED BY CORROSION, PRESSURES FAIRLY WELL ESTABLISHED.														
1167	—	25, 1, 99	—	2	4	3	31	—	1 lap	5/16	1/16	30	3·31	
1220	—	26, 1, 00	14+	2	3	9	27	W. I.	2 belts, 2 laps	3/8	1/16	35	3·36	Fractured along horizontal seams.
1289	—	28, 2, 01	—	2	3	9	27	—	2 laps	5/16	1/16 to 1/4	25	under 4·82	Fractured along vertical seam.
236	1873	22, 8, 87	14	2	3	0	41½	W. I.	2 laps	3/8	0·07	under 30	under 4·00	
1542	1888	8, 12, 04	16	2	3	9	24	—	—	—	0·10	50	2·67	
40	—	12, 6, 83	—	2	3	8	45	—	2 laps	5/16	1/8	50	4·02	Fractured through rivet holes of bottom seam and firehole.
358	1866	4, 9, 89	23	3	6	0	34*	W. I.	4 laps	3/8	1/16 — 3/16	50	3·04	*Conical firebox. The bulge occurred at about 34in. diam. A large piece blown out. Fracture through bottom seam.
107	—	10, 2, 85	15+	1	3	8	35	—	3 or 4 laps	3/8	1/8	40	2·50	
371	1872	19, 11, 89	18	2	3	9½	38½	W. I.	1 lap	3/8	1/8	50	3·43	
612	1875	19, 11, 92	17	2	6	3	39½	W. I.	2 belts, 2 laps	3/8	1/8	37	2·61	Fracture along top seam.
747	—	27, 4, 94	20+	2	5	6	42	W. I.	4 laps	3/8	1/8	50	3·75	Fracture along bottom seam and firehole.
888	1880	1, 8, 95	15	2	3	9	30	W. I.	2 laps	3/8	1/8	60	3·21	
1017	—	20, 3, 97	—	2	3	6	37	W. I.	1 lap	5/16	1/8	50	3·30	
1050	—	2, 11, 97	20	3	4	6	42	W. I.	2 laps	5/16	1/8	55	4·12	Fracture along bottom seam and through cross tube weld.
1090	1884	8, 3, 98	14	2	5	6	46¾	Steel	2 laps	5/16	1/8	47	3·91	Fracture along top seam and through cross tube welds.
1415	—	3, 11, 03	24+	3	6	8	45	W. I.	2 belts, 2 laps	3/8	1/8	50	4·02	Fracture along horizontal seam.
1827	—	6, 11, 08	30+	2	3	8	32	W. I.	1 lap	—	3/32 — 5/32	50	2·86	
671	—	24, 8, 93	—	1	3	10	40	W. I.	4 laps	3/8	5/32	40	2·30	A large piece blown out.
1589	—	31, 8, 05	17	1	—		47	W. I.	4 laps	3/8	5/32	30 or 40	2·68 or 2·01	Horizontal fracture across plate. Tested 1901 to 65lbs.

Report No.	Date of Build	Date of Explosion	Age. Years	No. of Cross Tubes	Height Ft.	Height Ins.	Diam. Inch	Material	No. and Type of Riveted Joint	Thicknesses New	Thicknesses Present	Collapsing Pressure Lbs.	Collapsing Stresses Tons	REMARKS
296	1882	25, 10, 88	6	2	3	10	31½	W. I.	2 laps	5/16	Mean 0·19	45	1·67+	Fractured along lower seam.
338	—	10, 4, 89	11+	2	4	6	30	W. I.	2 laps	3/8	3/16?	70	2·50?	Fractured along vertical seam and firehole.
1764	1887	2, 6, 08	21	2	—		Scaled 29	W. I.	1 lap	9/16	3/16 b	50	1·72+	Fractured along lower seam.
1235	1877	7, 5, 00	23	3	6	0	46	W. I.	2 belts, 2 laps	7/16	7/32	50	2·33	Horizontal fracture across plate.
1456	1884	14, 3, 03	19	2	3	10	42¾	W. I.	lap	—	7/32	60	2·61	
257	1874	3, 2, 88	14	2	6	5	47	W. I.	2 belts, 2 laps	3/8	1/4	107	4·49	Fracture along horizontal seam.
1032	1887	2, 6, 97	10	2	5	0	42¼	Steel	2 laps	3/8	1/4	65 to 71	2·37 to 2·70	
COLLAPSES DUE TO EXCESSIVE PRESSURES. THESE ARE SOMEWHAT DOUBTFUL CASES.														
1807	1887	12, 11, 08	21	2	4	4	32	W. I.	2 laps	5/16	1/8	45	2·57	
1200	1884	30, 10, 99	15	2	4	6	42½	Steel	3 laps	5/16	7/32	65	2·83	Fracture along lower seam.
126	—	26, 6, 85	4	2	4	8	40½	—	2 laps	5/16	1/4	80+	2·89+	Fracture along lower seam and through one cross tube weld.
11	—	11, 9, 82	4	2	5	0	36	Steel	lap	—	9/32	100	2·86	
1179	—	28, 2, 99	—	2	7	7	44	W. I.	4 laps	5/16	9/32	65	2·26	
1043	1882	9, 9, 97	15	1	3	10	29	W. I.	lap	5/16	5/16	95 to 130	1·96 to 2·69	
4	—	—	—	3	6	3	46	—	4 laps	3/8	1/4	80	3·28	Many rents in furnace, shell and crown.
214	11, 82	9, 2, 87	5	2	5	6	40	W. I.	2 belts, lap	3/8	11/32	70	1·82	Fractured along horizontal seam.
FIREBOXES FITTED WITH CROSS TUBES AND SCREWED STAYS.														
1802	—	11, 11, 08	—	2	4	0	52	W. I.	1 lap	3/8 — 7/16	1/8 to 1/4	49	4·54 to 2·27	Two rows of stays 14½in. apart, 9½in. pitch. Stayed part gave way.
1169	—	18, 1, 99	—	2	3	7	42	W. I.	2 laps	—	3/8	150	3·75	Two rows of stays 17½in. apart, 16½in. pitch. Stayed part gave way.

ing stronger than wrought iron ones. There is no indication that the firebox lengths affect the collapsing stresses, the average for fireboxes of 5 ft. to 6 ft. 8 in. being 3.31 tons, which is practically the overall stress for furnaces of from 3 ft. to 4 ft. 6 in.

On comparing the average collapsing stresses of Tables III. and V. we find, for thicknesses of 1-16 in., that they are 5.69 tons for fireboxes without cross tubes, and 3.87 for those with them, the ratio being as 1.0 to 0.68. For thicknesses of from 3-32 in. to 3-16 in. the mean collapsing stresess are respectively 4.15 and 2.98 tons, the ratio being as 1 to 0.72, and the conclusion to be drawn is that fireboxes with cross tubes are from 25 to 30 per cent. weaker than plain ones. In only two collapses had the fireboxes been strengthened with screwed stays. This number is too small for any definite conclusion to be drawn, but the average collapsing stress is 4.15 tons, which is equal to the stress for cylindrical fireboxes of about the same thickness of plate.

The following reports were either incomplete or otherwise unsuitable for incorporation in Table V.: Nos. 101, 172, 549, 606, 965, 1064, 1114, 1232, 1382, 1418, 1474, 1495, 1676, 1767, 1827. Cases of over-pressure: Nos. 88, 108, 145, 189, 219, 223, 336, 363, 468, 516, 685, 853, 860, 1190, 1298, 1553, 1631, 2023.

In the past these experiments have served as a guide in the determination of the safe working stresses for donkey boilers, the usually adopted factor of safety being four to five. No collapses occurred at these working stresses, which would be about 1.0 to 1.25 tons per sq. in. The nearest approaches to them are No. 296, with 1.67 tons, and No. 1,764 with 1.72 tons. Too much importance should not be attached to these isolated cases, more particularly as the No. 296 stress is estimated on the average thickness of the fracture which is across the fibre, and it is not at all probable that the part which first bulged was even thinner than 0.19 in. The collapse of No. 1,764 looks as if it had been a very similar one to No. 296.

From this comparison it will be seen than with regard to vertical boilers with cross tubes engineers have been living in a sort of fool's paradise, but fortunately without serious consequences. They thought that these boilers had a factor of safety at from four to five—actually it was only about two. They will now have to ask themselves the very serious question—a question which cannot be settled here—Should the working pressures of vertical boilers be reduced by about 50 per cent. in order to comply with the custom of allowing a margin of 300 per cent. for unforeseen contigencies, or should this old custom be assailed and a lower factor of safety adopted for other boilers and parts of boilers?

I have on many occasions ventured to call the factor of safety "a measure of our ignorance"—ignorance as to the actual intensity of stresses, ignorance as to the ability of materials to withstand them, ignorance of the working conditions of boilers to which boilers are occasionally subjected. The present enquiry tells us that the sum total of all these ignorances, expressed as it were in terms of donkey boilers, working pressures does not exceed 100 per cent., and the question which will present itself to engineers is—Is our ignorance with regard to shell plates, stays, flat plates, etc., greater, or is it less than our ignorance with regard to a type of boiler which, both as regards accessibility and working conditions, is looked upon as being of the lowest order?

It is hoped that the above investigations into the strengths of some parts of boilers which are a continuation of previous investigation into other parts may prove of service in the near future, when many works may consider it advisable to renew their boilers.

Speaking before the South African Institute of Electrical Engineers, Mr. J. W. Kirkland said that the means of making electricity available for general purposes in the process of railway electrification are not easily to be decided. The minimum voltage for the main transmission line is 100,000 volts. Anyone who knows anything about lightning-arrester protection and switchgear for 100,000 volts will realise that to supply 50 horse-power or 100 horse-power to an adjoining municipality from that voltage is economically impossible. He thus advocated a transmission scheme of three-phase, 50 cycles, at the highest voltage permissible over the mountain peaks, fed at infreqeunt intervals into a low voltage scheme of from 10,000 to 20,000 volts; from that low voltage scheme it would be possible to supply municipalities and private consumers without too great a cost for switchgear and lightning-arrester protection. Automatic sub-stations tapping off the lower tension system would supply the railways.

At the beginning of 1915 the Swedish State Railways equipped fifty ore trucks —self-clearing type—with ball bearings as an experiment. The trucks, according to the *Iron and Coal Trades Review*, were all six wheelers, weighing 11.5 tons and carrying 35 tons, so that the load on each axle at full load was about 15 1-2 tons. In the comparative trials made as to the starting and running resistance with standard and bearings, it was found that with the plain bearings the running resistance was largely dependent on the time during which the trucks had been in motion, the load, and the temperature of the tire. The starting resistance also depended on the same conditions. With ball bearings, however, the running, resistance was quite independent of these external factors, and was 38 per cent. lower than with plain bearings. The starting resistance with ball bearings was not greater than the running resistance, and only a fraction of the starting resistance of trucks with plain bearings. Over four years experience has shown that the length of trains can be increased from 15 to 38 per cent.—according to gradient—where ball bearings are exclusively used. No trouble has been caused through the hot bearings so frequent with ore trains.

TRANSFORMER AND FUEL OIL STORED IN CONCRETE TANKS

During nearly two years' test, three concrete tanks, at the Trafford City Foundry of the Westinghouse Electric and Manufacturing Company, built in the summer of 1918, have proved satisfactory as fuel oil containers. Recently, one of the tanks was used to store transformer oil, and held the light-flash oil as easily as the heavy fuel oil.

Each of the tanks has a diameter of 37 feet with a capacity of 125,000 gallons. Built of reinforced concrete, the tanks have successfully resisted the weather and the little seepage that occurred was easily stopped. Recently the tanks were inspected by a representative of the United States Bureau of Standards, who is making a study of the use of concrete tanks for storing oil.

The tanks have been used to store oil for use in both the foundry and works at East Pittsburgh, Pa., a small pumping station being used to drain oil into cars for shipping. It is thought that as the first tanks have proved so successful other concrete containers will be installed as needed.

NEW USE FOR CO_2

The effect on the growth of plants caused by increasing the amount of carbon dioxide in the atmosphere has been tried in Germany, and the results are said to have been very promising. The gas, obtained in the process of smelting iron ore, was supplied by pipes to an area of some seven acres, and the crops taken off this land were, from 82 per cent. upwards, greater than those from similar, but untreated plots.

Mr. Harvey C. Rose, son of City Treasurer J. O. Rose, has been appointed as resident engineer, with headquarters in Guelph, in connection with the construction of Provincial Highways in Western Ontario. Mr. Rose will have as his section of the highway the road between Guelph and Hespeler, which has been designated as a provincial highway, and the road from Hespeler to Kitchener, by way of Kossuth; also the road from Kitchener to Galt, via Preston, and from Guelph to Puslinch Station, on the Brock road. The road from Guelph to Mount Forest and Owen Sound has also been designated as a provincial highway and some construction work will be done on it this year.

The Pratt and Cady Co., Inc., Hartford, Conn., have a booklet describing the Davis' Hot Water Service Heaters which they will be glad to forward on request to anyone interested.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

HAVING covered in previous articles the groundwork of an arithmetical nature, we propose to take up the actual study of that part of engineering which is essential to the stationary engineer. As the first part of a steam plant to be considered is the boiler, we will start at that end, and take up in turn its functions, design and operation.

Strength of a Sphere

A boiler has at once to be strong enough to contain steam at a high pressure, and as light as possible in construction to offer the least resistance to the transfer of heat through the plates. To meet these requirements, it must be built in the form which is best suited to them. The ideal form would be that of a sphere, but as this is not a practicable shape, most boilers are built to a design which is a compromise between the ideal and the possible. This takes the form of a cylinder with flat or spherical ends, except in special cases, such as a locomotive type, where the firebox is usually of a square section. When flat plates are used in the construction of a boiler, special means of staying them must be introduced.

We have said that the sphere would be the ideal form of construction. Why should a spherical form be better able to resist pressure than any other kind? We will go into the reason for this and make it plain.

If we have a sphere subject to internal pressure, the effect of this pressure tends to tear the sphere apart on a diameter, or on a diametrical plane. We can, therefore, consider the forces as acting on a plane at any diameter. The area of this plane will be $D^2 \times .7854$, and the total pressure will be the pressure per square inch multiplied by the area of the planet or if S=Total stress, then $pd^2 \times .7854 = S$. Resisting this force is a ring of metal whose sectional area is equal to the circumference of the mean diameter of the sphere at the diametrical plane, multiplied by the thickness of the metal. Suppose we have a sphere of 60 inches diameter inside, and 1 inch thick, sustaining an internal pressure of 1 inch thick, sustaining an internal pressure of 100 lbs. per square inch. Then the total stress on any diametrical plane would be

$$100 \times 60 \times 60 \times .7854 = 282744 \text{ lbs.}$$

The metal resisting this stress will have a mean diameter of $60.5 \times 3.1416 \times 1 = 190.06$ sq. inches. If the metal has a tensile strength of 60,000 lbs. per square inch, which is usual for boiler plates,

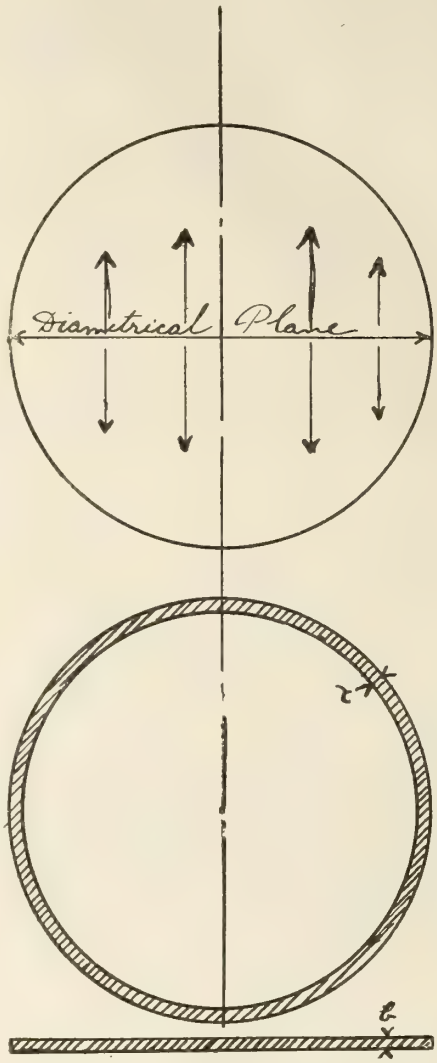


DIAGRAM OF SPHERE.

the breaking stress would be

$$190.06 \times 60{,}000 = 11{,}403{,}600 \text{ lbs.}$$

If we allow a factor of safety of 6, that would give a safe working stress of $11{,}403{,}600 \div 6 = 1{,}900{,}600$. This divided by the area gives $1{,}900{,}600 \div 2{,}827.4 = 672.2$ lbs per square inch, inch, which is considerably higher than the stress it is carrying. Let us take the example another way, and see what thickness of metal would be required to sustain a pressure of 100 lbs. per square inch, the safe allowable stress being 10,000 lbs. per square inch, which is the same as before. We have

$$pd^2 \times .7854 \times 100 = \text{Total stress}$$

and $3.1416d \times t \times 10{,}000 = \text{Resistance.}$

These two must be equal, that is the resistance must equal the stress. We know every factor except the thickness, and this we must find. To do this we equate the two quantities thus

$$3.1416d \times t \times 10{,}000 = pd^2 \times .7854$$

Substituting the figures we have

$$3.1416 \times 60 \times t \times 10000 = 100 \times 60 \times 60 \times .7854$$

Then to find t we must divide the known quantities on one side of the equation by the known quantities on the other, and the sum becomes

$$t = \frac{100 \times 60 \times 60 \times .7854}{3.1416 \times 60 \times 10000}$$

Cancelling out, as we learnt to do when studying fractions we have

$$t = \frac{3}{20} \text{ or } .15 \text{ inches}$$

which is roughly 1/6 of the thickness we originally took.

As we have noted, it is not practicable to make a boiler of the spherical form, and the introduction of the flat ends introduces a longitudinal stress as well as the bursting, or circumferential stress. However, this stress is only half of the circumferential stress, as we will show immediately. Incidentally, this will prove the reason for the comparatively light construction of the circumferential joints in a boiler to that of the longitudinal ones.

Taking our sphere again, imagine a ring of metal which is a section of the sphere at a diameter. Imagine it to have an internal diameter d, a thickness t, and a breadth b. Let p= internal press and f the stress induced by that pressure. Then the total force tending to rupture the ring will be $p \times d \times b$. The resistance to this stress furnished by the metal in the ring will then be $2t \times b \times f$. Now as the resistance equals the bursting stress we have

$$p \times d \times b = 2t \times b \times f.$$

The stress f then tending to burst the ring will be $f = \frac{p \times d \times b}{2t \times b}$. The b on top and bottom cancel out, and we have

$$f = \frac{pd}{2t}$$

Now the stress on the end of the boiler tending to tear it apart longitudinally may be called f_1. This force will be represented by the product of the pressure per square in. on the area or $pd^2 \times .7854$. The metal resisting this will be a ring whose section is $3.1416d \times t$. The resistance offered will be $3{,}1416 \times t \times f_1$. Then f_1 will be

$$f_1 = \frac{d^2 \times .7854 \times p}{3.1416d \times t}$$

Cancelling out we get $f_1 = \frac{dp}{4t}$. As $f = \frac{dp}{2t}$ we see that the stress f_1 is equal to only half of f.

The above calculations show the stresses that would be put upon a hollow metal sphere, or a cylinder with flat ends, formed of solid sheets. No boiler is formed in that way, because the sheets have to be joined together by rivetting in various fashions, which introduce weaknesses as compared with a solid plate. The flat plates have to be stayed, and furthermore are weakened by being bored for the reception of tubes. The shells and heads are pierced for pipe openings and manhole openings, and where this occurs, some method of reinforcing must be resorted to. All these factors have to be reckoned with in the design of a boiler, and they necessarily introduce a large number of calculations. These are all made by means of standard formulae, but it is not our intention to merely work out examples on these. The engineer should know something of the principles on which these formulae are founded, and we will as far as possible, explain these principles first. In order to do this, we will take up the design of a boiler according to the Ontario rules, and work it through from beginning to end. The reader will thus gain a clearer conception than by the mere working out of formulae.

Some Definitions

There are some terms used so frequently that it is well to have a clear understanding of their meaning before we go too far. Some of them we have used already in this article, such as tensile stress, safe working stress, factor of safety. Shearing and compressive stress, elastic limit, etc., are others, which we will define at once.

Stress.—When a material is subjected to a force, internal or external, which tends to cause distortion, it is said to be subject to a stress.

Strain.—If a material, which is subjected to a stress, alters its form as a result, the amount of alteration is called the strain. In other words, stress is the cause and strain the effect. These two terms are often confused and loosely used even by those who know better.

Ultimate Strength. — The ultimate strength of a material is the highest resistance it offers to rupture, either by shear compression or tension. The ultimate strength therefore corresponds to the breaking stress

Factor of Safety.—The factor of safety is a factor by which the ultimate strength or breaking stress is divided in order to obtain the safe working stress. It is a variable factor depending on the material, workmanship, nature of the duty to be done, etc. In boiler practice it ranges from 4.5 to 6. Factors of safety for different materials have been found empirically and are applied according to the results of experience.

Thus, in the case of a bridge subjected to live loads of varying intensity, a factor as high as 10 or 12 may be used. For a beam carrying a fixed load not subject to shock or variation, the factor may be 4. The object of the factor of safety is of course to allow a margin to take care of unexpected shocks and stresses which cannot be allowed for in calculations.

Tensile Stress.—A stress applied to a material, which tends to extend it longitudinally is called a tensile stress. The resistance which the material offers to this stress is its tensile strength.

Compressive Stress.—A stress which tends to close the molecules of the metal together, or in other words to shorten a bar, is called a compressive stress. The resistance offered by the metal is the compressive strength.

Shearing Stress. — A stress which tends to make one part of the material slide over the other part is a shearing stress. Opposed to this is the resistance or shearing strength of the metal.

Torsional Stress.—Torsional stress is a twisting stress such as that applied to a bolt by the tightening of the nut. It is really composed of shearing and tensile stress in combination.

Elastic Limit.—This is a term which is very much used in connection with boiler problems and should be understood by every engineer. When a metal is subjected to a tensile stress it tends to elongate. When the load is removed the material returns to its original form. This is true up to a certain point, after reaching which it fails to return but retains a permanent set or distortion. This point is called the limit of elasticity or elastic limit. After this is reached any further pull will result in a "fielding" of the material, which is not in proportion to the stress, until final rupture takes place. Up to the elastic limit the elongation is in proportion to the load applied. This point occurs usually at about one-half the ultimate strength of the material.

Modulus of Elasticity.—This is the relation that exists between stress and strain, and may be expressed, if E = Modulus of elasticity, then

$$E = \frac{\text{Stress}}{\text{Strain}} = \frac{\text{Stress for sq. in. section}}{\text{Elongation in one inch}}$$

Kent's Pocket Book gives the definition as the load per unit of section divided by the extension per unit of length, which is as above. Thus, if a stress of 60,000 pounds per square inch produces a strain of .02 inches in a piece 10 inches long, the strain per inch will be .002. Then E will be

$$\frac{60{,}000}{.002} = 30{,}000{,}000.$$

Conversely we can find the strain if we know E, and the stress, or we can find the stress if we know E and the strain.

Thus if E = 30,000,000, and strain = .002, then stress will be

Stress = E × strain.

Stress = 30,000,000 × .002 = 60,000.

If we know E and stress we find strain by

$$\text{Strain} = \frac{\text{Stress}}{E} = \frac{60{,}000}{30{,}000{,}000} = .002$$

If we call the strain = S, stress = f, and modulus = E. Then we have

$$E = \frac{f}{s}$$

$$f = E \times s.$$

$$s = \frac{f}{E}$$

HERE IS ANOTHER MIRACLE

Copper is a red metal and if mixed with tin or zinc it imparts color to them according to the proportion in which it is mixed. For instance two pounds of copper and one pound of zinc makes yellow brass, while copper and tin mixtures make a red bronze of a lighter color than pure copper. But if one pound of manganese is mixed with five pounds of copper the alloy is pure white. Where did the red go? And equally as strange, if the manganese is removed the red comes back, where did it come from? One pound of nickel mixed with four pounds of copper will bleach it to a pure white, being, not quite so powerful as bleaching agent as the manganese.

In a lecture recently delivered before the Institution of Civil Engineers in London, England, Sir Dugald Clerk revived an interesting proposal made by the late Lord Kelvin for the heating of rooms. This proposal is not easy to explain without diving into mathematics and the abstruse laws of heat, but it may be expressed as a process of using an engine to extract some of the heat from the cold air outside a room and adding it to the heat of the air inside the room. The curious and puzzling thing about this process is that the heat so added is, under certain conditions, much greater than the heat equivalent of the work done by the engine. In theory, therefore, an electric motor may be used very efficiently to warm a room. Whether the notion will work out satisfactorily in practice remains to be seen, but in view of the ever-increasing cost of fuel this fascinating problem is likely

We have received an interesting booklet illustrating the Moore Steam Turbines, made by the Moore Steam Turbine Corporation, Wellsville, New York, U.S.A. This is numbered Bulletin 24. It gives a general description of single and multi-stage turbines, as manufactured by the firm, and also clear descriptions of the details of construction. In connection with the turbines, reduction gears are also supplied. Several illustrations of typical applications of the units are shown.

The Brush Pilot Gauge Company, of Springfield, Mass., are now making plug gauges with a brush attachment on the nose, that cleans out the hole before the gauge enters, thereby minimizing the wear and assuring greater accuracy in gauging.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

IN the last lesson various types of electrical circuits were taken up and Ohm's law was discussed. In this present issue, it will be well to discuss at some length various applications of Ohm's law in the proportioning of feeders, wiring, etc. Before doing so a knowledge of the various materals used and their properties may not be out of place.

Some materials conduct electricity better than others, just as some materials are more suitable for insulating purposes than others. Silver is the best conductor and would be ideal for the purpose if it were not so expensive. Copper is next and is the metal most in commercial use to-day. Gold is next in order, but of course is too expensive. Next to it is aluminum, and in copper and aluminum we find the most suitable metals for transmission lines and electrical apparatus. The choice between the two is governed by their relative cost in conjunction with the weights of each necessary, and by their mechanical characteristics as well as by the space available.

Aluminum has found considerable use on high tension line work and the aluminum cable is often reinforced by a central steel wire for mechanical strength. It should be mentioned that while aluminum is a much inferior conductor to copper, its lighter weight renders it just as economical and in some cases cheaper by the pound, depending upon the relative prices of the two metals.

During the war zinc was quite commonly used in Germany, not only for electrical wiring, but also for equipment of various kinds. Iron wire is used very commonly for telegraph and formerly to a large extent for telephone circuits. In this case its current carrying capacity is not of so much importance, and its cheapness is of every material advantage.

The following table gives the relative resistance of some of the metals in the order of their conductivity.

Copper is taken as equal to	100
Silver	92.5
Copper (annealed)	97.5
Copper (Matthiessens standard)	100.0
Aluminum (99 per cent. pure)	161
Zinc (pure)	362
Iron (very pure)	570
Lead	1280

Wire Gauges

The commercial wire in use to-day is made in a number of varying sizes and in this Country and the United States according to what is known as the B & S. (Brown and Sharpe) wire gauge. In this gauge the sizes of the wires bear a very definite numerical relation to one another. Many other gauges have been in common use but are being rapidly superceded, and one of the largest electrical manufacturing companies has even discarded the use of gauge numbers entirely, calling every size wire by its decimal equivelant or by its area in circular mills.

The B & S. gauge is based on a series of sizes such that if the diameter of one size is multiplied by the number 1.084, the diameter of the next size larger will be given. This property is valuable in some respects for it enables one to determine approximately the characteristics of various sized wires when those of one are known. The area of any wire whose gauge number is known when multiplied by 1.261 will give the area of the next size larger, and the area of any wire whose gauge number is known, multiplied by 2 will give almost exactly the area of the third size larger.

No. 10, B. & S. gauge copper wire which is about one-tenth inch in diameter (101.9 mills) has a resistance of about one ohm per 1,000 ft., and this fortunate coincidence is a useful thing to remember.

Mills and Circular Mills

The mill has been used above in speaking of wire diameters and it simply means the one-thousandth part of the inch. For instance, we might have a wire 571 mills in diameter, this would be equal to 571-thousandths of an inch, or .571 inches.

In ordinary life the area of a circle is found by squaring the radius and multiplying by 3.1417. It can also be found by squaring the diameter, multiplying by 3.1417, and dividing by four. This gives the true measure of the area, but the electrical engineer, through sheet inherent laziness, perhaps, or because of its greater convenience, has adopted another measure of area—the circular mill, this is simply the area in mills squared. It does not give the true area, but this is of little importance when resistances of other characteristics are given in terms of circular mills since the result will be correct. In the table given herewith the values for the area of wires in circular mills have been rounded off to even figures.

Carrying Capacity of Wires

When an electric current is sent through wire the resistance causes a certain voltage drop, and a consequent loss of power. This power lost is equal to the voltage drop multiplied by the current carried in amperes, and is expressed in watts, the formula expressing this relationship is

$$W = E\ I.$$

If we know the resistance of the wire and the current carried we can also easily determine the power lost since

$$E = I\ R.$$

Where E equals the pressure drop in volts I, the current carried and R, the resistance. If this expression is substituted in equation, $W = E\ I$, it becomes

$$W = I\ R \times I, \text{ or } W = I^2R.$$

The energy thus lost is created into heat and in heaters, etc., does useful work, or in the case of wires carrying current to motors, etc., is lost. The heat generated plays an important part in the proper selection of any given wire size, and rules have been adopted by various organizations to limit the current carrying capacity to such values as will be safe for insulation. The last two columns in the table give the National Electric code standard, and it will be noticed that a difference exists between the values given for rubber-covered and weather-proof insulation. The weather-proof wire can safely stand a higher temperature than the rubber-covered, and so is allowed a greater carrying capacity.

In designing a line for any given work, whether it be running of motors or the lighting of a building, two factors have to be taken into consideration, the current carrying capacity of the line and the voltage drop in the distance transmitted. On extremely short circuits the current carrying capacity will govern, since comparatively little resistance is introduced, while on longer circuits the voltage drop will control. For instance it may be of interest to find out what wire will be required to carry current to a 50-horse-power motor (direct current), at a voltage of 550.

In the first instance let us suppose that we have a line 100 ft. long. The amount of electrical energy required will be $50 \times .746 = 37.3$ kilowatts (since 1 h.p. = .746 kilowatt). At 550 volts the current carried will be neglecting friction losses, etc. $37.3 \times 100 \div 550 = 61$ amperes. Consulting the table we see that for a current of 61 amperes we will require a wire, a No. 5 wire in rubber-covered or a No. 7 weather-proof. Since odd sizes are sometimes hard to get, and in the smaller sizes are not sold, it would be well to use either No. 4 or No. 6, depending on the insulation. If No. 6 were used, 200 ft. of it would have a resistance of $0.3872 \div 1000 \times 200 = 0.07745$ Ohms, (from table). At 61 amperes this would give us a voltage drop of $0.7745 \times 61 = 4.75$ volts, or .86 per cent. which is negligble.

Let us now take the same motor and calculate the size wire required if it were 5000 ft. away. In the first place we must come to a decision as to what

TABLE 1—PROPERTIES OF COPPER WIRE.

Number B. & S.	Diameter in Mills 1 mill = .001 inch	Area in Cir. -Mills CM=D²	Wt. per 1000 ft.	Feet per lb.	Ohms. per 1000 ft. at 59° F	Feet per Ohm. at 59° F	Carrying Capacity Rubber Covered	Carrying Capacity Weather Proof
0000	460.0	211,600	640.5	1.561	0.0480	20810	225	325
000	409.6	167,800	508.0	1.969	0.0605	16510	175	275
00	364.8	133,100	402.8	2.482	0.0764	13090	150	225
0	324.9	105,500	319.5	3.130	0.0963	10380	125	200
1	289.3	83,690	253.3	3.947	0.1215	8233	100	150
2	257.6	66,370	200.9	4.977	0.1532	6529	90	125
3	229.4	52,630	159.3	6.276	0.1931	5187	80	100
4	204.3	41,740	126.4	7.914	0.2436	4106	70	90
5	181.9	33,100	100.2	9.980	0.3071	3256	55	80
6	162.0	26,250	79.46	12.58	0.3872	2582	50	70
7	144.3	20,820	63.02	15.87	0.4883	2048	...	...
8	128.5	16,510	49.98	20.01	0.6158	1624	35	50
9	114.4	13,090	39.63	25.23	0.7765	1288	...	...
10	101.9	10,380	31.43	31.82	0.9792	1021	25	30
11	90.74	8,234	24.93	40.12	1.235	810	...	...
12	80.81	6,530	19.77	50.59	1.557	642.3	20	25
13	71.96	5,178	15.68	63.79	1.963	509.4	...	...
14	64.08	4,107	12.43	80.44	2.475	404.0	15	20
15	57.07	3,257	9.858	101.4	3.121	320.4	...	...
16	50.82	2,583	7.818	127.9	3.936	254.1	6	10
17	45.26	2,048	6.200	161.3	4,963	201.5	...	...
18	40.30	1,624	4.917	203.4	6.259	159.8	3	5

per centage of the power we can afford to waste, and just what voltage we can afford to loose. While wiring formula are given in which the capital cost figures and which are necessary for large installations, we will assume that a voltage drop of about 5 per cent will be about right.

Five per cent. of 550 volts = 27.5 volts.

The amperes carried are the same as before and remembering Ohm's law we can readily determine the resistance of the wire which will give this figure.

$$R. = E. \div I.$$

substituting

R. = 27.5 (the voltage drop) ÷ 61 = .45 Ohms. The total length of wire equals 10,000 ft., and the resistance per 1000 ft. will therefore be .45 ÷ 10,000 × 1,000 = .045 Ohms. This would require about a number 00000 wire, and its current carrying capacity would be more than ample. By allowing double the voltage drop or 10 per cent. we can cut the size of wire down to No. 0.

By doing so we would cut the cost of the transmission line down considerably, but we would be payng considerably more for power.

The first table given in this issue takes in wire only up to No. 0000 size. Above this size conductors are usually rated in circular mills, and are usually supplied stranded for ease in manufacture and for greater flexbility.

Table two gives corresponding data concerning conductors over four nought in size.

TABLE 2—PROPERTIES OF COPPER CABLE.

Area in Circular Mills	Approx. dia. over copper in fractions of an inch	Ohms, at 1,000 ft. at 59° F.	Carrying Capacity Amperes Rubber covered	Carrying Capacity Amperes Weather-proof.
2,000,000	52-32	0.00518	1,050	1,670
1,750,000	99-64	0.00593	950	1,520
1,500,000	91-64	0.00692	850	1,360
1,250,000	41-32	0.00829	750	1,185
1,000,000	75-64	0.01036	650	1,000
950,000	36-32	0.01091	....	....
900,000	35-32	0.01153	600	920
850,000	69-64	0.01221	....	....
800,000	33-32	0.01296	550	840
750,000	32-32	0.01382	....	....
700,000	31-32	0.01481	500	760
650,000	30-32	0.01595	....	....
600,000	57-64	0.01729	450	680
550,000	28-32	0.01885	....	....
500,000	53-64	0.02074	400	600
450,000	25-32	0.02305	....	....
400,000	47-64	0.02592	325	500
350,000	22-32	0.02963	....	....
300,000	41-64	0.03457	275	400
250,000	19-32	0.04147	....	....

Resistance and Temperature

The resistance of a conductor is not constant with varying temperatures. The resistance of metallic conductors increases with the temperature rise, while that of carbon decreases. A peculiar fact is also noticeable in the behavior of what we commonly take to be insulators, when they are at a red heat or above, for many substances, perfectly satisfactory insulators when cold conduct electricity quite noticeably when hot. Firebrick, magnesite brick, the refractory filament of the old Nerust lamps are all examples of this type of insulator.

The resistance of metals decreases rapidly when they are cooled to very low temperatures. At—273 degrees centigrade, if it were possble to reach it, the resistance would probably vanish. A scientist in Holland has succeeded in producing extremely low temperatures approaching this point and has found that a current of electricity will circulate for days in a circle of lead wire and that is very large in amount.

Any change in resistance is due to the temperature alone, and is not dependent upon whether the change in temperature has been caused by current flowing or not. Ordinary, simple metal conductors, such as copper, tin, aluminum, zinc, etc., change resistance about 4-10 per cent per degree centigrade change in temperature while alloys in general and certain alloys in particular change in resistance much less than this. Iron changes in resistance most of all, altering 6-10 per cent. per degree.

Canadian Plant.—A new factory is being erected by the Coleman Lamp Company of Wichita, Kansas, at the corner of Queen East and Don roadway, for the manufacture of all kinds of portable lamps.

Editor, Power House.

Dear Sir:

What pressure can be carried on a boiler stay, the plate being 7/16 and the pitch 9x9 inches?

What is the rule when stays are diagonal?

ANSWER.—For stays supporting the flat surface of a boiler head, if stays are of steel unwelded, a tensile strength of 8,000 lbs. per square inch can be allowed. You give the pitch of stays as 9 in. x 9 in.=81 square inches supported by one stay. As you do not give size of stay we must assume it. Suppose we have stays of 1½ in. diameter, the area would be 1.5 x 1.5 x .7854=1.767 square inches. The stay would then be able to support a total pressure of 8,000 x 1.76=14,080 lbs. As the area to be supported is 81 square inches the pressure allowed would be 173.8 lbs.

If you want to find the size of stay for a given pressure, say 100 lbs. per square inch take the area supported multiplied by the pressure which gives total pressure, and divide by the allowable stress on stay 7000, which gives area of stay. To find diameter divide by .7854 and take square root. The formula would be:

where S=Surface supported
P=Pressure per square inch
F=Allowable stress on stay
A=Area of stay.

$$\frac{S \times P}{F} = A. \qquad \text{Diameter} = \sqrt{\frac{A}{.7854}}$$

To find pressure when area of stay is given:

$$P = \frac{A \times F}{S}$$

The method of finding stress on a diagonal stay is as follows: Find allowable stress on direct stay, and multiply it by the length of direct stay divided by length of diagonal stay. The length of the diagonal stay can be found by the rule for the hypotenuse of a right angled triangle which is square of base+square of side=square of hypotenuse. We have then $42^2+14^2=1960$ $\sqrt{1960}=44.2$. Then if the direct stay can carry 100 lbs. the diagonal can carry $100 \times \frac{42}{44.2}$

If the diameter of the direct stay is 1 in. then its area is .7854 and the area of the diagonal stay must be

$$.7854 \times \frac{44.28}{42} = .8288$$

and the diameter would then be 1.026 inches.

The rule for staying flat plates taking the thickness of plate into account is:

$$\frac{C\,(T+1)^2}{S-6} \text{ working pressure.}$$

Where C is a constant which varies according to type of stay and workmanship. T=thickness of plate in 16ths. S=surface supported by 1 stay. C varies from 120 to 200.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, JULY 20, 1920 No. 14

PRINCIPAL CONTENTS

Air Pumps for Condensing Equipment 327
Board of Trade Reports of Furnace Failures 335
A Course of Instruction 340
Theory and Practice of Electricity 342
Editorial 344
Progress in New Equipment 346

The Late W. L. McGhie

THE late Mr. W. C. McGhie, chairman of the Board of Stationary Engineers since its inception, passed away at his home at 58 Asquith avenue, Toronto, on July 9th. Mr. McGhie was widely known and well liked by the engineers of his province, and his passing will be deeply regretted by them. He was a comparatively young man, being only 51 years old.

Mr. McGhie was born in Peel County, where he received his early education at the public school. From thence he went to the Parkdale Collegiate, Toronto, where he finished his educational studies.

He started his career as a stationary engineer in the employ of Mathew Brothers, picture frame makers. He went from there to the Toronto Street Railway, which he left for the Kemp Manufacturing Co. From thence he went to the Rolf Clarke Co. In 1908 he was appointed chairman of the Board of Stationary Engineers, which position he retained up to the time of his death. During his incumbency he was largely responsible for the drawing up of the Stationary Engineers' Act.

Mr. McGhie was a past president of the Canadian Association of Stationary Engineers, a member of the Universal Craftsmen's Council No. 27, Toronto, and a member of the Alpha Lodge, A.F. & A.M.

He is survived by his widow, who was a daughter of the late J. C. Shear, J.P., and a family of five, four daughters and one son.

We understand that nothing has yet been done in the matter of appointing a successor to Mr. McGhie.

Changes in the Act

AN Order-in-Council has been made, authorizing some important changes in the act regarding stationary engineers' certificates. The third class certificate will now allow its holder to operate a plant up to 200 Boiler Horse Power, instead of 150 B.H.P. as formerly. The second class certificate will authorise the possessor to operate a plant of 600 B.H.P. instead of 300 B.H.P., or just double. This amounts to practically making the second class certificate cover most of the plants in Ontario, the number possessing over 600 Boiler Horse Power being limited. The size of plant that can be operated by a man already in charge of it, irrespective of his grading, is also raised to 200 B.H.P., instead of 150 B.H.P. These changes should be welcomed by the stationary engineer, as they would appear to make things easier for them. One result, we imagine, will be a lessening of the number of candidates for a first class certificate. It is hardly to be expected that many men will go to the trouble and expense of obtaining the highest grade certificate if the next lower one will serve their purpose. The change will also be welcomed by owners of plants, as it will save changes of personnel being made, that otherwise might have been necessary.

E. J. Dodd, writing from London, says: At the Canadian Exhibition the MacLean business and technical newspapers and magazines and The Financial Post were displayed at the stand of the Department of Overseas Trade and that quite a number of copies were sold, mainly to persons interested in buying from Canada. One of these was a member of the staff of the Russian Bolsheviki Trade Ambassador, M. Krassin, who made special enquiries and asked if he might be allowed to follow up the reading of the papers by a call on the MacLean Newspapers' London Office. It is difficult to know just what is going to happen in Russia, but one thing is certain, Russia cannot get on a normal producing basis without machinery plant and industrial brains. The Jews who are controlling Russia know this and there are bound to be developments favorable to Canada.

UNITED STATES operated its railroads for twenty-six months, and now the national pastime in that country is figuring out what it cost. It used to be a popular fallacy that running railroads was an easy way to make money, but in these twenty-six months the United States Government owns up to a loss of $715,000,000. One thing the Government was particularly capable at was hanging on new employees, for at the end of the twenty-six months the pay-day casualty list showed an increase of 244,510 recruits, bringing the number from 1,647,097 in 1916, to 1,891,607 in 1919. And on top of this the railroad unions prepare to get wage increases that will add $1,100,000,000 to operating expenses.

THOSE who are engaged in the controversy about building or taking over transportation lines in Ontario for the purpose of electrification, should think seriously and well about the changing aspect of transportation. It is folly to overlook the coming of the truck, as well as the passenger car. Banks are recognizing this in many places, and are financing the making of trucks and tractors, but not passenger cars. When well-built highways are put through the country, and the use of trucks is made possible and profitable, there is bound to be a falling-off in the call for electric or steam road service. The form of locomotion that will take the load from the barn direct to the city market is by all odds the most desirable, as the start, the route and the terminal are all capable of being adjusted to the convenience of the truck owner.

Gas Production vs. Electrical Generation

A VERY lively interest has been shown during the past year or so, in the proposed establishment of super-power stations for the generation of electricity from steam. In England, where the coal situation has been acute, this proposal has been seriously considered, and the question of its advantages from a conservation view point much mooted. The gas industry which is a very well developed one in Great Britain, disputed the claims of the electrical engineers, as to the thermal efficiency of power generation from these stations. Sir Dugald Clerk, the leading authority on gas production and gas engineering in the United Kingdom, and one of the outstanding men in the world in that line, read a paper before the Royal Society of Arts, giving some highly interesting and illuminating figures, which are not without some appeal to Canadian readers.

First of all, Sir Dugald points out that if the present rate of mining, and the increase in that rate keeps on as it is doing, the coal supply of Great Britain will be denuded in less than 200 years. He shows that without coal Great Britain could no longer support a population such as she has at the present day, but would probably be able to support a population of about 20,000,000, or about the same as she had in 1830. In order then, that this great change from a manufacturing to an almost entirely agricultural nation, which would be attended with great suffering, might be postponed as long as possible, coal conservation becomes a very real necessity. The work of the nation must be done with the least possible consumption of coal, and every atom of usefulness must be recovered from each pound of coal burned. Sir Dugald then gives figures showing the thermal efficiency of a pound of coal burned under a boiler to produce electrical energy, and that of a pound of coal carbonised in a gas retort to make gas.

In the United Kingdom about 20,000,000 tons of coal are carbonized annually, the average heat value per lb. being 13,000 B.T.U. The average thermal efficiency is 71 per cent. That means that in order to evolve gas, coke, and tar, 29% of the heat value is lost. Of the remaining 71%, 25% is available in the form of coal gas, and 46% in the coke and tar. The principal product is gas, and if the total heat loss is charged to the gas, then $29 + 25 = 54$ units are required per ton of coal to produce 25 units in the form of gas. Then the thermal efficiency of the gas-making process is $\frac{25}{54} = .46$ or 46%. Of the 20,000,000 tons consumed, the amount required to produce the heat value of the gas generated would be 5,000,000 tons. As the gas is generated with an effiiciency of 46% it requires actually 10.9 million tons. There is still remaining in the coke and tar products the heat equivalent of 9.1 million tons.

The electrical generating stations of the country, using coal with a heat valve of 11,600 B.T.U. consumed 7.3 million tons, and the thermal efficiency of generation was 8.5 per cent. If the coal had been of the same thermal value as that used for gas, the amount used would have been 6.5 million tons. The heat available from the electricity generated being 8.5 per cent. of the heat value of the coal consumed, shows that this heat could have been obtained by the combustion of a little over half a million tons.

The meaning of these figures is this. One ton of coal burned to coke, tar, and coal gas, makes available for power purposes nine times more energy than the same ton of coal burned under a boiler to generate electricity. The paper goes on to show that in the application of this heat by the consumer, gas has an advantage over electricity in many cases. For instance in heating rooms, 100 heat units at the gas works give 27 heat units in the consumer's house. One hundred heat units in the electric generating station on the other hand gives only 3.8 units at the consumer's premises. For cooking, gas applying 3.4 heat units at the oven requires 100 heat units at the gas works, while 100 heat units at the generating station only delivers 1.6 units at the oven. Comparing the performance of the best gas works and electrical generating stations the gas engine gives 13.6 per cent. thermal efficiency, as against 10.4 per cent. for the electric stations. In only the illuminating field does the use of electricity over gas show a gain.

Of course there are many other factors besides thermal efficiency which determine the use of electricity for distribution. Sir Dugald points out that in their own works electric cranes, etc., are in use. The point he wishes to make, and seems to have done so quite successfully, is that the super-power station, generating electricity which is to be supplied to a large radius, is not the best means of coal conservation.

The figures here given should be of interest to many consumers in Canada, where we have vast deposits of coal suitable for gasification, and where we waste coal daily with the utmost cheerfulness.

The paper is printed in pamphlet form, and entitled, "Distribution of Heat, Light and Motive Power by Gas and Electricity," and is crammed full of interesting data.

WELL, WHAT DO YOU WANT?
BAY WINDOW
PROFESSOR
I'D LIKE TO TRADE A TEN THOUSAND DOLLAR EDUCATION FOR A COUPLE OF DOUGHNUTS AND A CUP OF COFFEE.

Progress in New Equipment

THE JONES UNDER-FEED MECHANICAL STOKER

To anyone interested in the economical and efficient burning of coal with the utmost conservation of labor, the mechanical stoking of boilers and furnaces is a subject that will prove both interesting and profitable.

Recently the greatly increased price of coal, the difficulty of securing it at any price, and the scarcity of labor, have combined to offer a wonderful opportunity for mechanical stoker plants to prove their worth, and they have met this opportunity with a remarkable showing.

A new stoker in the Canadian field is the Jones Automatic-Cleaning ("A-C") Under Feed Stoker, manufactured in Canada by the Under-Feed Stoker Company, of Canada, 81 Victoria St., Toronto, formerly the Jones Under-Feed Stoker Co. It is claimed that this stoker will effect a guaranteed fuel saving of at least ten per cent; it will greatly reduce the labor required, it will absolutely prevent smoke owing to the complete and efficient combustion of the fuel, and it will adequately take care of heavy overload conditions due to high peak-loads which are impossible with hand firing. These various economies result in such a saving that the stoker equipment soon "pays for itself—then pays dividends."

Under-Feed Principle of Combustion

Most steaming coals have a high volatile content that is distilled by the heat encountered in the furnace. To obtain proper combustion these volatile gases must be properly mixed with air and burned at a high temperature almost the moment they are released. Under-feed stoking is the only way this can be accomplished efficiently. The operation of the Jones "A-C" Stoker requires every particle of coal and every particle of gas to pass through the incandescent zone, or zone of intense heat. Air under pressure is admitted through the tuyere openeings just below this zone, necessitating complete and efficient combustion of the coal and volatile gases.

Operation

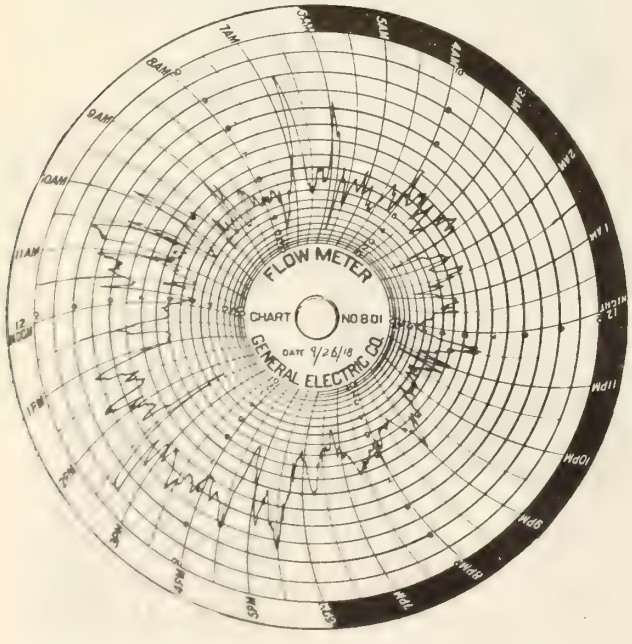
The coal hopper is located directly in front of the stoker. Coal is fed into this hopper either by hand or by gravity from the storage bins. A steam cylinder is mounted immediately below the hopper and in front of each retort, and a ram is connected to the piston of this cylinder. When steam is admitted into the cylinder through the automatic control valves, this ram is drawn outward and a charge of coal falls into the ram case. The automatic control valve reverses the stroke and the charge is forced into the retort, or coal magazine. A rod is connected to the ram and travels through the front end of the retort below the ram with each operation of the steam piston. On this rod inside the retort are bolted two pusher blocks so that the coal is carried upward and rearward with each stroke of the ram.

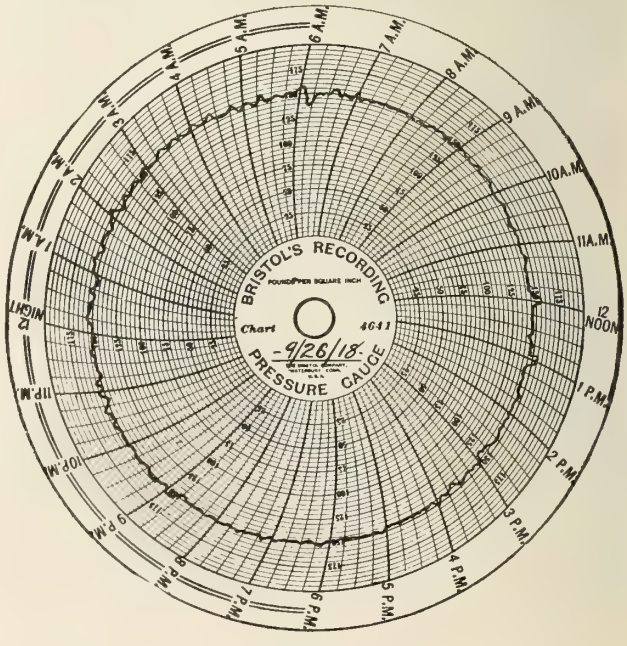
No moving part is exposed to the fire and the only movement is the straight quick thrust of the ram and pusher blocks buried deep under green coal, a condition that insures continuous operation and removes the liability of shut down. The upward and rearward travel of the coal caused by the positive thrust of the ram, insures a continuous breaking-up and automatic slicing of the fire as well as thorough mixing of air and gases.

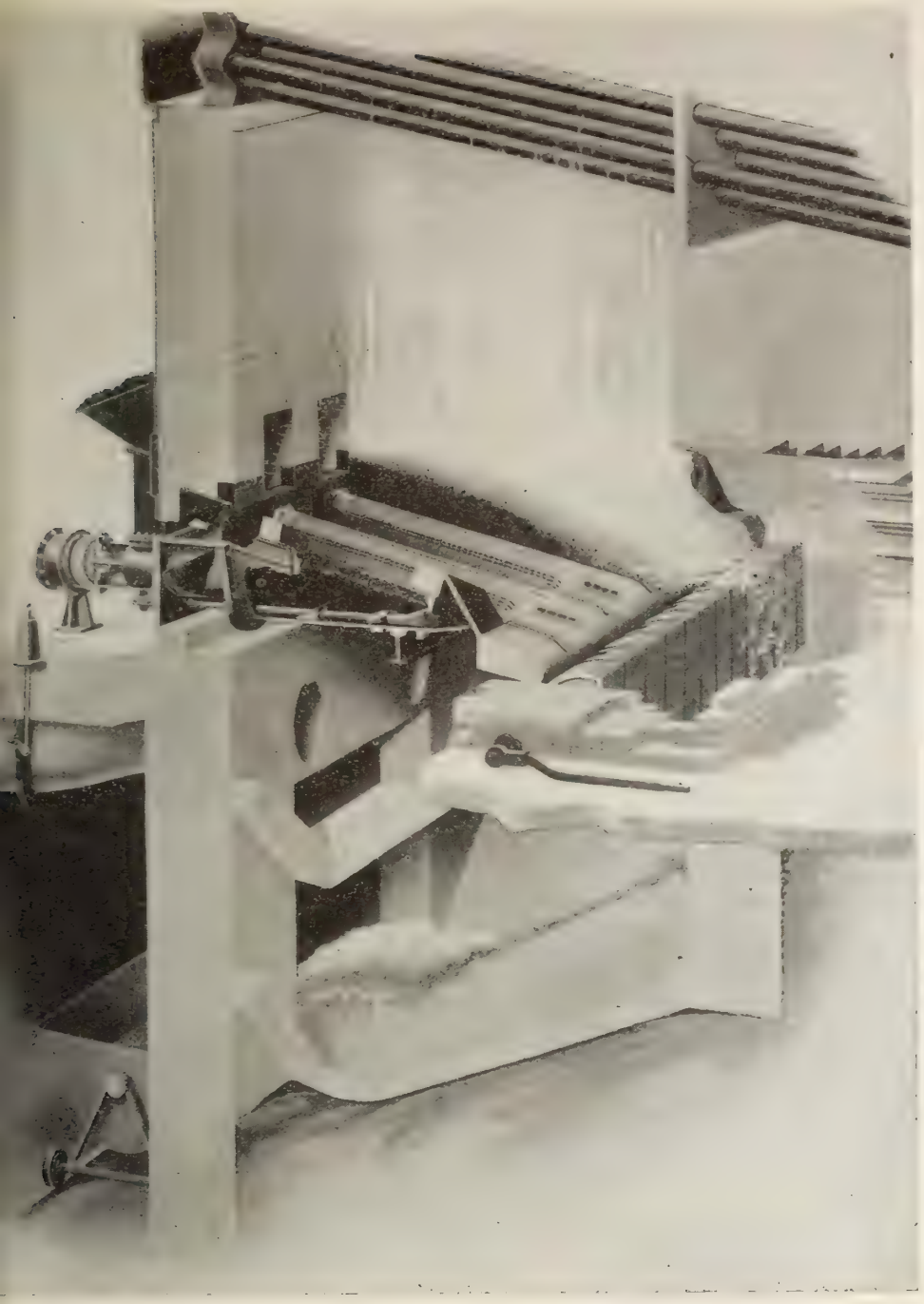
Automatic Cleaning

The intermittent breaking up and ram and pusher blocks previously explained, carries the whole fuel bed slowly toward the rear. Before the fuel bed reaches the dump plate at the rear, the coal is entirely burned and there is nothing left but dead ash. This gradual movement of the fuel bed keeps the fire clean of all ash and refuse. Dropping the balanced dump plate drops the ashes into the sealed ash pit below. This operation is necessary only at occasional intervals and is simple and easy to perform.

Particular emphasis should be placed on the fact that the gradual movement of the fuel bed toward the dump plate is not a gravity movement. The slope of the retorts is not sufficient to cause the ash and refuse to slide or roll tow-







ard the dump plate. It is impossible for the coal to avalanche.

Prevention of Clinker

The intermittent and breaking up and rearward movement of the fuel bed caused by the quick, positive action of the steam ram and pusher blocks prevent the formation of large clinkers. This is done very successfully as shown by actual test. An analysis of the ash show a negligible amount of combustible.

Due to their design, the side tuyeres prevent the formation of clinker on the side walls, by keeping the bed of fuel away from the walls for a considerable height above the top of the retort. Also, due to the air circulation, no clinkers adhere to these tuyeres. There are no clinker formations on the bridge wall because the fuel is practically all consumed by the time it reaches the dump plate.

Fuel Economy

The highest fuel economy is obtained in any stoker when the correct amount of air is supplied to completely burn the coal. Too much air cools the boiler heating surfaces and necessitates the burning of more coal. Too little air does not furnish sufficient oxygen for complete combustion and all available heat of the fuel is not utilized. A low percentage of C02 in the flue gases indicates too much air. A high percentage of CO indicates too much air. Independent adjustments of the fuel and air controls, as exclusively featured on the Jones Under-Feed Stokers, are therefore absolutely necessary to obtain the maximum fuel economy. For this reason cheap coals are burned satisfactorily with the Jones "A-C" Stoker.

Automatic Control of Fuel and Air

The steam pressure itself automatically controls the air supplied to the fire through the tuyeres and also the coal supplied to the retorts. Should the steam pressure drop slightly, both the air pressure and coal supply are increased. If the steam pressure goes up, the air pressure and coal supply are decreased in proportion.

The controlling valve is an important and distinctive feature of all Jones Under-Feed Stokers. It is installed on the steam line to the stoker cylinder and has eight rates of operation. This permits of any desired speed of coal feed for the battery of stokers. Moreover, any retort of the battery may be operated at a different rate from any other retort—a highly valuable feature since it gives absolute control of the fire.

The length and stroke of the pusher blocks may be adjusted to meet any fuel condition encountered by the adjustment of a pin on the connecting bars below the ram outside the furnace. The pusher blocks may also be set as different points on the pusher road. These adjustments permit any desired rate of speed and thickness of fuel bed.

Fires are easily banked, and held any length of time, by feeding in a supply of coal with the ram and shutting off the air and steam supply to the stoker.

Even Steam Pressure

The automatic air and fuel controls of the Jones "A-C" Stoker are so immediately responsive to changes in the steam load, that an even steam pressure is maintained at all times, regardless of variations in the steam consumption.

The flow meter chart and the pressure gauge chart as shown were taken simultaneously at the plant of the Michigan Limestone & Chemical Company, Rogers City, Michigan. The sudden changes in the load, as shown on the flow meter chart at 6.45 a.m., and 2.30 p.m., are not marked by perceptible changes in the pressure, as shown on the pressure gauge chart. The pressure is held very close to 150 pounds at all times over the 24-hour period, regardless of the wide variations shown on the flow meter chart.

Flexibility and Capacity

Extreme flexibility is afforded due to the wide range of operation of the coal and air supply. The shape and size of the retorts are such that a maximum supply of coal may be fed into the furnace when necessary. This is also accomplished by the controlling valve should it be desired for any reason to suddenly "boost" any particular retort. The tuyere openings are so designed and arranged that an abundant supply of air is supplied to burn the coal. The air distribution system below the retorts is well balanced and capable of wide adjustment. These are the reasons for the large coal-burning capacity per square

foot of furnace area. This flexibility and coal-burning capacity are of extreme importance in plants where there is a wide variation in load, or where heavy overloads are frequently required.

Smoke Prevention

Where there is complete combustion there is no smoke, and with this stoker you have complete combustion.

Accessibility

Observation doors are built in the front setting opposite each row of tuyeres. These doors enable the fireman to watch the fire and keep it in good condition. The operator can work a bar through the doors and down each row of tuyeres should any small clinker formation be noticed on the tuyere blocks. Holes in the fire are easily filled by feeding more coal to the particular retort. As each steam cylinder can be operated independently of the others, the coal supply to each section of the fire is subject to individual control, so that a perfect fuel bed is maintained at all times.

Simplicity—Low Maintenance

Particular attention is called to the great simplicity in design of the Jones "A-C" Stoker. There is an almost entire absence of moving parts. The tuyere blocks are always covered by green fuel and are cooled by the air circulating through them. Each block is held in the retort by a rod operated from the front of the furnace, so that each individual tuyere block may be slipped into place without disturbing any of the others. In fact, every part is readily accessible. Correct design, resulting from twenty-five years' experience. best quality of raw materials and careful manufacture, combine to keep the maintenance cost of this stoker at a minimum.

Adaptability

Since little space is necessary for installation, these stokers are adaptable to unusual local conditions. Ashes are carried away by means of an ash car, steam jet ash conveyor, belt conveyor, hoist or any other suitable ash disposal system. Basements for ashes are not essential. Typical installations are shown.

Service

The engineering department of the Under-Feed Stoker Company, of Canada, Ltd., will be glad to give assistance in the handling of any power plant plans involving the possible use of stoker equipment. As the oldest manufacturers of under-feed stokers their experience enables them to solve unusual combustion problems, whether applied to steam boilers, heating furnaces, drying ovens, or other special work.

A NEW BALANCED VALVE

The following is a description of a new balanced valve, the invention of Mr. Allen Norgrove, Le Pas, Manitoba:

This invention relates to improvements in slide valves for steam engines and has for its object to provide a valve for this purpose so designed that the sliding element of the valve is balanced by the steam pressure in all directions, whereby the tendency of the sliding element to bind against the walls of the valve, due to inequality of pressure on its various sides, is entirely removed.

In carrying out my invention I provide a casing, in which the slide valve is adapted to reciprocate, so constructed

Fig. 2.

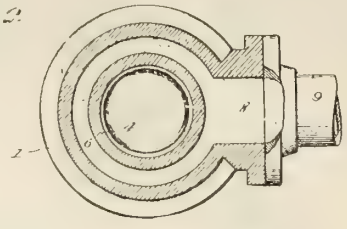
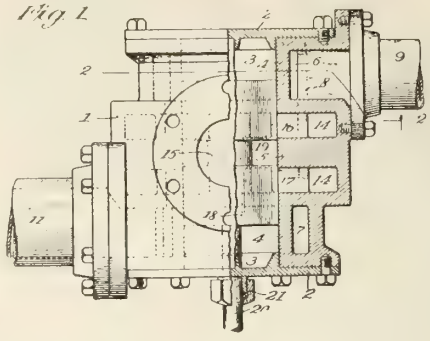


Fig. 1.



that steam passing into the engine cylinder strikes the slide on diametrically opposite sides, passes around a groove in the slide, and enters a chamber leading to the engine cylinder through diametrically opposite ports disposed at right angles to the first ports through which the steam is admitted to the slide. In a similar manner exhaust steam leaving the engine cylinder strikes against the slide on diametrically opposite sides, travels around the groove in the slide and leaves the groove through two diametrically opposite ports at right angles to where the steam leaving the cylinder first strikes the slide. Two such valves are provided on each cylinder of the engine. It will, of course, be understood that the slide in the valve is reciprocated by suitable mechanism connected with the engine, this mechanism being well known in the art and forming no part of the present invention.

Fig. 4.

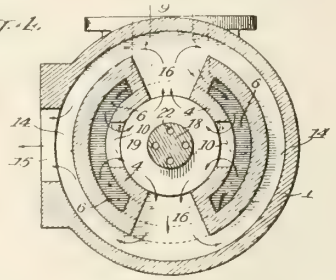
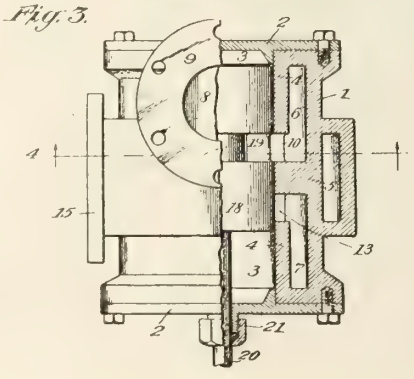


Fig. 3.



By reference to the accompanying drawing the nature of the invention may be more clearly apparent.

Fig. 1 is a side view partly in section and partly in elevation of the valve in neutral position.

Fig. 2 is a section looking in the direction of the arrows on line 2—2 of Fig. 1.

Fig. 3 is a side view partly in elevation and partly in section, but at right angles to Fig. 1 showing the valve in intake position.

Fig. 4 is a section in the direction of the arrows on line 4—4 of Fig. 3.

Fig. 5 is a full section showing the valve in exhaust position, the section being taken from the same side of the valve as Fig. 1.

Fig. 6 is a section on line 6—6 of Fig. 5.

In the drawings 1 is a valve casing provided at each end with plates 2. The casing is formed with a central valve chamber 3 defined by walls 4, preferably cast integral with the casing. Disposed one above the other and completely separated from each other by a partition 5 are two annular steam chambers 6 and 7. The upper steam chamber 6 communicates by means of passage 8 with the steam feed pipe 9. In the same horizontal plane, but directly opposite each other, are two ports 10 passing through the wall 4, permitting the passage of steam from the inlet steam chamber 6 to the valve chamber 3 (see Figs. 3 and 4.) In similar manner the lower steam jacket 7 connects with the exhaust pipe 11 through passage 12, and communicates with the valve chamber 3 by means of diametrically opposed ports 13 lying in the same horizontal plane and preferably directly beneath the ports 10 in the inlet or live steam jacket. The arrangement of ports for the exhaust steam jacket is in all respects similar to that of the inlet steam jacket.

Surrounding the jackets 6 and 7 is an annular chamber 14 communicating with one end of the engine cylinder through passage 15. Passing through the walls of the jacket 6, in the same horizontal plane as inlet ports 10, are diametrically opposite ports 16 connecting the annular chamber 14 with the valve chamber 3. The ports 16 are so placed that their centre line is disposed at right angles to the centre line of the ports 10 (see Fig. 4). Directly beneath the ports 16 is a similar pair of oppositely positioned ports 17 connecting the chamber 14 with the valve chamber 3, these ports being in the same horizontal plane as exhaust ports 13, but having their centre line at right angles to the centre line of the ports 13, the arrangement being exactly similar to the arrangement shown in Fig. 4 for the steam inlet valve. The outer chamber 15 is not divided horizontally, but webs 5 ft. extending

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb.	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	30
Stove bolts	50
Wrought washers	50
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank ..... add	$1 50
Nuts, square, tapped ..... add	1 75
Nuts, hexagon, blank ..... add	1 75
Nuts, hexagon, tapped ..... add	2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs ..... 40 and	5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals ..... 0 18 to	0 70
Soldering coppers, lb.	58
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 50
Linseed oil, raw, single bbls.	2 90
Linseed oil, boiled, single bbls.	2 92
Plaster paris, per bbl.	4 50
Sandpaper, B. & A. ....list, plus	43%
Emery cloth .....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

Gross

METALS

	Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

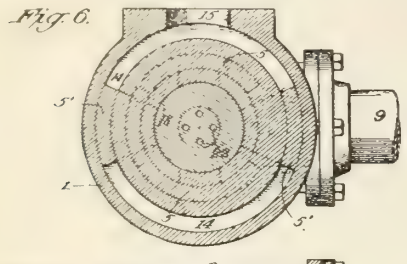
	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

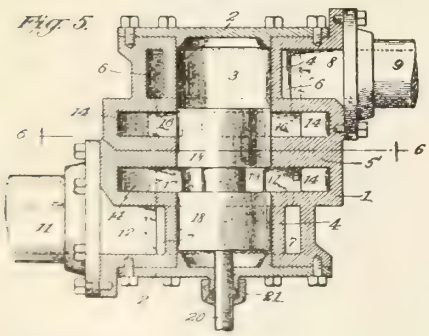
Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

from the partition 5 tend to separate the ports 16 and 17, although these could be well dispensed with at the point where they extend across the chamber 14, only the partition 5 being necessary.

Sliding in the valve chamber 3 is a piston 18 provided on its circumference with an annular groove or duct 19. This duct is preferably made slightly narrower than the partition 5 and is adapted, upon reciprocation, to register with ports 10 and 16 and then with ports 13 and 17. The piston is reciprocated by a rod 20 passing through gland 21 on lower plate 2 and suitably connected with the valve operating mechanism on the engine in any manner well known in the art. The piston is preferably constructed with open ends in order that gases may pass freely from one end of the valve chamber to the other to avoid compression of the gases in the valve chamber. In the drawings I have shown holes 22 passing lengthwise through the piston to prevent compression of the gases in the valve chamber.

In operation the live steam from pipe 9 passes through passage 8 and fills the upper live steam chamber 6. When the piston 18 is moved inward to permit groove 19 to register with ports 10 and 16, as in Figs. 3 and 4, the steam passes





through ports 19, impinging against opposite sides of the piston with equal pressure. The steam then travels around the groove 19 in both directions and out the diametrically opposite ports 16 exerting an equal pressure on the opposite sides of the piston (see Fig. 4). It will thus be seen that the valve is balanced both by the steam impinging against it and the thrust of the steam leaving the groove. From ports 16 the steam passes into the annular chamber 14 and then into the engine cylinder through passage 15. When the engine cylinder is exhausting the valve piston is moved to the position shown in Fig. 5, when the groove 19 registers with ports 13 and 17. The exhausted steam being pushed from the engine cylinder passes through the passage 16 into chamber 14. From chamber 14 it passes out the diametrically opposite ports 17 into groove 19, the pressure being equal upon each side of the piston 18. The steam then passes around the groove 19 in both directions and at the opposite ports 13 into the lower exhaust jacket 7, and thence through passage 12 into the exhaust pipe 11. It will be seen that while the piston is in intake position ports 13 and 17 are closed by the main body of the piston, and while the piston is in exhaust position the ports 10 and 16 are closed by the body of the piston. It will also be seen that when the ports are closed by the piston, the pressure of the steam in the ports against the piston always balances on diametrically opposite sides.

During one cycle of operation in one valve, a similar valve connected with the opposite end of the engine cylinder is operated in a similar manner, but is reversed to feed steam to the engine cylinder while the first is exhausting, and vice versa.

The Large Locomotive Boiler

By F. W. BREWER

THE boiler is essentially the most important part of a locomotive. It must be carefully designed, well made, and constructed of the best material, since, besides the stresses due to steam pressure, it has to withstand the strains caused by expansion and contraction, and also those arising from the severe conditions under which locomotives ordinarily work. Moreover, continues "Locomotive," as it is difficult to determine with absolute accuracy all the stresses to which it is subject, it must be of such strength as to provide an adequate margin or factor of safety. Whatever its defects may be there is no doubt that the ordinary multitubular locomotive boiler, on the whole, is admirably adapted to fulfill the duties peculiar to railway traction. It has one conspicuous advantage in that it enables a large amount of heating surface to be got within a comparatively small compass. This is of the utmost importance, because, other things being equal, the hauling efficiency of the engine is entirely dependent upon the capacity of the boiler, which should be large enough to supply more than sufficient steam for ordinary requirements in order that the engine may be able to respond to special demands upon it for greater power. It being essential, therefore, that steam should be generated as rapidly as may be necessary at all times while the engine is running, the whole heating surface must be arranged so as to effect this object, and this is best accomplished by allowing both steam and water to circulate freely throughout the boiler.

Heating Surface Versus Power

It must not be supposed that a large amount of heating surface necessarily means a high evaporative power, or that a nominally small heating surface invariably implies a low evaporative efficiency. The boiler barrel, for instance, may be so overcrowded with tubes as to render ineffectual the greater proportion of the heating surface presented by them, due solely to the absence of a proper circulation. The disintegration of the steam particles from the water is then consequently retarded, so that the water is apt to rise with the steam and produce what is technically known as priming. Similarly, if the water spaces surrounding the firebox are too narrow, and if the sides of the box are vertical instead of being inclined towards the top, the circulation of the water is again impeded, and the production of steam is consequently injuriously affected. From this it follows that for a boiler of a given diameter and length (including the firebox casing) it is better to employ a relatively moderate number of tubes and to sacrifice some of the width and length of the inner firebox, the alternative advantage being a much better circulation of the water by reason of which a greater quantity of steam is generated in a given time, while the formation of scale is lessened and the tendency to priming reduced. Again, the proportion of firebox surface to tube area, the length and diameter and arrangement of the tubes, apart from their number, and the diameter of the boiler barrel itself are all matters which must be taken into consideration as affecting steam production. Thus the firebox, which is exposed to the incandescent fuel and heated gases, has a much higher evaporative efficiency per square foot than the tubes, so that, within limits, it is always preferable to use as large a firebox as possible, consistent with the work to be done and the quality of the

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH
THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

When writing to Advertisers kindly mention this paper.

FAIRBANKS-MORSE

Building a Bigger Canada

THESE are days of progress—days when industry is leaping ahead and Canada is assuming her place in the world of commerce. Giant structures are being reared to house the machinery, men and equipment necessary to a bigger business.

Great highways are being constructed to provide for the easier transportation of Canada's products; elevators, wharves, factories, mills, mines—everywhere the hand of the contractor is set to some big task.

And wherever this construction work is going on, Fairbanks-Morse contractors' equipment is playing an important part—rendering its services as a factor in this work of progress. From the shovel to the steam and electric hoists, from the concrete mixer to the heavy road machinery, drill and jack, to truck and railway car, Fairbanks-Morse equipment is the choice of the contractor, because he knows that behind the smallest tool is the same quality guarantee and service that supports the largest unit of Fairbanks-Morse equipment.

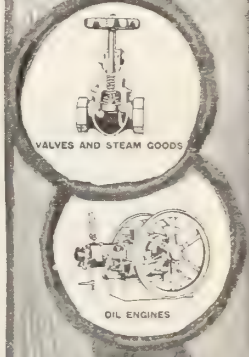
He knows that the Fairbanks-Morse 100% quality seal is the ideal of the Fairbanks-Morse institution—a standard and a guide in building a bigger Canada.

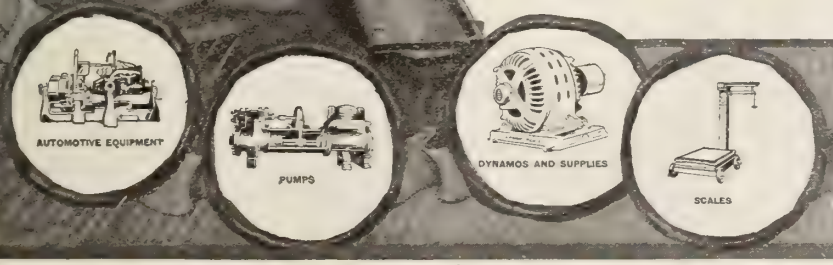
The Canadian Fairbanks-Morse Co. Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Saskatoon Regina
Calgary Vancouver Victoria

11





A True Steam Trap-- Not a Hot Water Collector

The object of a steam trap is to save steam.

One glance at some steam traps of the "bucket" or "float" type shows how poorly they fulfill their mission. They are simply receptacles for water that has dropped below the steam point and water instead of conserving steam.

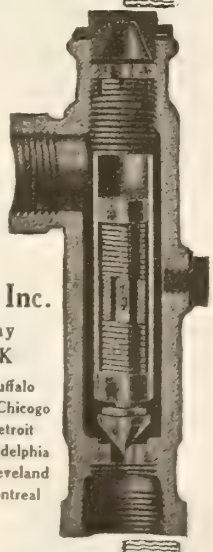
Our first thought, in designing the Steam Trap Sarco, was to build a device that would **save** heat by passing the condensate on to the hot well as **rapidly as it is collected.**

The Sarco does its work with an absolute minimum loss of steam. There is no chance for the condensate to collect and cool. The automatic operation of a sensitive expansion element opens and closes a valve, releasing the hot condensate the **minute it collects. This** conservation of heat units represents a very substantial annual saving, even on steam lines of moderate size.

The Sarco saves money in other ways also. It doesn't waste steam by leakage. It doesn't require constant repairs. It can be installed quickly on any steam line without resorting to expensive construction work. And it costs only one-third as much as a "bucket" type trap.

For all around economy, the Sarco everytime. You don't have to buy it on chance either. Our 30 days' free trial offer gives you the option of putting it to the test at our expense.

Write to-day for Booklet J-13



Sarco Co., Inc.
239 Broadway
NEW YORK

Ellicott Square, Buffalo
Monadrock Blk., Chicago
Majestic Bldg., Detroit
Drexel Bldg., Philadelphia
Williamson Bldg., Cleveland
Peacock Bros., Montreal

STEAM TRAP
SARCO

fuel employed. The tubes, however, play an important part in the economy of the engine, since they serve to utilize the heat as it leaves the fire box, and by imparting the heat to the main body of water in the barrel, though necessarily less effectively than the directly heated plates of the firebox itself, they provide, nevertheless, an indispensable contribution to the total heating surface.

Length of Tubes

As regards the length of the tubes, practice teaches us that the minimum for modern express engines should be 12 ft. between tube plates, while this length can often be advantageously increased, because in such engines the velocity of the escaping gases is usually very high, and long tubes, therefore, abstract a greater proportion of heat than do short tubes. The tubes are arranged either in vertical or in diagonal rows. Vertical rows are generally considered preferable as it is thought that they promote circulation and assist the rising of the steam bubbles, at the same time allowing solids in the feed water to pass to the bottom of the boiler. To compensate the lower evaporative power of the tubes, their aggregate area in contact with the water is very large compared with that of the firebox, and may be anything from ten to fifteen times greater.

At one period the size of the boiler as a whole was mainly governed by the mean theoretical tractive force which an engine was calculated to develop with a given load at a given speed. That is to say, a boiler of minimum dimensions was generally provided, and this sufficed for moderate needs. Modern requirements, however, have by degrees reversed this order of things until to-day it may more correctly be said that the hauling power is only limited to the extent to which the size of the boiler can be increased. It is now fully recognized that the actual—as distinct from the nominal—tractive force is appreciably augmented by enlarging the steaming capacity for a given cylinder volume. The dimensions, therefore, can only be said to define the minimum size of boiler necessary for a given theoretical tractive power. They cannot of themselves be taken as a general indication of the absolute power, for that is inseparable from the boiler capacity, and will be greater proportionately to the increased facilities for steam production. Most British locomotives, it is true, have done exceptionally good work, having regard to their nominal tractive force and heating surface, and while there are many other conditions which have their influence on the hauling efficiency (such as the setting of the valves, the diameter of the blast-pipe, the weight on the driving wheels, and so on), the fact remains that it is now generally advisable to use a much larger boiler than that determined by the former methods of calculation. The most that can be said is that cylinder volume is an approximate guide, while the maximum size of boiler possible is determined by considerations which lie quite outside. These are the restrictions due to height, width, length, and weight. Generally speaking, the height of the chimney-top above rail-level must not exceed 13 ft. 6 in.; the width, or space available transversely between the tires of the driving wheels, so that it will be seen that these two limitations are the primary ones, and being interdependent are alone sufficient to fix the size of the boiler diametrically. Owing to difference in the vertical loading gauge, what might be possible on one line might be out of question on another, but it may be taken as a general rule that large-diameter boilers and large driving wheels cannot go together. The diameter of the one or the other must be kept down, and since the boiler capacity is of paramount importance, it may be preferable to use relatively small driving wheels, more especially as the tractive power for a given cylinder diameter and piston stroke will then be correspondingly greater.

As regards the length of the barrel and firebox combined, this must be such as to permit of the rigid wheelbase being short enough to enable the engine to traverse safely the shortest curve on the line over which it will be required to run. There is also an assumed limit to the length to which tubes can be usefully extended. The same may be said respecting the length of the firebox, as, although the objection to the use of long coupling rods is removed by placing all the driving wheels in front of the box and employing a supplementary carrying axle underneath it, yet very long grates are difficult to fire efficiently. The condition as to weight depends upon the strength of the permanent way and bridges, but on all the more important main-line railways a reasonable allowance is now made for the probable development of the locomotive in this respect.

But it will be understood, no doubt, that there are certain other factors which have to be reckoned with in connection with the increase in boiler capacity. For example, in the case of express engines the limit to which a boiler can be advantageously enlarged for a given cylinder diameter is reached when the cylinders, owing to back pressure and the necessarily reduced port opening high speeds, can use only a comparatively small quantity of the steam generated. This limit will be determined by the particular type and arrangement of the valves and valve gear, by the respective areas of the steam and exhaust passages, and by the diameter of the blast-pipe, which details ought to be planned with a view to increasing the positive pressure on the pistons, without, however, reducing the compression below the amount necessary to absorb the momentum of the moving parts at the end of each stroke. It is not easy to adjust these matters to a nicety, but the big boiler, if provided with adequate grate area, is of itself a help in this connection, since it allows of a larger blast nozzle being used; and the latter, by diminishing back pressure, permits the cut-off to be later, and this, in turn, enables the engine to haul a heavier load at a given speed, or to take a given load at a higher speed, as may be required.

"MEAD-MORRISON"

CANADIAN MM C

CANADIAN MM C

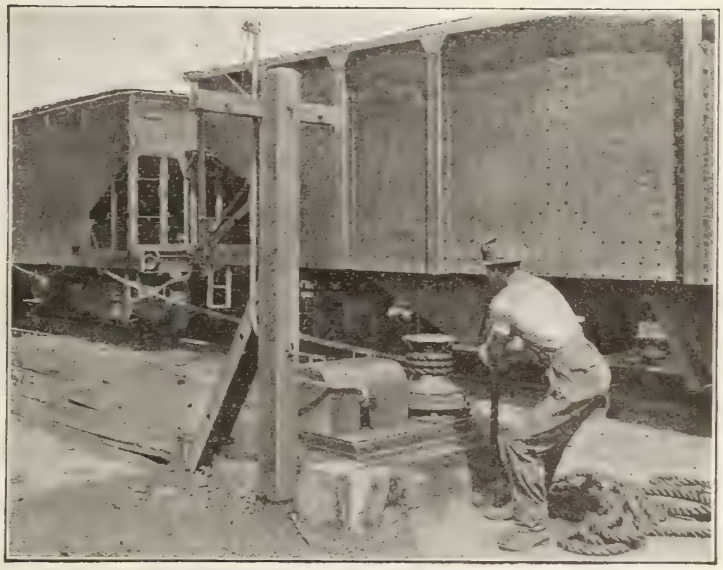
Electric Car Puller

How long does it take you to spot that car ?

How do you get the empties back on the other siding ?

This ***Car Puller*** requires only ***One Man.***

The capacity of the Puller is a Rope Pull of 3,500 pounds at a rope speed of 60 feet a minute.

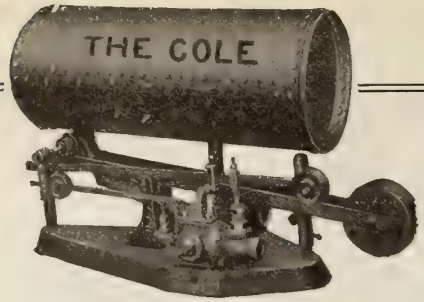


GETTING ALONG WITHOUT THE SWITCHING LOCOMOTIVE

Furnishes ***Dependable Service***
under all conditions

PUT YOUR PROBLEM UP TO US!

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS: WELLAND ONT.



Now is the Time to Start Remodelling Your Heating System

By doing it the "Cole" way, you get the utmost efficiency possible.

May one of our expert engineers visit your plant? He will advise you.

Interesting literature upon request

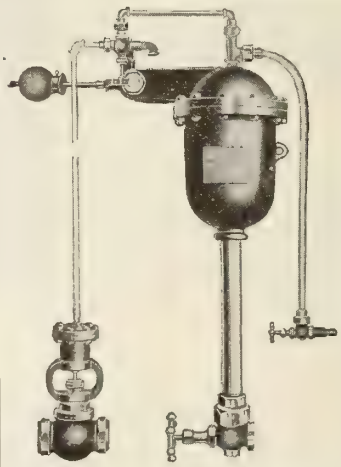
GEO. W. COLE LIMITED

2002-4 Dundas St. West

TORONTO, CANADA

Montreal, Que. New Glasgow, N.S. Vancouver, B.C. Winnipeg, Man.

110-112 Church Street, Toronto, Canada



Insure Constant Level

The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gauge the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way. They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers and they feed continuously with perfect uniformity.

Write for full particulars.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penna.

CRANE MALLEABLE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

The
Disposal Board have

STOCKS

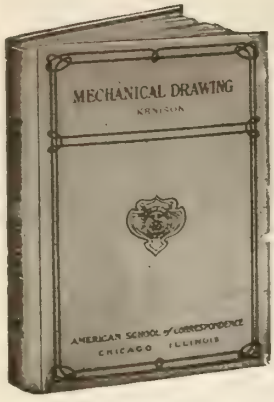
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."



Clearance Sale of High Grade Technical Books

FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

Title of Book	Name of Author.	Binding	No. of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	....
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	276	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Gas and Oil Engines	L. E. Brookes	Cloth	192	Yes	.85
Ford Car	V. W. Page	Cloth	288	Yes	....
New Catechism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Setting Valves of Canadian-made Engines	G. C. Keith	Paper	31	Yes	.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
How to Run Gasoline Engines	C. Von Culin	Paper	144	Yes	.50
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkins' Indicator	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Aids to Engineers Examinations	N. Hawkins	Cloth	222	No	1.50
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy or $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

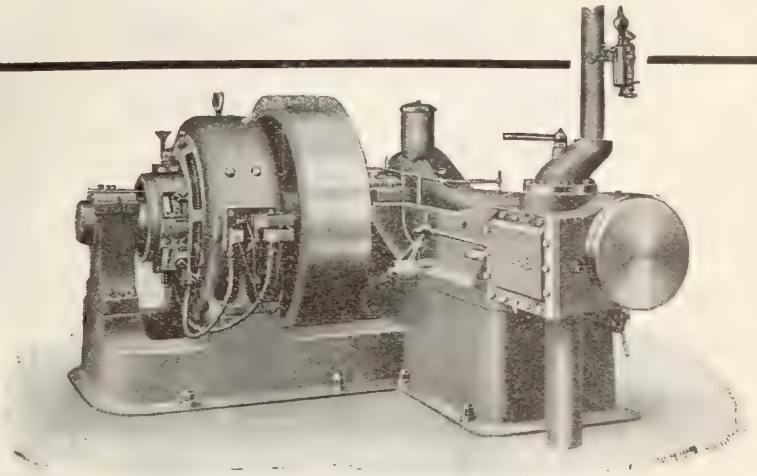
153 UNIVERSITY AVENUE, TORONTO, ONT.

ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

Amherst, N.S.

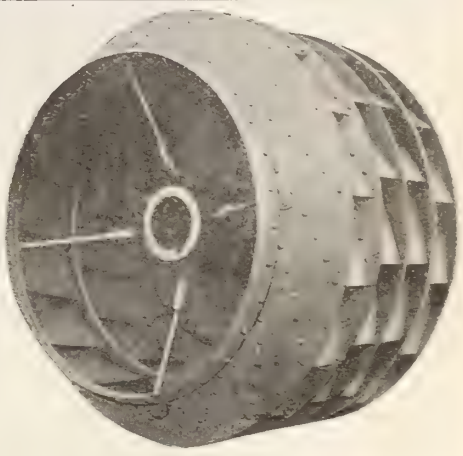
Montreal Office: Phone Westmount 6800

Toronto Office: 20 Victoria Street

GREEN'S

HI-EFFICIENCY HI-SPEED

RADIAL FLOW FANS



Economical, Sturdy, Efficient

Green's Radial Flow Fans are possessed of many advantages. They require approximately 20% less horse power than any other fans. Are so designed that the rotor and bearings are easily accessible without changing the alignment or dismantling the flue work. Any blow back through the fan inlet or dead space on the fan wheel is impossible due to the design of rotor and housing. They run at speeds best suited for direct connection to turbines or motors and are also suitable for gear or belt drive.

Consult our engineers. They will gladly furnish you complete information with regard to fans to cover your individual requirements.

GREEN'S ECONOMISER, LIMITED.

TORONTO

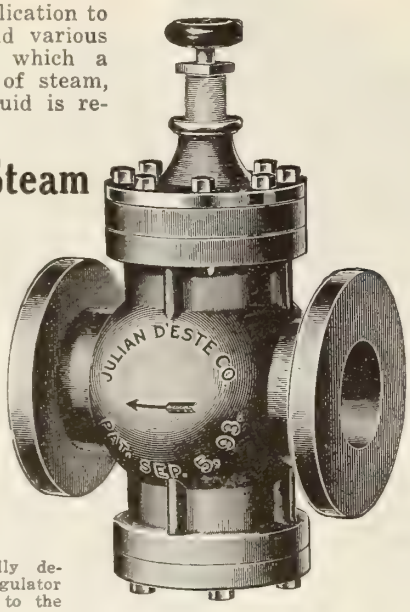
HINTS TO BUYERS

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: 83 BARCLAY ST., NEW YORK CITY; 174 N. MARKET ST., CHICAGO, ILL.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings ***Forgings***
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. ***Write for our latest catalogue.***
Patterns ***Machine Work***

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE
THE E.S.MANNY Co
27 COTE St MONTREAL, QUE

LANCO BALATA BELTING
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO
SCANDINAVIA BELTING

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS
BOILERS & TANKS, WATER FILTERS THERMOMETERS, GAUGES
E. J. Philip & Sons, Engineers 57 Queen Street, West, Toronto, Canada

When Writing to Advertisers Kindly Mention this Paper

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

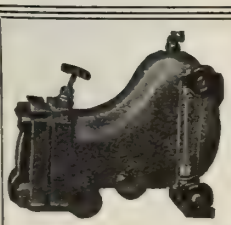
Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal



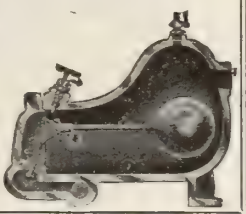
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

ECONOMIZER Carling BLOWERS SUPERIOR

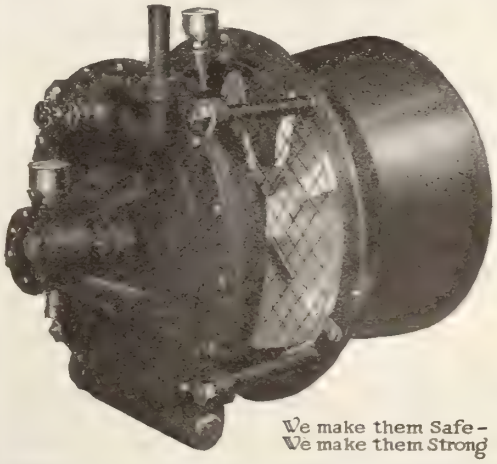
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

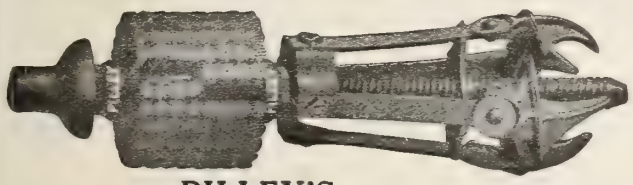
CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Showing ease with which Plibrico is laid in place.

PLIBRICO SAVES COAL

by making your furnace air and gas-proof.

Plibrico can be installed by inexperienced labor, Plibrico also makes an excellent material for baffle construction and repairs.

A High Grade Refractory.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate shipment.

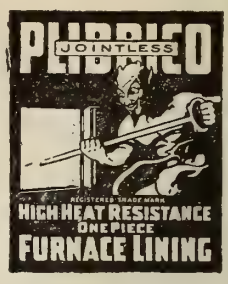
Write for book on furnace building.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory: 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

The Safe and Certain Boiler Cleanser

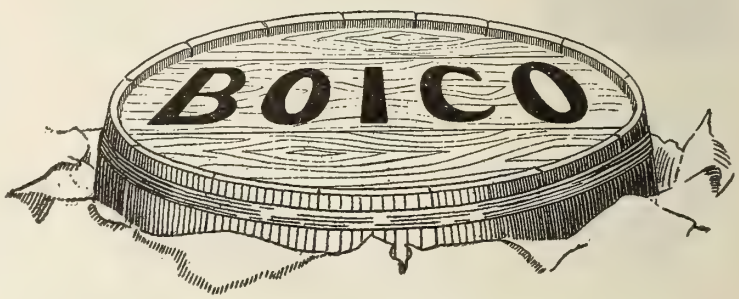
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

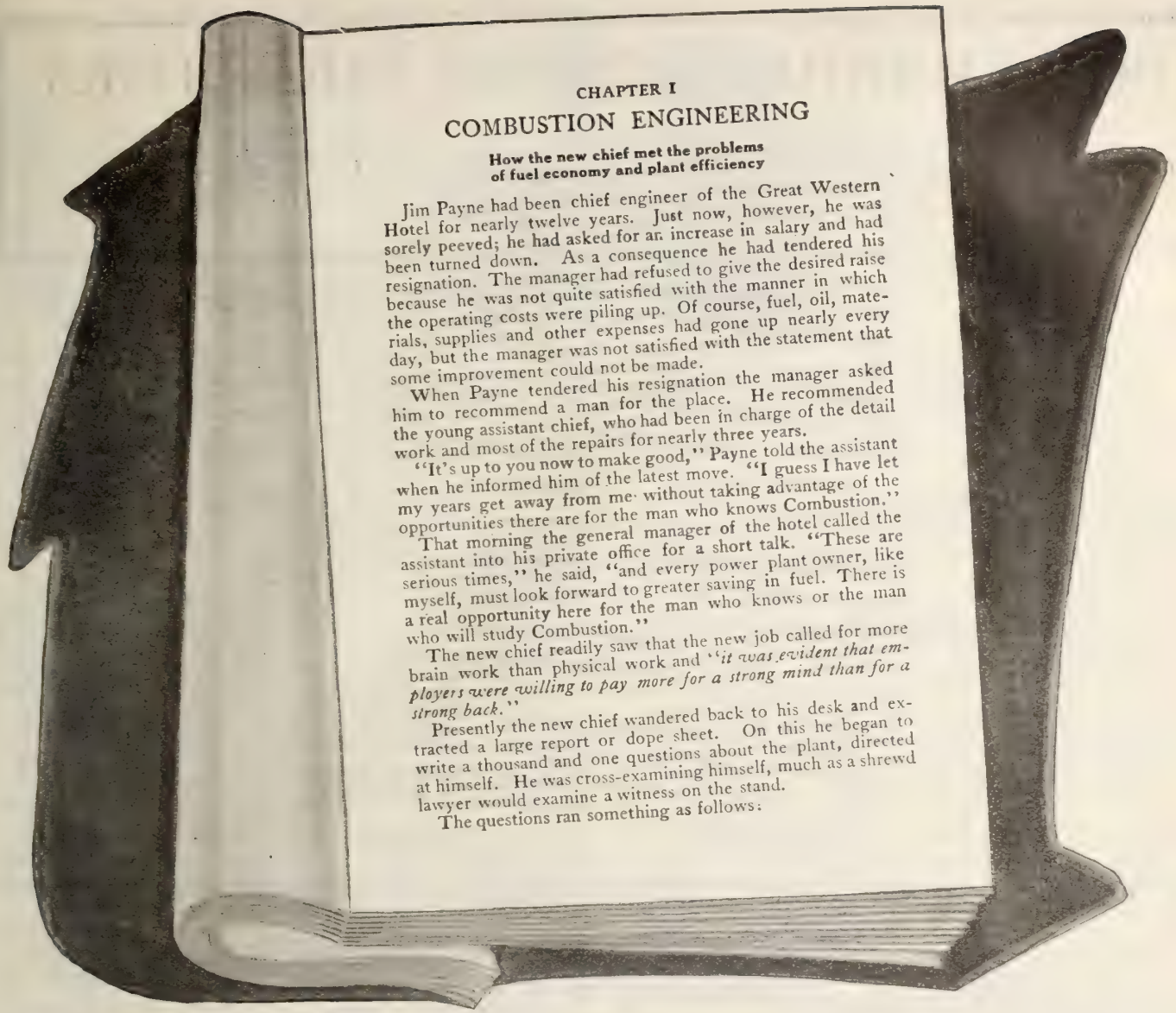
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.



CHAPTER I

COMBUSTION ENGINEERING

How the new chief met the problems of fuel economy and plant efficiency

Jim Payne had been chief engineer of the Great Western Hotel for nearly twelve years. Just now, however, he was sorely peeved; he had asked for an increase in salary and had been turned down. As a consequence he had tendered his resignation. The manager had refused to give the desired raise because he was not quite satisfied with the manner in which the operating costs were piling up. Of course, fuel, oil, materials, supplies and other expenses had gone up nearly every day, but the manager was not satisfied with the statement that some improvement could not be made.

When Payne tendered his resignation the manager asked him to recommend a man for the place. He recommended the young assistant chief, who had been in charge of the detail work and most of the repairs for nearly three years.

"It's up to you now to make good," Payne told the assistant when he informed him of the latest move. "I guess I have let my years get away from me without taking advantage of the opportunities there are for the man who knows Combustion."

That morning the general manager of the hotel called the assistant into his private office for a short talk. "These are serious times," he said, "and every power plant owner, like myself, must look forward to greater saving in fuel. There is a real opportunity here for the man who knows or the man who will study Combustion."

The new chief readily saw that the new job called for more brain work than physical work and "*it was evident that employers were willing to pay more for a strong mind than for a strong back.*"

Presently the new chief wandered back to his desk and extracted a large report or dope sheet. On this he began to write a thousand and one questions about the plant, directed at himself. He was cross-examining himself, much as a shrewd lawyer would examine a witness on the stand.

The questions ran something as follows:

WHAT are your chances for real success?

Do you realize the opportunities that a knowledge of Combustion offers to the man who wants to be more than merely the average?

It is not so much a strong back today as it is a strong mind that counts!

The man who knows Combustion can state his own salary and his services are always in demand.

Would you like to have the opportunity of getting a thorough knowledge of Combustion and Boiler Room Management in your spare time and at a very small cost, payable monthly if so desired? Jos. W. Hays, author of the Course and Educational Director, formerly Consulting Combustion Engineer of the U. S. Navy; W. L. Abbott, Chief Operating Engineer of the Commonwealth Edison Company; Fred R. Low, Editor of "Power"; Prof. S. W. Parr, Department of Chemistry, University of Illinois; Joseph Harrington, formerly Administrative Engineer, U. S. Fuel Administration; David Moffat Myers, formerly Advisory Engineer for the U. S. Fuel Administration; Arthur L. Rice, Editor of "Power Plant Engineering," and I. E. Moultrop, Bureau of Construction, Edison Electric Illuminating Co., have now made it possible for you, thru the Hays Course in Combustion Engineering and Boiler Room Management, to obtain a thoro knowledge of Combustion in your spare time without interfering with your present work in the least.

This Free Book

will tell you some interesting pointers that the average power plant and boiler room man should know, particularly about Combustion Engineering

The coupon will bring to you, without any expense whatever, a copy of this interesting book, covering power plant and boiler room management. It tells you how other men like yourself have, thru the Hays Course, achieved real success and how the same can be made possible in your case.

If you are determined to get out of the ordinary class and to push ahead where your services will be worth much more than they are today, get your copy of this book at once. It will help you from the time you receive it. It will interest and inspire you because it shows a better way toward bigger things. It also shows how, thru the Course, in addition to obtaining a knowledge of Combustion, you get, as well, a liberal education, paving the way for real executive ability.

Your request for this book will obligate you in no way whatever—merely clip the coupon below and return it today with your name plainly written or typed. Promptly upon receipt of the coupon the book will be sent you—absolutely FREE.

Send for Free Book—"Opportunities for the Combustion Expert."

Name .....

Address .....

City ..... State .....

Position .....

With .....
(Name of Company)

Hays School of Combustion

Dept. 50 0-A, 1412-14S. Michigan Ave., Chicago, Ill.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken. but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
J. C. Wilson Mfg. Co., Ltd., Belleville.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Bowlig Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford
Wilson Mfg. Co., J. C., Belleville.

CASTINGS, SEMI-STEEL
J. C. Wilson Mfg. Co., Ltd., Belleville.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

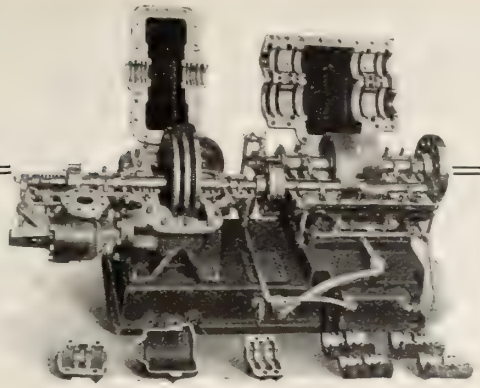
CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.



The Design of Moore Steam Turbines Prevents Steam Leaks

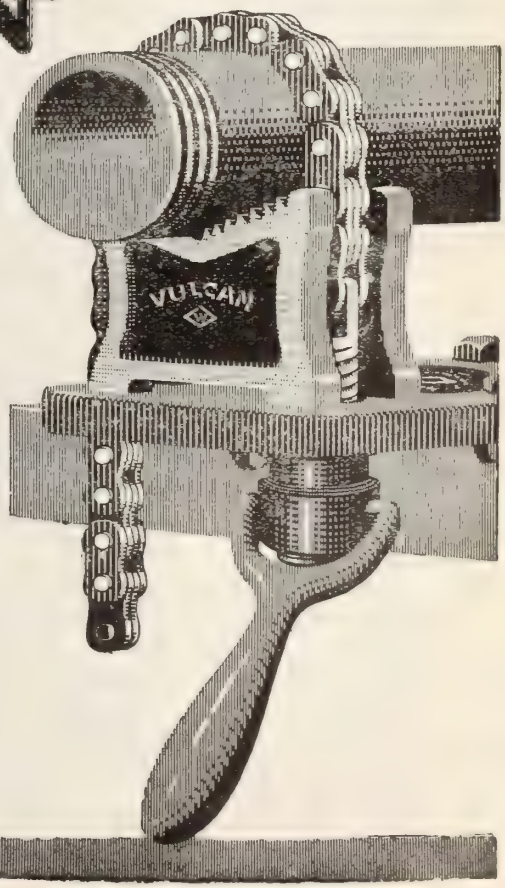
Ample surfaces at the joints have been provided to prevent leakage of steam—also the number of vertical joints have been reduced to a minimum. In a turbine having numerous vertical joints it is almost impossible to prevent leakage and consequent loss of efficiency in operation.

The careful designing to prevent all steam leakage is but one feature of Moore Steam Turbines. Send for our booklet. It explains fully the others.

STEAM TURBINES MOORE WELLSVILLE NEW YORK

Moore Steam Turbine Corporation
Wellsville New York U.S.A.

WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE



IN general, you know there's no comparison between a cast and a wrought tool.

The same principle applies to pipe vises.

Williams' "Vulcan" No. 4, for 3/8 to 8 in. pipe, is stronger, quicker in action and cheaper.

3 sizes for 1/8 to 8 in. pipe—at your dealer's.

J. H. WILLIAMS & CO., LTD.
"The Drop-Forging People"
ST. CATHARINES, ONTARIO
W. Bruce Campbell, Western Agent, 78 Confederation Life Bldg., Winnipeg

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empare Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
J. C. Wilson Mfg. Co., Ltd., Belleville.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto., Ont.
Jeffrey Mfg. Co., Montreal, Can.
Morse Chain Co., Ithaca, N.J.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons. Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
Pyro Products Co., Toronto.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

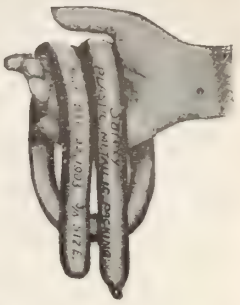
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for

LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

LADD

WATER TUBE BOILER

The Ladd Water Tube Boiler is a combination of rugged, simple and accessible construction.

Built in any size and for any of the many methods of firing—stoker, oil, gas, powdered coal, etc.

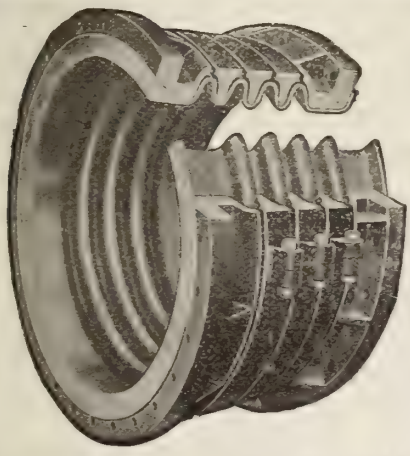
Our Engineering Department will be glad to co-operate with you on your boiler problems—no matter how intricate or elaborate they may be.

Our catalogue will be of interest to you.

GEORGE T. LADD COMPANY

First National Bank Building, Pittsburgh, Penn.

Chicago Office: 528 McCormick Bldg.



BADGER

SELF-EQUALIZING EXPANSION JOINTS

Our Expansion Joints can be installed in a pipe line as easily as any flanged fitting; they have no complicated parts; they are compact; the greatest diameter is usually that of the flanges; hydraulic test on every joint before shipment; they will safely care for expansion on high and low pressure and exhaust-pipe lines.

E. B. BADGER & SONS CO.

PITTS ST., BOSTON

Canadian Agents:

FRAZER & CHALMERS OF CANADA, LIMITED

Beaver Hill, Montreal, Canada

FOR REMOVING SCALE

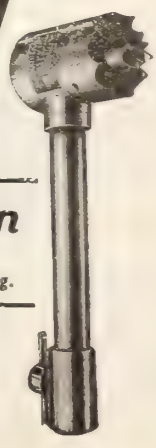
from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★



Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co, Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co. Inc. Montreal, Que
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

Gates Refractories, Limited

Contractors for all Kinds of Power Plant Brickwork

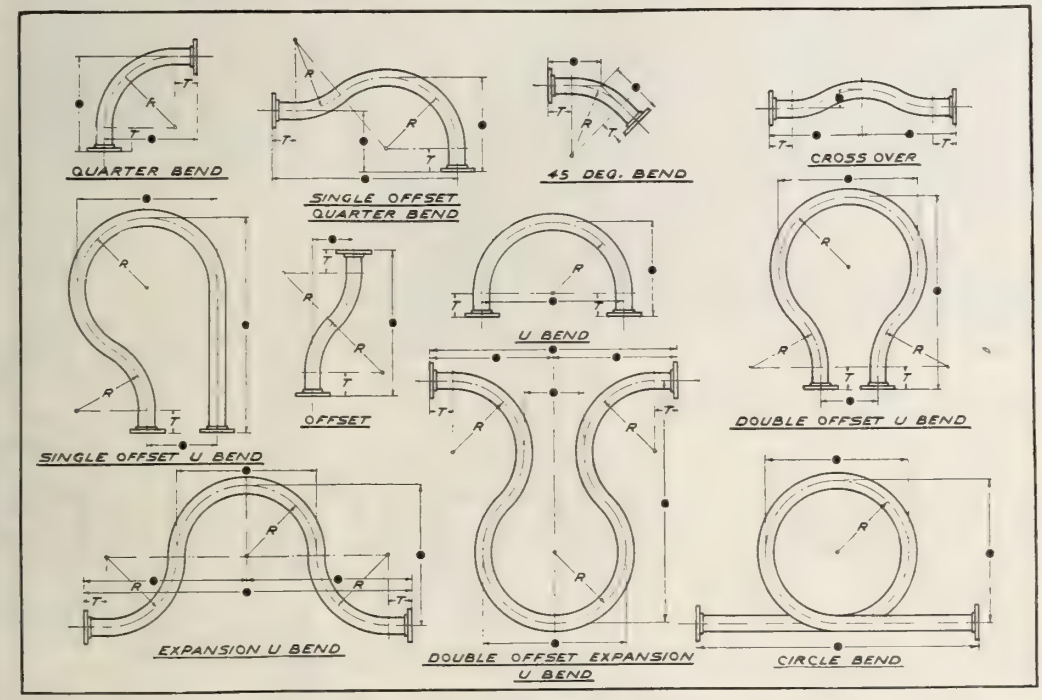
If it's Fire Bricks, Fire Cement or any kind of refractory materials see Gates. Prompt attention assured.

Our engineers are experts in all kinds of refractory work. Their wide and varied experience enables them to cope with the toughest problems and advise on the proper materials for maximum efficiency. Consult them on any problems—without obligation.
Remember our specialties are Boiler Setting, Furnace Building, and Oven Work. Write us for estimates.

Write us for full particulars of the Gates' special door arches, furnaces and refractory linings.

Head Office: 382 St. [illegible]s Street, Montreal

PAGE WROUGHT PIPE BENDS



ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY IRON, TUBE & LEAD Co. LIMITED

100 CHURCH STREET, TORONTO, ONT.

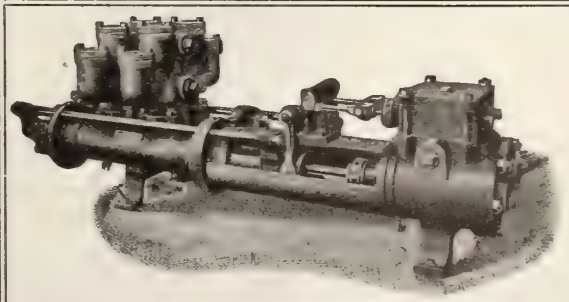
WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300



PUMPS

that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Phillip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Phillip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Phillip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

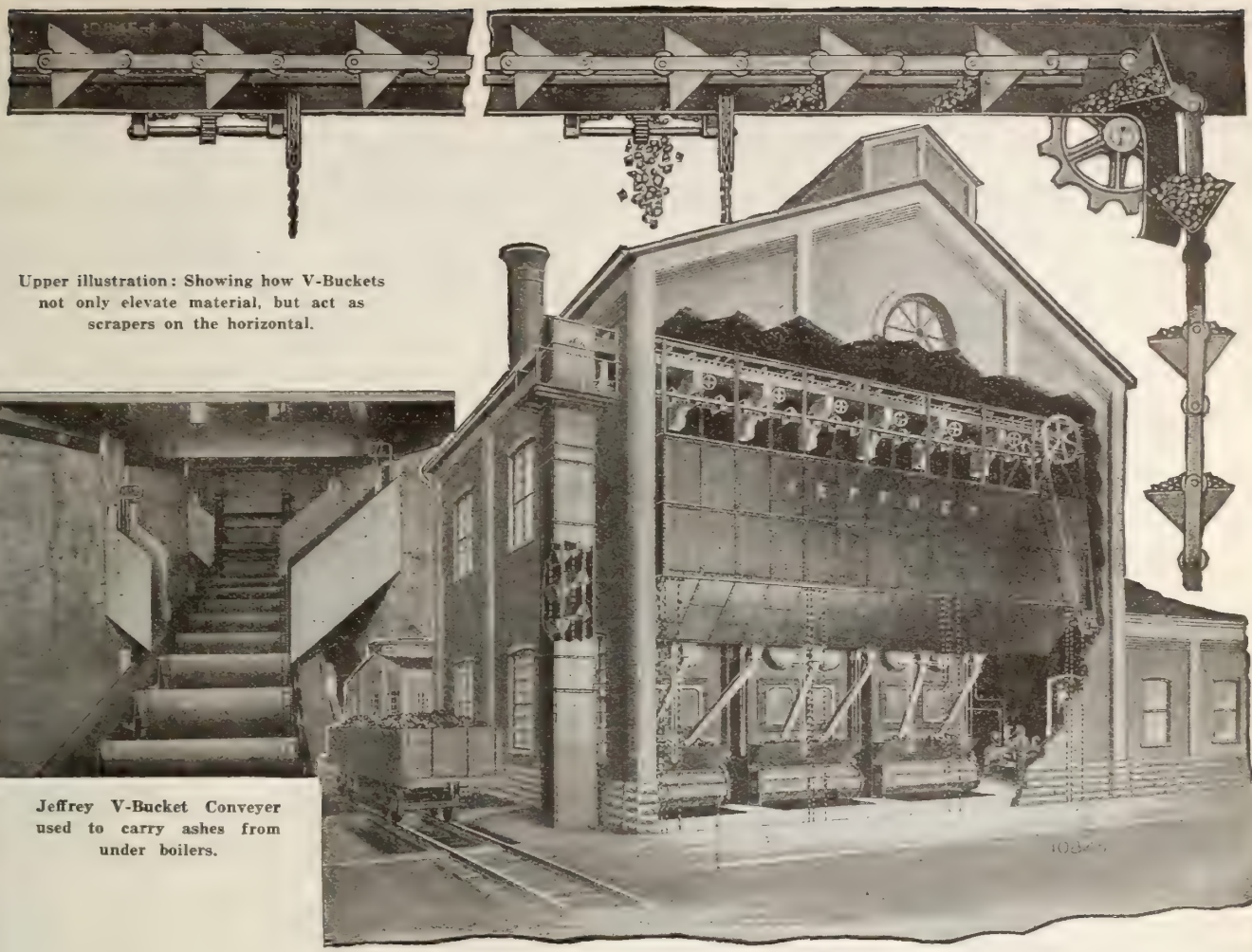
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



Upper illustration: Showing how V-Buckets not only elevate material, but act as scrapers on the horizontal.

Jeffrey V-Bucket Conveyer used to carry ashes from under boilers.

Coal being distributed to bunker in boiler house by a Jeffrey V-Bucket Conveyer. Coal passes direct to elevator or first through a Jeffrey Single Roll Crusher and then to Elevator.

The Jeffrey V-Bucket Elevator-Conveyer

Is economically adapted to the small Power Plant

The Jeffrey V-Bucket Conveyer may be used either as a run-around Conveyer or as a Combined Elevator and Scraper, and where conditions will not permit of a vertical elevator being extended sufficiently high to spout the material to points desired.

The V-Bucket Conveyer is also of advantage in places calling for a run-around conveyer where the capacity is less than 50 tons per hour, as given by our small pivoted bucket carriers. It is also especially adapted to the handling of slack and stoker sized coal.

Jeffrey Coal and Ashes Handling Machinery includes Bucket Elevators, Conveyers of the Scraper, Belt, Apron, Pan and Drag Chain Types, Single Roll Crushers, etc.

Consult Jeffrey Engineers about your problems.

THE JEFFREY MANUFACTURING CO.

Canadian Branch and Warerooms: MONTREAL

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
E. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

SWING JOINTS
Franklin Williams Co., New York.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

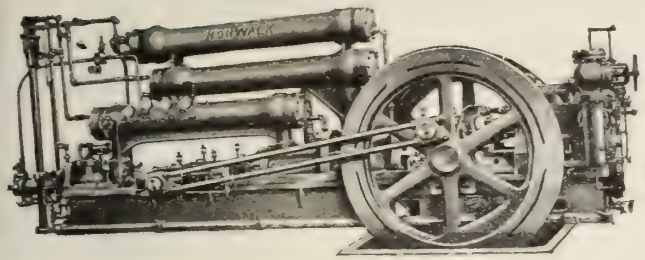
NORWALK
AIR & GAS · COMPRESSORS

The Right Capacity

Guesswork is costly, and particularly so in compression service. Under-equip and you cripple a plant; overstep your needs and you invite waste, besides making a larger initial investment than is necessary.

Economy lies in the right capacity for full and sure results under all conditions, and Norwalk engineers protect you by determining that capacity **before** the installation is made.

You are invited to call upon us for counsel in connection with any compression problem. We will give you the benefit of forty years' experience.



24-in. Stroke Large Four-Stage Single Steam Cylinder Driven Air Compressor

The NORWALK IRON WORKS CO.
Pioneer Builders of Compressors
South Norwalk, Conn.

A. S. LEITCH COMPANY, TORONTO
Canadian Sales Representatives

ANY·CAPACITY ANY·PRESSURE

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR

H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

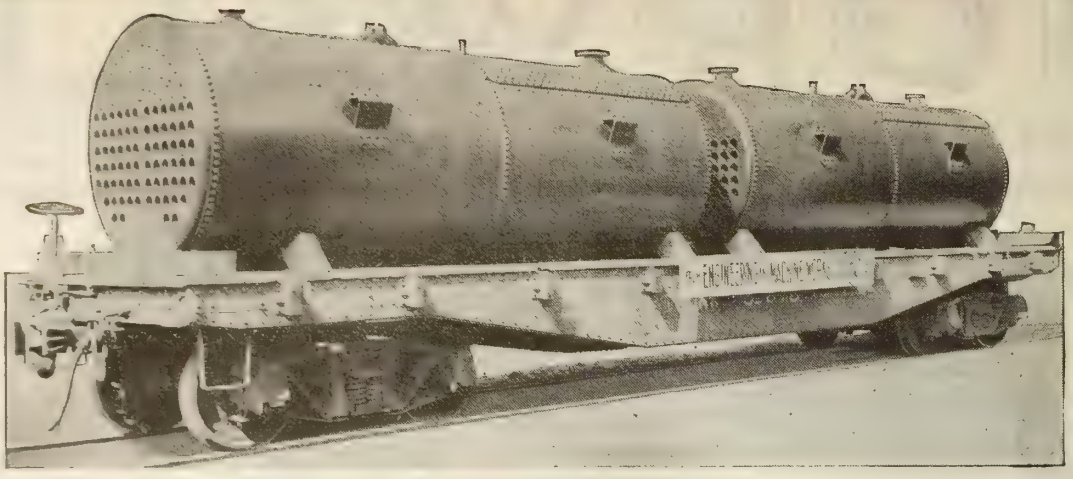
Bowser & Co., Ltd., S. F., Toronto, Ont.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.



It Doesn't Often Happen—

but it is so at present—our facilities and our materials supplies are just so matched that we can take care of new orders promptly—Boilers, all types, tanks, plate work, etc.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

INDEX TO ADVERTISERS

All-Way Oiler Manufacturing Co. 10
Anderson, The V. D. 4

Badger & Sons Co., E. B. 61
Betson Plastic Fire Brick Co. 12
Bishop & Co., S. C. 61
Busch-Sulzer Bros.—Diesel Engine Wks. 56

Can. Fairbanks-Morse Co. 47
Can. Farnsworth Co. ....Inside back cover
Can. Mead-Morrison Co. 49
Carling Turbine Blower Co. 55
Chaplin-Fulton Manufacturing Co. 50
Cole, Limited, Geo. W. 50
Coppus Eng. and Equipment Co. 8
Crane, Limited 50

Darling Bros. 54
Dart Union Company 11
De Laval Separator Co. 75
Department of Labor 55
D'Este Company, Julian 54
Dominion Belting Company 11
Dunlop Tire & Rubber Goods Co. ....
Inside front cover
Durabla Manufacturing Company 4

Electric Welding Company, The 63
Eng. and Mach. Works of Canada, Ltd. 68

Federal Engineering Company 54

Gates, W. W. 63
Gilman, Frank 61
Goldie & McCulloch Co. 16
Goodyear Tire and Rubber Co. ..14 and 15
Green's Economizer, Ltd. 53

Hays School of Combustion 57
Holden Co., Ltd., The 6
Homestead Valve Manufacturing Co. .. 10
Hoyt Metal Company 54

Imperial Oil Company 3

Jeffrey Manufacturing Co. 65
Jointless Fire Brick Co. 56
Jones Underfeed Stoker Co. ....
17, 18, 19, 20

Ladd Co., The George T. 61
Laurie & Lamb 55
Leitch Co., The Arthur S. ....
Inside front cover
Leonard & Sons, E. 9
Lunkenheimer Company 21

Manny Co., The E. S. .....46 and 54
Mason Regulator and Engr. Co. 16
McLaren, D. K. 5
Ministry of Munitions 51
Moore Steam Turbine Co. 59
Morrison Brass Manufacturing Co., Jas.
Outside back cover
Murphy Iron Works 7

Northern Electric Co. 13
Norwalk Iron Works Company 67

Page-Hersey Iron, Tube and Lead Co... 63
Penberthy Injector Co., Ltd. 1
Philip & Sons, E. J. 54
Pilley Packing and Flue Brush Mfg. Co. 55

Republic Flow Meters of Canada, Ltd. 59
Robb Engineering Works 53

Sanford-Riley Stoker Company 7
Sarco Company, Inc. 48
Scaife, Wm. B., & Sons Co. 68
Shell-Bar Boico Supply, Ltd. 56
Smart-Turner Mach. Co. 63
Starrett Co., L. S. 12
Steel Mill Packing Company 61
Sterling Engine Company 12

Tagliabue Company, C. J. 7
Taylor Instrument Company 50
Technical Books 52

Victoria Foundry Company 54

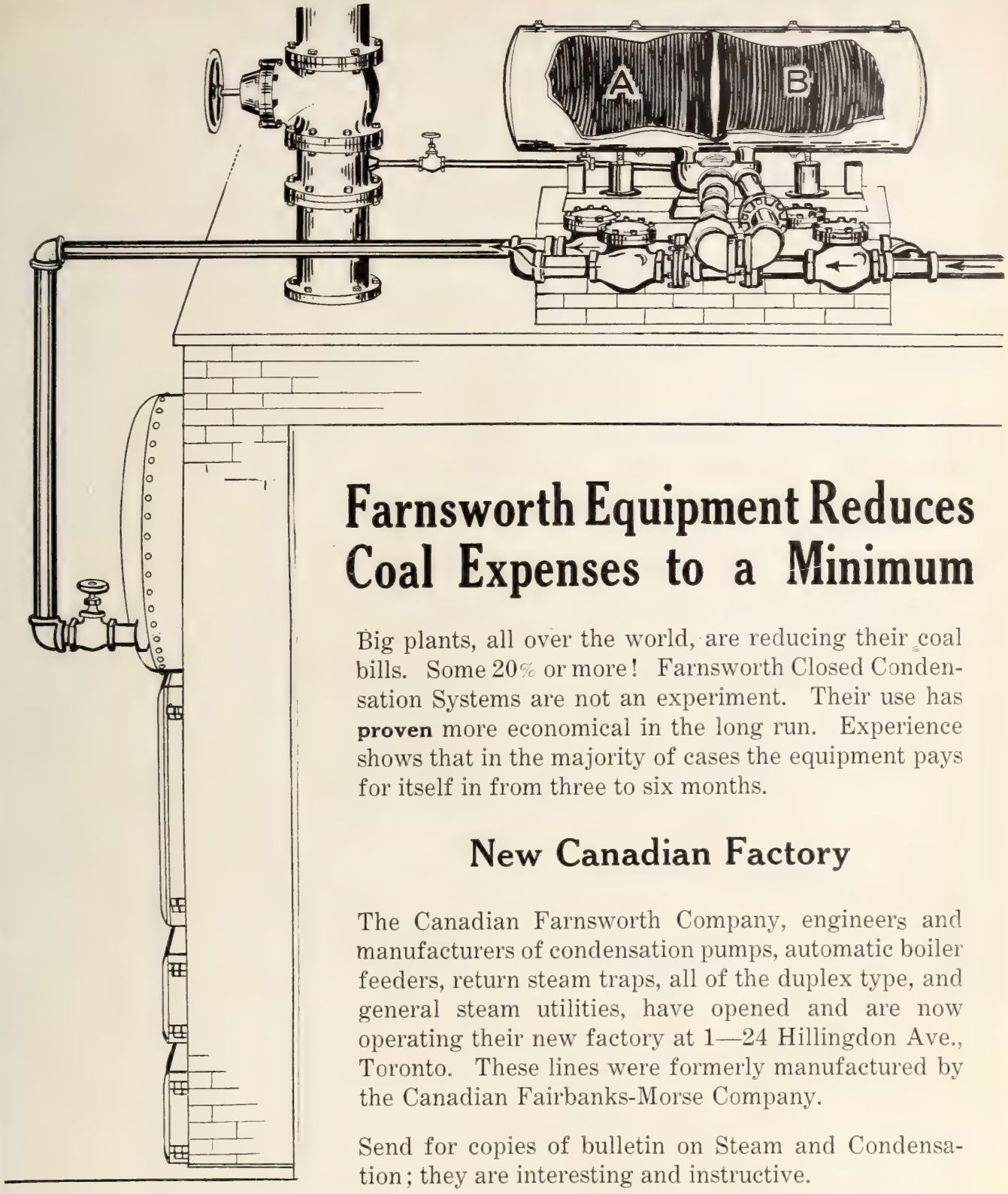
Wall, J. W. 55
Watson & McDaniel Co. 55
Williams Co., J. H. 59
Worthington Pump and Mach. Co. 2

York Manufacturing Company 10

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



Farnsworth Equipment Reduces Coal Expenses to a Minimum

Big plants, all over the world, are reducing their coal bills. Some 20% or more! Farnsworth Closed Condensation Systems are not an experiment. Their use has **proven** more economical in the long run. Experience shows that in the majority of cases the equipment pays for itself in from three to six months.

New Canadian Factory

The Canadian Farnsworth Company, engineers and manufacturers of condensation pumps, automatic boiler feeders, return steam traps, all of the duplex type, and general steam utilities, have opened and are now operating their new factory at 1—24 Hillingdon Ave., Toronto. These lines were formerly manufactured by the Canadian Fairbanks-Morse Company.

Send for copies of bulletin on Steam and Condensation; they are interesting and instructive.

The Canadian Farnsworth Company

1-24 Hillingdon Ave., Toronto, Ont., Canada

W. H. Rose, Gen. Mgr. **Telephone : Beach 825**

MORRISON

STEAM GOODS

"Beaver" Globe Valve
Bronze

The Morrison Standard Is High!

Morrison's Steam Specialties are made by skilled workmen of materials which long experience and modern science show to be best.

Though every care is taken with their construction, this is not enough. To conform with the Morrison Standard every specialty must be factory tested to withstand stress far in excess of that which it will be called upon to endure in actual service.

This high safety factor is why users recommend Morrison products every time—they always make good.

Some of Our Lines

Stop Valves
Check Valves
Gate Valves
Safety Valves
Relief Valves
Reducing Valves
Steam Traps

General Boiler
Mountings
Injectors
Ejectors
Inspirators
Jet Pumps
Steam Gauges

Pipe, Tools, etc.
Vacuum Gauges
Ammonia Gauges
Gauge Board Outfits
Lubricators
Pipe Fittings
Steam Whistles
Engine Indicators

A full description of these and other Morrison lines will be found in the Morrison catalog.
Write for a copy.

The James Morrison Brass Mfg. Co., Limited

93-97 ADELAIDE ST. W., TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 15. Publication Office, Toronto—August 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Uehling
CO_2 Equipment
COAL TALLY
CO_2 Recorders in the Chief Engineer's Office keeping him posted on furnace conditions for each individual boiler
Conserve Coal and Cash
with
UEHLING
CO_2 Recording Equipment
(the Cash Register of the Coal Pile)
This equipment makes fuel waste visible to firemen and chief engineer, thereby showing them how to reduce the waste. It is easy to operate and maintain and is equally valuable for stoker and hand-fired plants, and for any kind of fuel. This equipment should pay for itself many times over in the course of a year
WRITE FOR NEW CATALOG
UEHLING INSTRUMENT COMPANY
Combustion Engineers
2008 Empire Bldg., New York
CO_2
CO_2 Indicator at boiler front to guide the fireman

BELLISS & MORCOM, LTD.

Engines and Air Compressors

The fact that some of Canada's largest engine rooms are equipped with Belliss and Morcom Engines and Air Compressors proves conclusively that they are among the most reliable and economical engines on the market, because such firms are invariably keen buyers. Illustration shows a Belliss and Morcom installation in the Power Plant of the Montreal Tramway Co. When you are in the Market do not fail to investigate the Belliss and Morcom line. **Full information on request.**

We Can Make Immediate Installations On

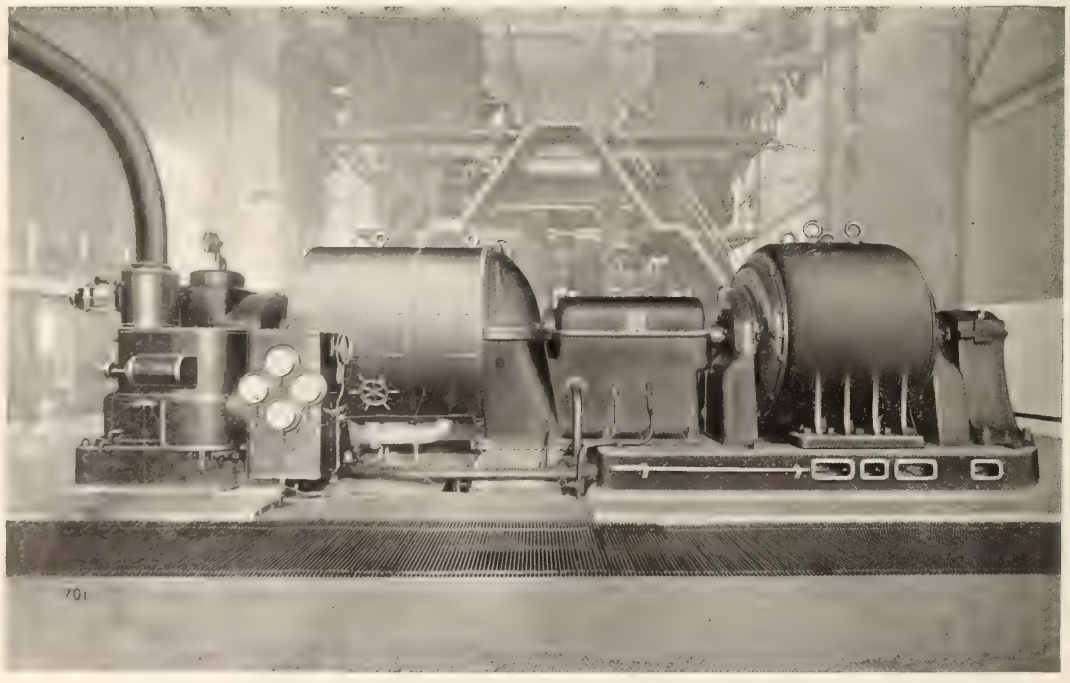
Steam Engines	Air Compressors	Pressure Filters
Gas Engines	Condensing Plants	Gravity Filters
Oil Engines	Centrifugal Pumps	Water Softening Plants
Diesel Engines	Boiler Feed Pumps	Refuse Destructors
Steam Turbines		

Enquiries Cheerfully Answered

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. **Montreal**



Belliss & Morcom 2000 K.W. Steam Turbine at Montreal Tramways Power Plant

BOILERS

FOR POWER AND HEATING PURPOSES

You will find Waterous Horizontal Return Tubular Boilers in the largest industrial and municipal power plants in the country. There are reasons for this. They are economical of fuel, carry a big reserve steam pressure for use in emergencies, can be used with hard and dirty water, and are readily cleaned and easily taken care of. They cost little new; their upkeep and maintenance expense is negligible.

Waterous Horizontal Return Tubular Boilers are built in all sizes from 40 inches by 10 feet to 72 inches by 18 feet. Most standard sizes are carried in stock. If we cannot supply at once from our yards we can turn out your order for you in quick time. On the next boiler you need let us quote you prices and delivery.

Boilers in Stock

1—54 x 14 Horizontal
2—60 x 14 "
4—66 x 16 "
14—72 x 18 "
2—40 H.P. Locomotive

Waterous

BRANTFORD, ONTARIO, CANADA

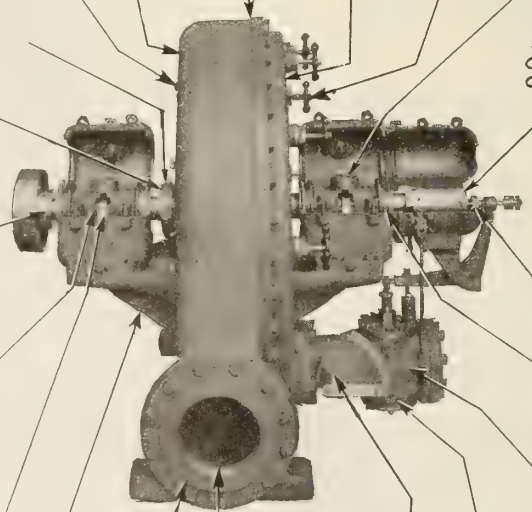
POWER HOUSE, August 5, 1920. Vol. XIII., No. 15. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

THE PRODUCT OF THIRTEEN YEARS REFINEMENT

Designed especially for driving fans, blowers, generators and pumps.
Made ranging in horsepower from one to five hundred.

Sturtevant
(REG U S PAT OFF.)
TRADE MARK

TYPE 6 TURBINE


SIMPLICITY IN ALIGNING ROTOR AND NOZZLES THROUGH THESE INSPECTION HOLES
ALL JOINTS AT POINTS OF CONTACT ARE SCRAPED AND GROUND WITHOUT THE USE OF GASKETS OR PACKING
INDIVIDUAL NOZZLE CONTROL VALVES FOR HIGH EFFICIENCY CORRESPONDING TO LOAD
EXHAUST CASING
STEAM CASING
FLOATING STUFFING BOX ACTS AS A RELIEF VALVE
SPHERICALLY SEATED SELF ALIGNING BEARINGS
NO OIL NOR COOLING WATER NEEDED ON METALIC PACKING
SIMPLE BUT POWERFUL GOVERNOR OF THE CENTRIFUGAL TYPE
TAPER FIT ON ROTOR AND COUPLING HUBS
BALL BEARING SELF ALIGNING FOR GOVERNOR SPINDLE
SPLIT BEARINGS ARE EASILY REMOVED WITHOUT DISTURBING SHAFT
THREADED THRUST COLLARS HOLD ROTOR IN PLACE
LARGE SOLID OIL RING FURNISHING AMPLE LUBRICATION
INDEPENDENT EMERGENCY TRIPPER, AN EXTRA SAFETY CONTROLLING DEVICE
EXHAUST CAN BE ON EITHER END
EMERGENCY BUTTERFLY VALVE
BEARING BRACKETS CAST INTEGRAL WITH CASING, ELIMINATING TROUBLES ARISING FROM UNEQUAL EXPANSION
RELIEF VALVE ON OPPOSITE END OF EXHAUST RELEASES STEAM IN CASE EXHAUST IS CLOSED
BALANCE CONTROLLING VALVE OPERATES VERTICALLY THEREBY ASSURING A PERFECT CONDITION OF ACTION

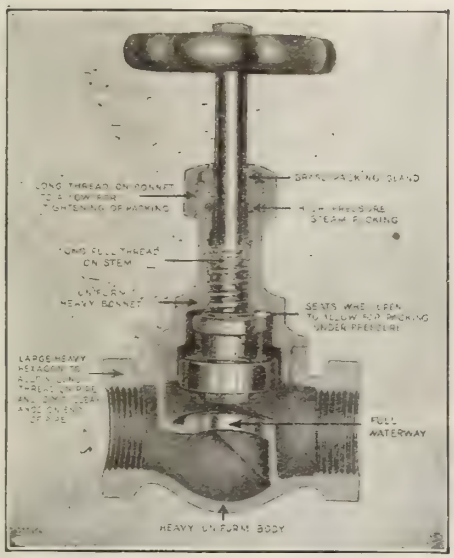
WRITE FOR 3-PART CATALOG 256U

Address:

B. F. STURTEVANT COMPANY OF CANADA, LIMITED

Head Office and Works: GALT, ONTARIO
Sales Offices: TORONTO and MONTREAL

The "EMCO" Composition Disc Valve


LONG THREAD ON BONNET
TO ENSURE TIGHTENING OF PACKING
BRASS PACKING GLAND
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHICH TEND TO YIELD AND INCREASE UNDER PRESSURE
LARGE HEAVY HEXAGON TO ASSIST IN SECURING TIGHT JOINT
FULL WATERWAY
HEAVY UNIFORM BODY

A-840

This design is approved and registered by inspectors of steam boilers for a pressure of 175 pounds, in the following provinces:—

Globe Valve A-840

British Columbia -	No. 2590
Alberta - - -	No. 1102
Saskatchewan - -	No. 2365
Ontario - - -	No. 1755

This "Emco" Composition Disc Valve with its nine pronounced features of superior construction has firmly established itself with engineers, because of the service it renders under constant working pressure.

The accompanying illustration enumerates its outstanding "good points," and coupled with these are reserve strength and durability.

"Emco" A-840 is made of the best bronze metal and each valve is hydraulic tested before leaving our factory.

When buying specify our lines. They are carried in stock by the larger and more progressive jobbers in Canada.

EMPIRE MANUFACTURING CO., LIMITED

LONDON and TORONTO, CANADA

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

Among babbitt mixtures "Copper Hardened" babbitt has been and is yet extensively used. There is something catchy in the word that appeals to the imagination as expressing a degree of hardness that would give relief from the most prolific cause of bearing troubles from squashing. It also has a tinny appearance and conforms to the usual physical tests for toughness and malleability and the price is much lower than Genuine, and every prospect pleasing.

This is a Quaternary formula, containing four ingredients, and its tin content usually ranges from 40 per cent. to 44 per cent., which approximates the quantity of tin used in Wiping Solder.

Now a solder must have a low fusibility and flow readily, so that it will follow quickly the soldering iron or copper as heat is applied. Wiping Solder not only has a low melting point, but possesses a peculiar characteristic of remaining in a pasty state throughout a range of temperature of 60° Fahrenheit before it solidifies, which accounts for the fact that it can be applied to a joint with a wiping cloth; hence its name, Wiping Solder.

"Copper Hardened" babbitt contains not exceeding two per cent. of copper, because it is not considered good practice to use copper to an extent exceeding 5 per cent. of the tin content of an alloy. However, this percentage of copper does not apply in every case, as in lead base metals, with low tin content or no tin, there should be no copper. Neither does a "Copper Hardened" babbitt possess any special antifrictional qualities nor the vaunted hardness, and when frictional heat causes it to fail, because of its low fusibility, the underlying reason is not suspected.

(Continued next month)

For copy of complete article:

"New Truths and Old Fallacies"

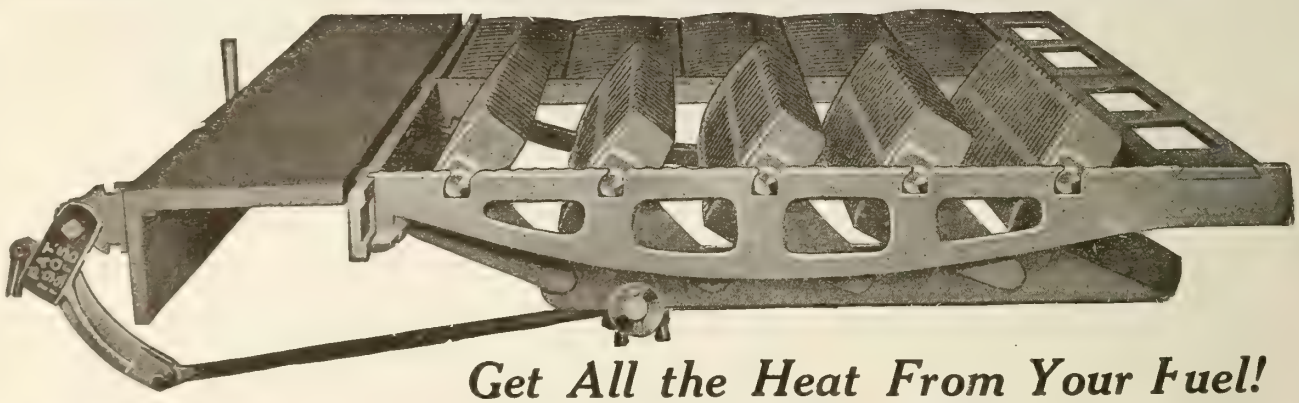
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:

Montreal: 225 St. Ambroise St.



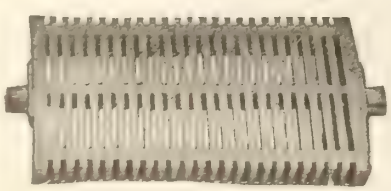
Cyclone Grates

Get All the Heat From Your Fuel!

All grades of hard coal, of soft coal and of screenings surrender every atom of heat if the combustion is perfect.

Cyclone Grates give perfect combustion because of their 60% air space and 90% air draught. Not a clinker can form nor live fuel get into the ash pit.

Put Cyclone Grates to the test. Write for full particulars of the grates and our 30 days free trial offer.



The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

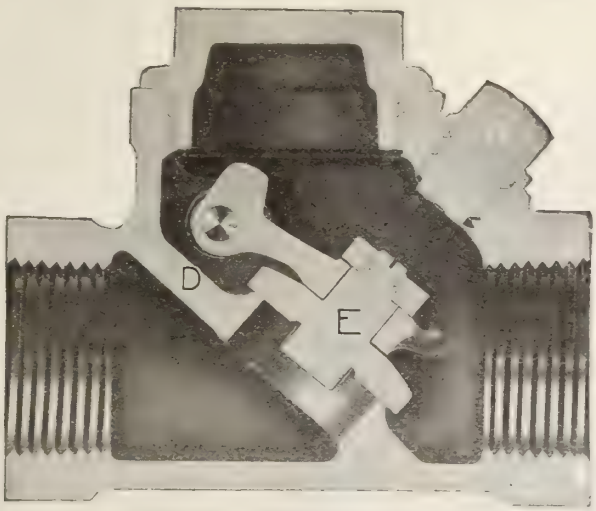
20 McGee Street **Phone G. 2660** **Toronto, Ontario**

AGENTS:

ST. JOHN, N.B.: F. W. Blizzard, 329 Charlotte St. MONTREAL: Mason Regulator and Engineering Co., Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. CALGARY: The Western Foundry and Metal Co. WINNIPEG: Vulcan Iron Works.

TRADE
PENBERTHY
MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY



SWING CHECK VALVE
(Sectional View)

MADE-IN-CANADA

Get Away From Check Valve Troubles

by installing

The Penberthy Double Plug Check Valve

on Your Steam Lines

GOVERNMENT APPROVED FOR 200 LBS. PRESSURE

The illustration above shows a sectional of this high-grade check valve. Note the liberal thickness of metal evenly distributed throughout. Makes the valve strong and durable. Will give long and efficient service.

The double plug construction makes it possible to take the valve apart if mounted on a wall pipe without disconnecting same from the pipe. The plugs also act as bearings for the disc carrier pin and in case of wear it is only necessary to renew either plugs or pin, making valve as good as new. The top plug "A" is also removable for insertion of screw-driver when regrinding disc and seat is necessary.

Stocked by leading jobbers everywhere.

Manufactured by

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

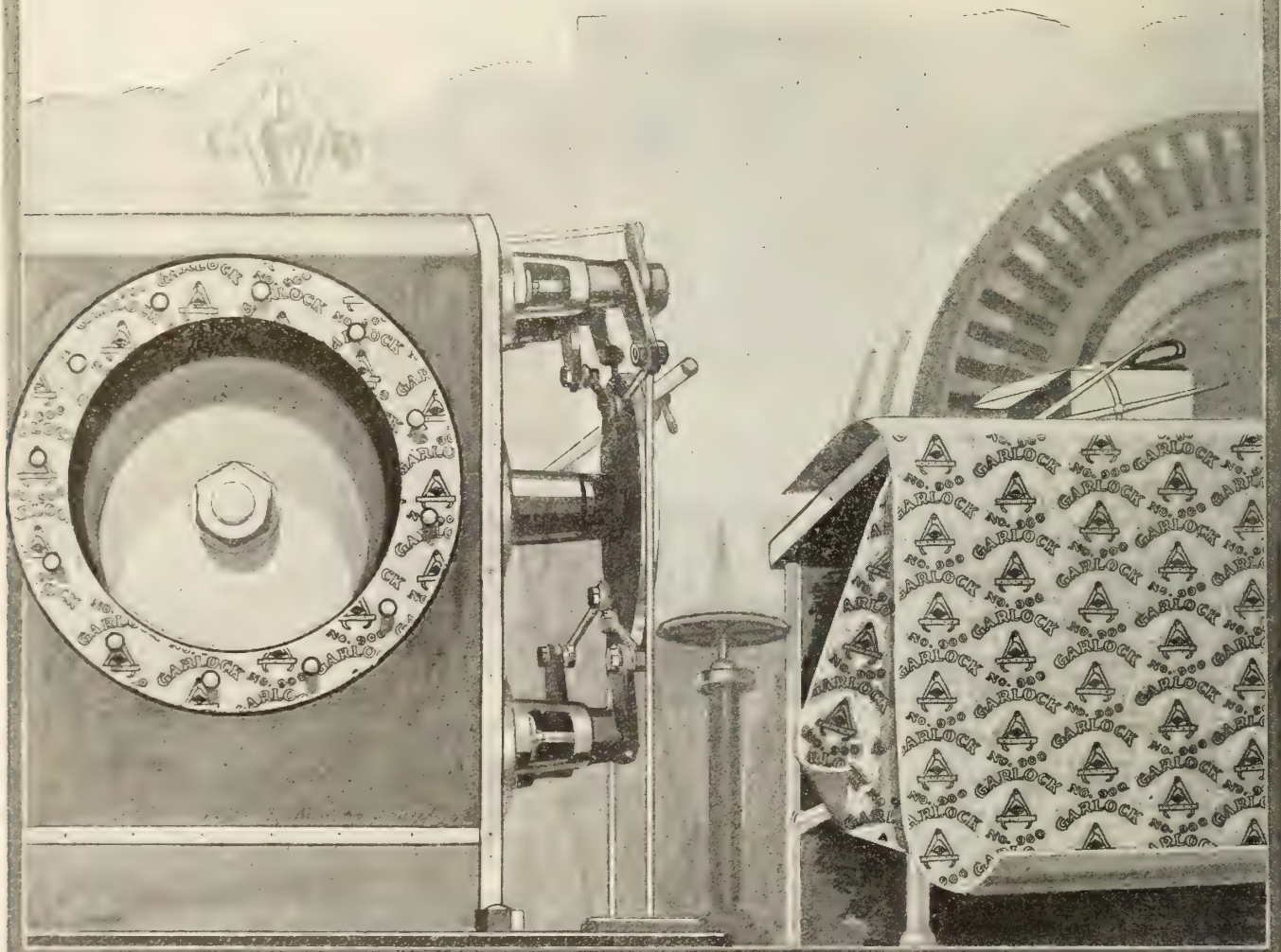
GARLOCK~No. 900
SHEET PACKING

The modern tendency in engineering is toward higher pressures and increased superheat. No. 900 sheet packing has met this continued advance and given entire satisfaction under severest conditions.

Due to its high tensile strength, No. 900 gives lasting service on joints that are frequently broken, and under strainer box covers or handhole plates that are often removed.

No. 900 is equally adapted to steam, air, ammonia, acids, etc.

The Garlock trade-mark is your guarantee of reliability.



GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

Branches:

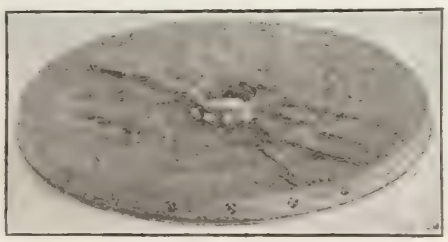
Montreal, Que.
Toronto, Ont.
Winnipeg, Man.
Calgary, Alta.
St. John, N.B.
Vancouver, B.C.

It Gets The Dirt

It's a BOWSER Oil Filter

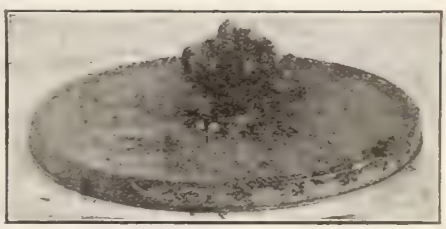
No. 1—Filter Disc and Cloth with dirt filtered from oil.

The pictures shown here are actual photographs of a filter disc and cloth taken from a Bowser Oil Filter in practical use.

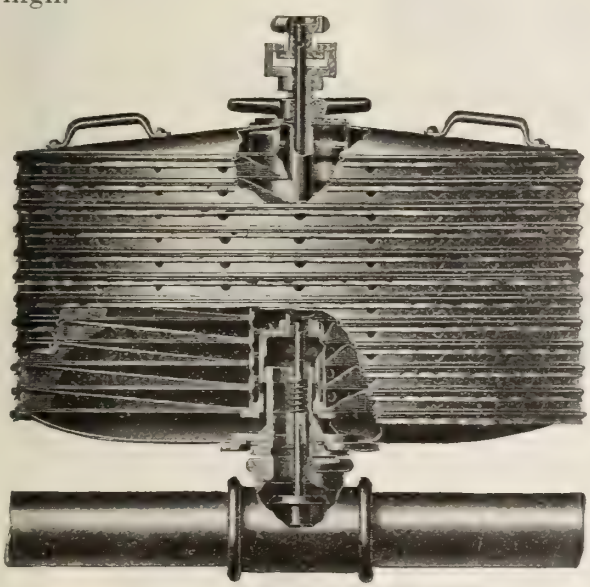


No. 2—Filter Disc with cloth removed

No. 1 shows filter disc with cloth lifted, ready for removal. No. 2 shows the same disc with cloth removed, and No. 3 shows the disc with the dirt scraped together in a pile. This pile of dirt is about 6 inches in diameter and from 2 to 3 inches high.



No. 3—Filter Disc with dirt scraped together



Sectional View of Filter Section Assembled

There are twelve of these filter discs and cloths in a Bowser filter section—each as effective as the one you see pictured. As many complete Filter Sections as needed are furnished in the Bowser System. You may judge for yourself as to the value of such equipment.

Bowser Systems are applicable to any size and type of power producing and transmitting machinery.

We will be glad to send literature and explain to you how the Bowser principle of Oil Filtration can be applied to your Power Plant.

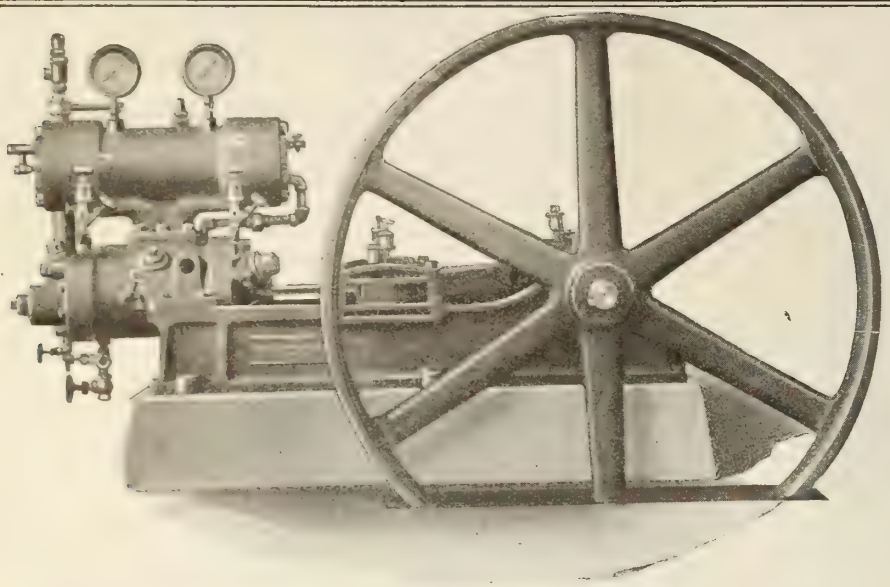
S. F. BOWSER & COMPANY, INC.

66 - 68 Fraser Ave., Toronto, Canada

Branch Offices in Principal U. S. Cities

LONDON	HAVANA	PARIS	SYDNEY
32 Victoria St., S.W.I.	Lonja del Comercio 427	5 Rue Denis-Poisson	6 Castlereagh Street

NORWALK
AIR & GAS · COMPRESSORS



A Norwalk 150-lb. Air Compressor

Protection

Now that materials of high quality are hard to get, and manufacturers are approached with substitutes, it is doubly worth while when buying an air or gas compressor to have the protection of the Norwalk name. Throughout all manufacturing difficulties Norwalk quality has not been lowered in the slightest degree—nor will it ever be.

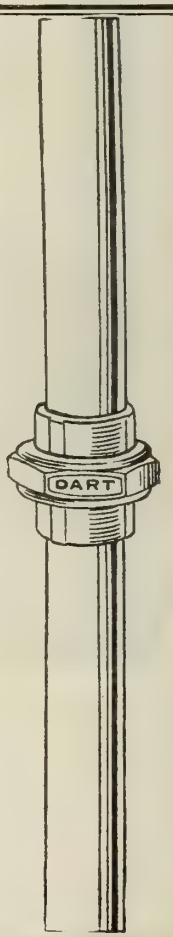
Write for Bulletins on Norwalk Compressors for air, oxygen, hydrogen, acetylene or carbonic acid gas—according to your need.

The Norwalk Iron Works Company
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

A. S. Leitch Company, Toronto
Canadian Sales Representative

ANY·CAPACITY ANY·PRESSURE

"Dart" Union
PIPE COUPLINGS



Manufactured by Dart Union Co., Limited, Toronto, Ont.

POWER APPARATUS

Of Established Reputation and Dependability

Weston Indicating Instruments

SANGAMO Integrating Instruments

ESTERLINE Graphic Instruments

ONDIT Oil Switches and Circuit Breakers

All above are standard equipment on our Power Switchboards.

CANADIAN CROCKER-WHEELER Induction Motors and Transformers A. C. Generators, D. C. Motors and Generators

CUTLER-HAMMER Control Apparatus, Magnetic Clutches, Lifting Magnets

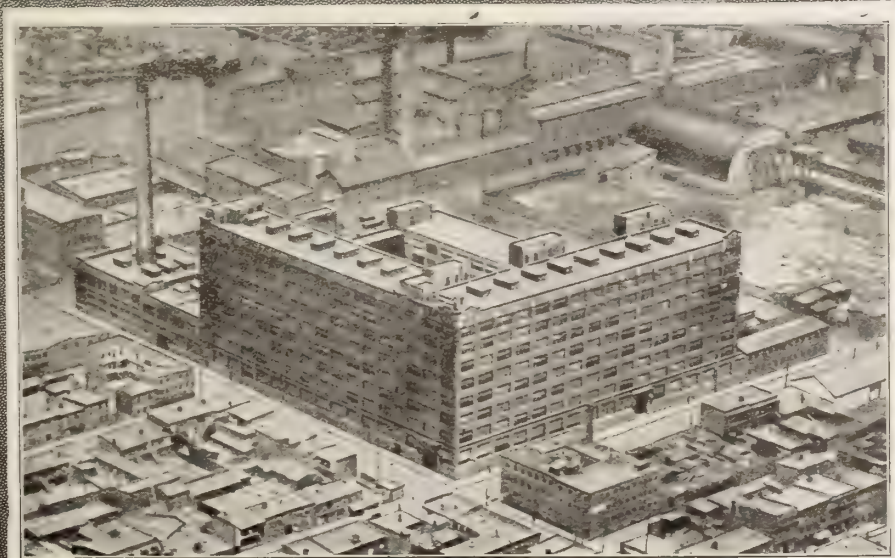
Wagner, Quality Single Phase Motors

All distributed by

Northern Electric Company LIMITED

MONTREAL

HALIFAX QUEBEC OTTAWA TORONTO LONDON HAMILTON WINDSOR WINNIPEG REGINA CALGARY EDMONTON VANCOUVER



LINDE

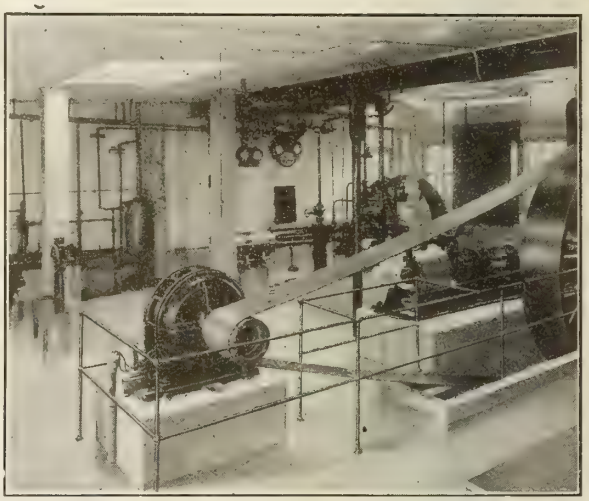
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

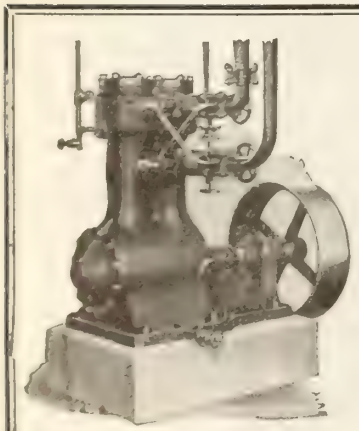


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

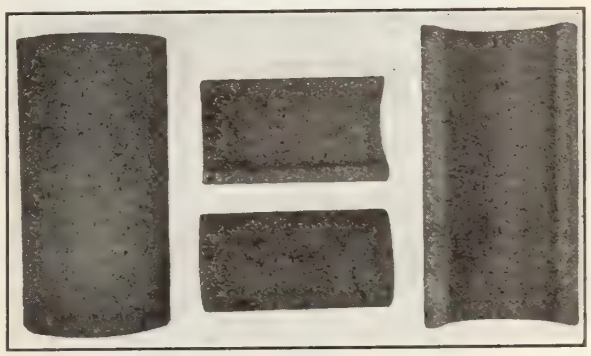
Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Does a Service Record of Twenty-Two Years Mean Anything to You?



Specimens of Nonpareil Cork Covering after serving for twenty-two years on a brine line in the plant of the Hawley & Hoop Confectionery Company, New York City.

What kind of "verdict" would you pass on a covering that withstood brine line service for twenty-two years and was still in good condition when removed from the pipes? Would not such a record impress you as being an indication of unusual merit?

The photograph above shows four half-sections of Nonpareil Cork Covering, installed on brine lines in the plant of the Hawley & Hoop Confectionery Company, New York City, in 1897. Twenty-two years later—in 1919, to be exact—when this covering was removed, it was in excellent condition and equal to the task of saving refrigeration for several years to come.

Now the Nonpareil Cork Covering of to-day affords a distinct advantage over that which was made in 1897. In those days, Nonpareil Cork was protected from moisture by wrapping it with canvas and applying several coats of lead-and-oil paint—a job that could be performed only after the covering had been erected. But the improved Nonpareil Cork Covering—the covering you get to-day—is thoroughly waterproofed at the factory. It is coated inside and out with waterproof mineral rubber—a material that repels moisture indefinitely.

"Nonpareil" is the short way of saying, "A covering for brine and ammonia lines that insures better service for a greater number of years."

Send for the 64-page, illustrated book, "Nonpareil Cork Covering for Cold Pipes." The facts contained in it are specific, interesting and valuable—and there is no charge for it whatever.

Armstrong Cork & Insulation Company

504 McGill Building, Montreal, Quebec, Canada

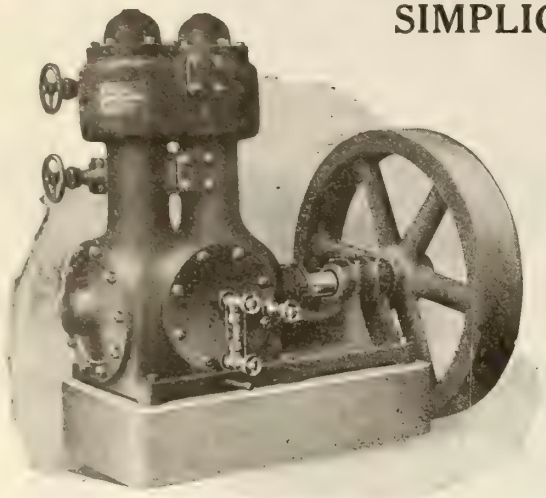
Also manufacturers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings; Nonpareil Cork Machinery Isolation for deadening the noise of machines, and Circle A Cork Brick for cold storage room floors

Nonpareil Cork Covering

For Brine and Ammonia Lines

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permits them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

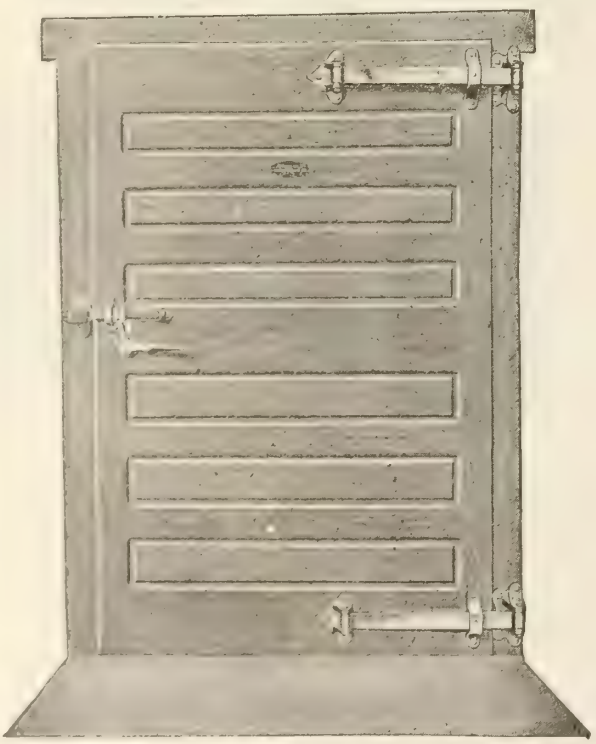
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

Average Product With Jeffrey Crusher Set For Minimum Opening

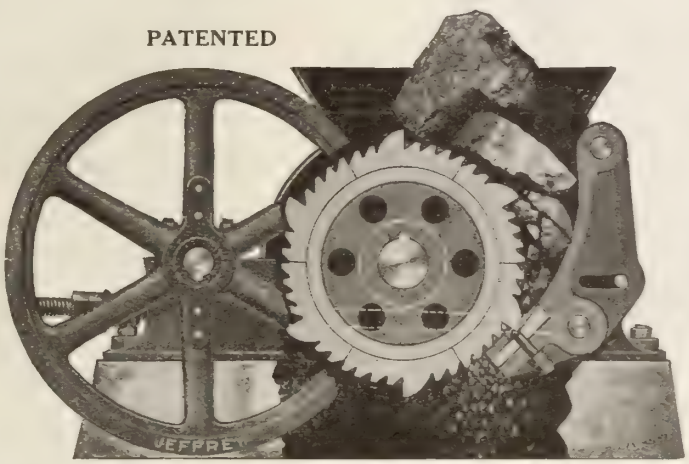
Note the Uniformity of Product and the Large Percentage Between 1" and 1¼" size

The Jeffrey Single Roll Crusher

Is Readily Adjustable to a Wide Range of Sizings — Without Change of Equipment

Adapted to all makes of stokers in Power Plant Service, or on Locomotives.

PATENTED



The Jeffrey Crusher is designed for great strength and hard service.

Renewable working parts are easily accessible.

A full conception of the various sized productions obtainable with the Jeffrey Crusher is shown by the illustration at the top and bottom of page.

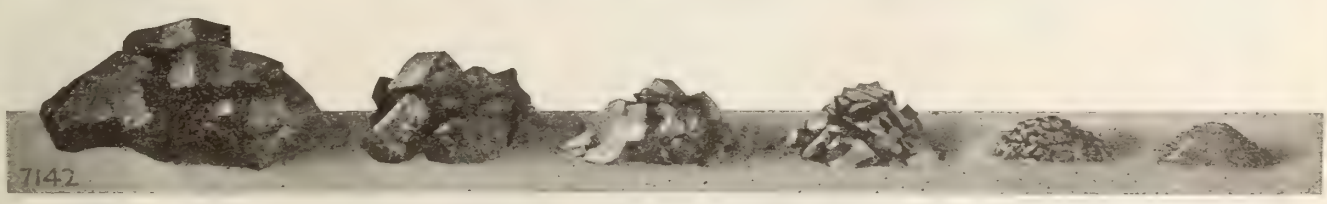
Shipment From Stock

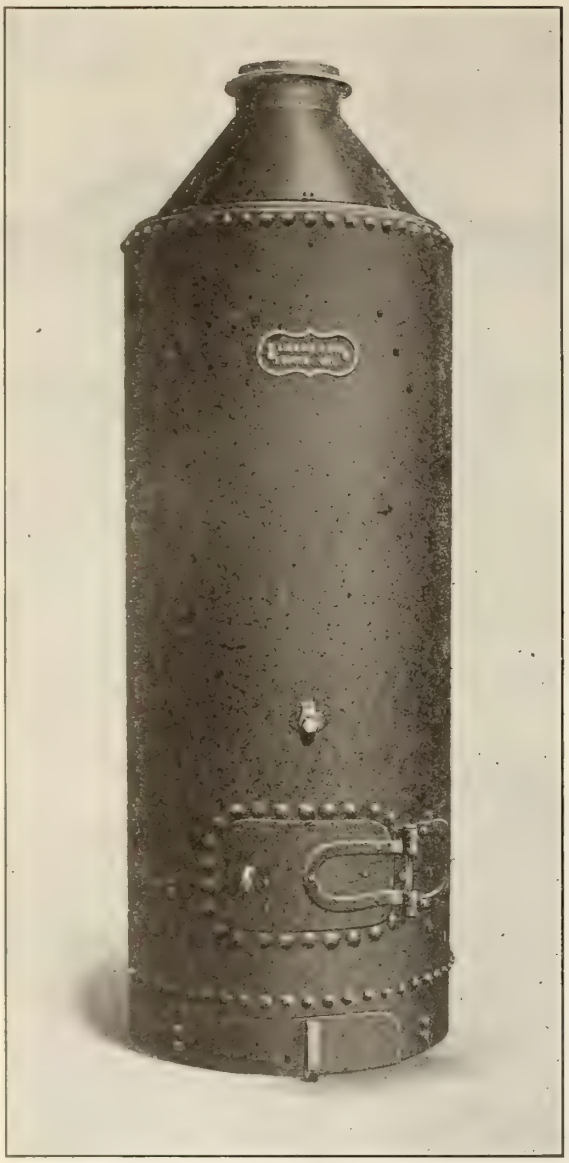
Bulletin No. 144 gives complete information why the Jeffrey Crusher safeguards your coal supply and eliminates the worry of buying properly sized coal. Send for it.

Over 1¼" Through 1½*	Over 1" Through 1¼"	Over ¾" Through 1	Over ½" Through ¾"	Over ¼" Through ½"	Through ¼"

Average Product With Jeffrey Crusher Set For Maximum Opening

Note the Small Percentage of Fines





UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube (Patented)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

E. LEONARD & SONS, Ltd.

Head Office and Works:
LONDON, - CANADA

Established 1834

LEONARD

The De Laval Oil Purifier

took this dirt out of used lubricating oil AFTER it had passed through a 'Filtering' system.

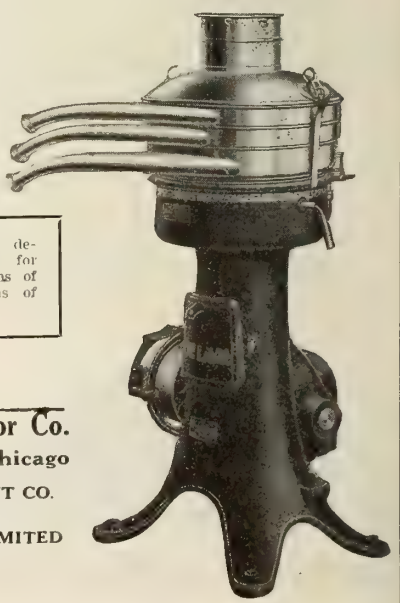
Some very convincing demonstrations of the superiority of the De Laval Method of Oil Purification over other methods have been reported by many large manufacturing concerns where the De Laval Method took out a large quantity of carbon, metallic particles, grit, dirt and water from used lubricating oil—**after** it had been passed through extensive settling and filtering systems.

The De Laval Method is simple, continuous and economical—removes all solid impurities and water, and restores the oil to its original usefulness.

The Oil Purifier is used for reclaiming and purifying lubricating oil, cutting oil from chips, cutting oil from soda-wash, hardening room drawing and quenching oils, fuel oils, etc.

Write to nearest De Laval office on your business stationery for Oil Purification Bulletin No. 100 and reports on the De Laval Method.

A complete experimental department is maintained for working out the problems of our customers by means of centrifugal processes.



The De Laval Separator Co.
New York Chicago

TURBINE EQUIPMENT CO.
Toronto, Ont.

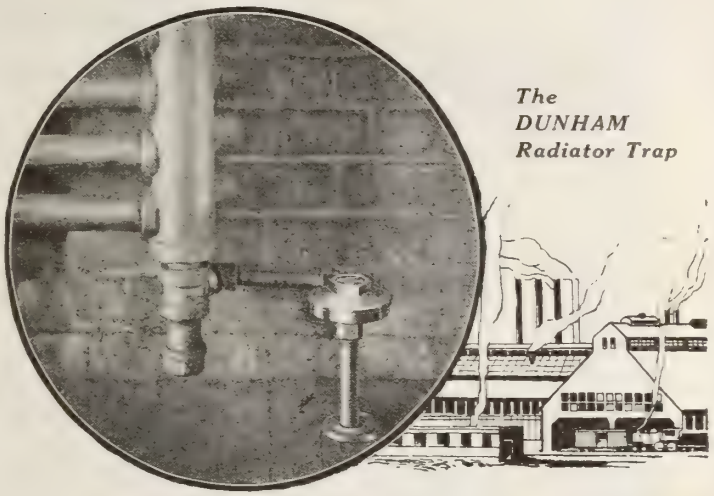
THE DE LAVAL CO., LIMITED
Peterboro, Ont.

The Smallest Part of a Steam Heating System is the Most Important

Made in Canada

You can see a leaky steam valve, but you cannot see steam leaking through an inefficient radiator trap back into the system. Dunham Radiator Traps cannot leak steam, and therefore conserve steam and fuel. They make jet water unnecessary; that proves they do not leak steam. Besides saving fuel, they put pep into lazy radiators by keeping them hot **all over.**

For proof, ask for our new Bulletin 110, "The Dunham Vacuum Heating System." Ask us to send one to the boss.



The DUNHAM Radiator Trap

C. A. DUNHAM CO., LTD.
TORONTO, CANADA

Halifax Vancouver Winnipeg Ottawa Montreal Calgary
London—64 Regent House, Regent Street, W.1

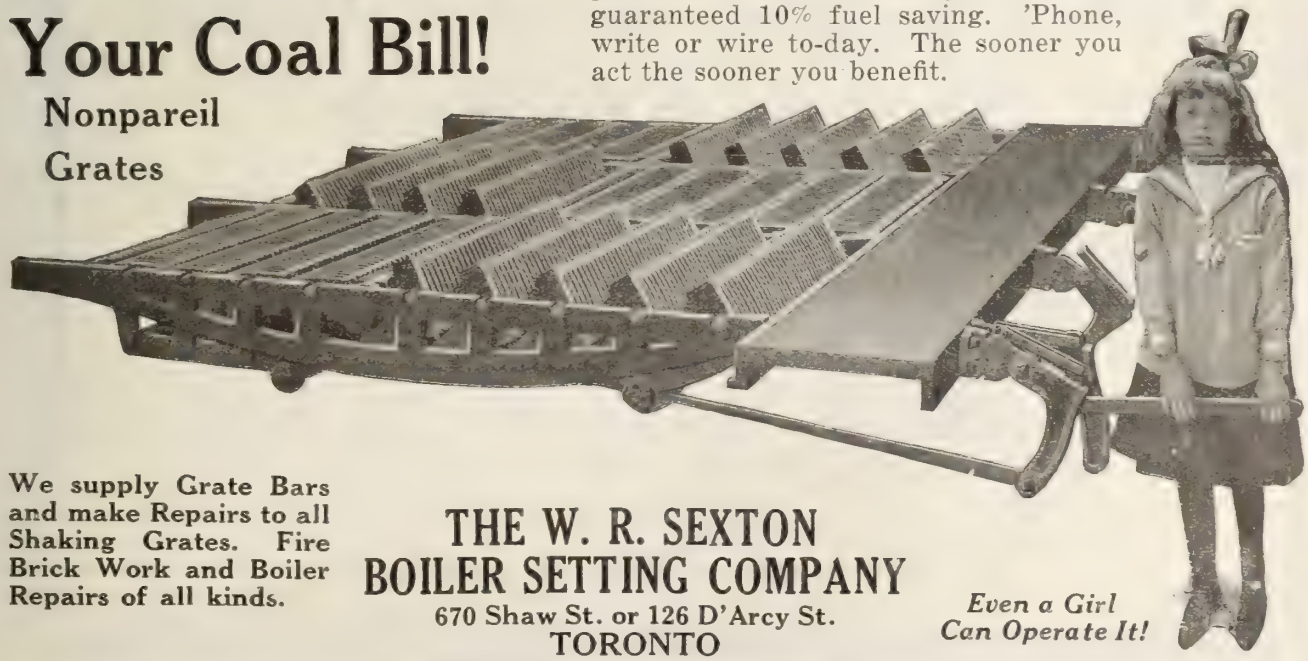
The DUNHAM HEATING SERVICE

A Guaranteed 10% Saving on Your Coal Bill!

Everyone who has to foot a coal bill deplores its size. Though we can do little to reduce the **price** of fuel, we **can** reduce the **quantity** your boilers consume. At least 10% too!

Nonpareil Shaking and Dumping Grates will do this for you. Get in touch with us. Learn the full particulars of our 30 days free trial offer and guaranteed 10% fuel saving. 'Phone, write or wire to-day. The sooner you act the sooner you benefit.

Nonpareil Grates

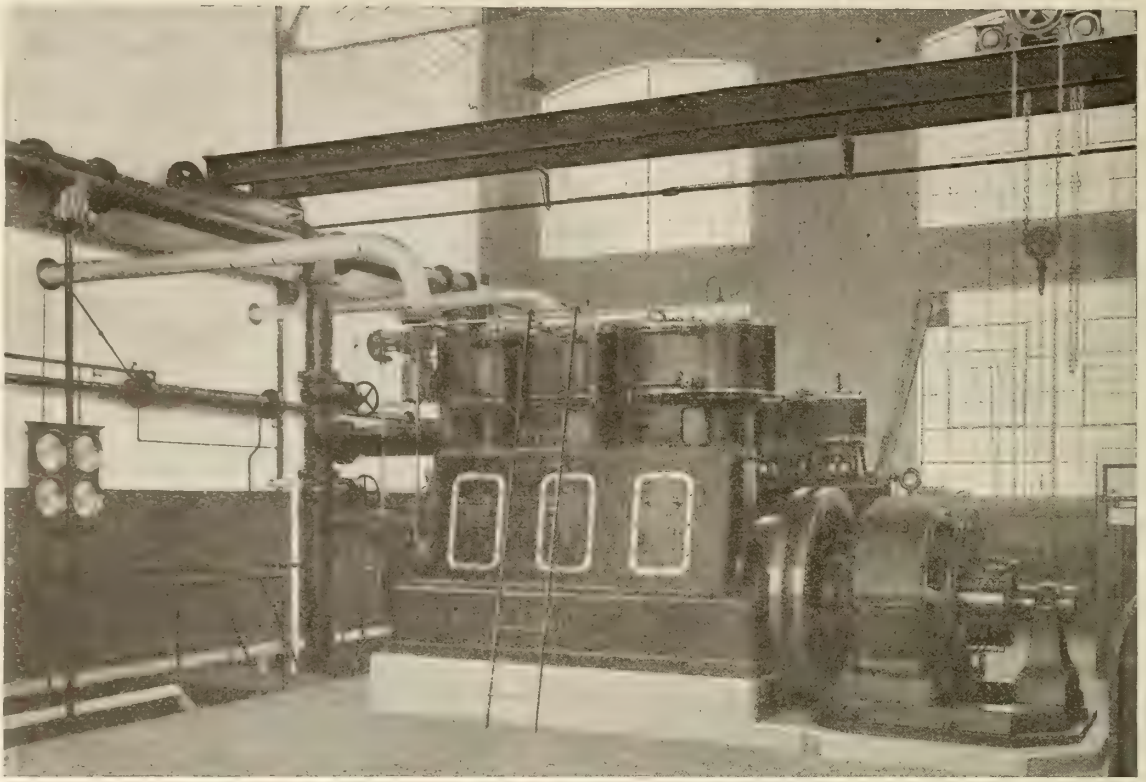


We supply Grate Bars and make Repairs to all Shaking Grates. Fire Brick Work and Boiler Repairs of all kinds.

THE W. R. SEXTON BOILER SETTING COMPANY
670 Shaw St. or 126 D'Arcy St.
TORONTO
Established 1900 Phone, Beach 1213

Even a Girl Can Operate It!

DEPENDABLE POWER EQUIPMENT



Vertical Enclosed Forced Lubrication
Steam Engines

Single, Twin, Compound, Triple Expansion and Three Cylinder Compound

The G. & McC. Co. Vertical Enclosed Forced Lubrication Steam Engine is designed to give long and satisfactory service under modern, high-speed conditions, to require the least possible attention, give perfect regulation and have all parts simple and easy of access.

To make a Steam Engine, durable, quiet running, dust and dirt proof, simple in design, which will give maximum power in the minimum of space was our desire. **This G. & McC. Co. Engine is a distinctly successful Made-in-Canada model.**

Our catalogue explains the engine in detail May we send you a copy?

The Goldie & McCulloch Co., Limited

Head Office and Works : GALT, Ontario, Can.

Toronto Office: Suite 1101-2, Traders Bank Bldg.

Western Branch: 248 McDermott Ave., Winnipeg, Man.

British Columbia Agents: Robt. Hamilton & Co., Vancouver, B.C.

Quebec Agents: Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Series of Articles on Power Plant Management

This Article Deals With the Combustion of Fuel Oil, and Its Comparative Merits With Those of Coal—The Selection of Burners and Features of Operation Are Dealt With

By ROBERT JUNE

THE shortage of coal and the high prices obtaining have led to the adoption of oil as a fuel for many boiler furnaces, and to the serious consideration of the desirability of its use in many other plants. In dealing with the combustion of fuel oil, it may be well at the outset to discuss the question—when is it advisable to substitute oil for coal under boilers?

Oil Versus Coal

Kent, in his pocket book, gives the following table, based on oil of 19,999 B.t.u., weighing 7.757 pounds per gallon, with 42 gallons, or 315 pounds per barrel:

Coal B.t.u. perlb.	1 lb. oil = .. lbs coal	1 bbl. oil = .. lbs. coal	1 ton coal = ..bbls. oil
10,000	1.9	598	3.34
11,000	1.73	544	3.68
12,000	1.58	499	4.01
13,000	1.46	460	4.34
14,000	1.36	427	4.68
15,000	1.27	399	5.01

It is approximately true, therefore, that one lb. of oil is equivalent to 1½ lbs. of coal, and that four barrels of oil are equivalent to one short ton of coal. On the above basis, therefore, oil at $2.00 per barrel, is equivalent to coal at $8.00 per ton.

There are other factors than a straight comparison of initial costs, to be taken into consideration, however, such as availability of both fuels, increased boiler efficiency, and comparative costs of labor and storage.

Advantages and Disadvantages of Fuel Oil

The advantages of liquid fuel may be summarized as follows

1. Reduction in number of firemen, coal passers, helpers, etc., by about four-fifths.

2. Fires readily lighted, easily regulated to suit plant demand, and can be promptly extinguished in case of emergency, as with water dropping out of sight in gauge glass. Boiler can be brought to 150 lbs. steam pressure with cold water in half an hour.

3. Higher efficiencies and capacities. Combustion is nearly perfect, as excess air is reduced to a minimum; furnace temperature may be kept practically constant, as furnace doors need not be opened for cleaning or working of fires.

4. Oil storage occupies less space than coal storage. Furthermore, this storage may be at a greater distance from the boiler.

5. Oil in storage does not decrease in heating value as does coal, nor is there the same danger of spontaneous combustion.

6. There is little refuse with oil, and this is easily disposed of.

Oil firing assures cleanliness and freedom from dust and ashes in boiler room, with constant saving in the wear and tear on equipment. It minimizes annoyance and damage to surrounding property.

7. There is no loss by banking.

8. Smoke can be practically eliminated.

9. Lower temperatures in boiler room prevail.

10. As there is less excess air, the area of the stack need only be three-fifths to two-thirds that required for coal. Hence, if a plant has insufficient draft with coal, a change to oil may make additional stack capacity unnecessary.

11. There is better diffusion of heat in an oil burning furnace. Hence, less burning out of boiler tubes. As firing tools are not required, there is no damage to furnace linings from this source.

The disadvantages of fuel oil are:

1. Oil must have flash point of 140 deg. F., or more, in order to minimize the danger of explosions. On account of fire risks, use of oil is prohibited by some city ordinances.

2. City ordinances may impose burdensome conditions relative to location and isolation of storage tanks, as for instance, that they be located underground and at least 30 feet from the nearest building.

3. Boiler upkeep and furnace maintenance will be higher with oil than with coal unless boilers and furnaces are especially constructed for use with liquid fuel. When feed water contains scale-forming constituents in any large quantity, cost of repairs is apt to be considerably increased owing to the intense temperature developed at the furnace.

4. On account of offensive odors, combustion of oil is prohibited by some cities. The burners also make a roaring noise objectionable in some districts.

5. There is danger of waste due to improper operation of burner and also the tendency of oil to creep by valves, and leak.

Comparative Efficiency—Oil and Coal

Coal burning boilers operating at 80 per cent. efficiency have at times been reported, but the cases are so exceptional as to exclude them from consideration in a practical discussion. Seventy per cent. to 77 per cent. efficiency undoubtedly represents the best station practice for coal burning boilers, and it is reasonably certain that nine coal burning boilers out of 10 operate at efficiencies less than 70 per cent.

With fuel oil, efficiencies as high as 82 and 83 per cent. have at times been obtained, and it is not at all unusual to obtain efficiencies of 78 per cent. With reasonable care and attention, any oil burning furnace should be operated day after day at 75 per cent. efficiency. Generally speaking, therefore, there is a clear gain of 5 to 10 per cent. in boiler efficiency through the use of fuel oil.

Conditions Surrounding Combustion of Fuel Oil.

The following conditions must be complied with in the successful combustion of fuel oil:

1. The oil must be thoroughly atomized. This is to be secured by proper selection of burner.

2. After atomization has taken place, the oil must be brought into intimate mixture with exactly the right quantity of air for its complete combustion. This condition is met by introducing air through the checker work under the burners and by controlling the quantity so introduced so that it varies with the amount of oil which is being fed.

3. Combustion must take place in the presence of refractory materials which will radiate the heat. Particular care must be taken to design a furnace which

will stand up under the high temperatures developed.

4. Combustion must be complete before gases reach heating surfaces of boiler. Otherwise the process of combustion will be stopped, possibly to be removed after the oil and air reaches the stack. This requirement is met by providing very large combustion spaces with a gas travel of sufficient length.

5. Overheating and blistering of boiler will result if the heat is localized on any portions. This condition is to be avoided by proper selection of burners and by their suitable location.

Selection of Burner Types.

In this country the burners in use are two general types steam and mechanical atomizers. In Europe, a third type, known as the vapor or carburetor, is used.

As between the steam atomizer and the mechanical atomizer, engineers of stationary boiler plants have been almost unanimous in their choice of steam atomizers; whereas marine engineers have come to depend chiefly on mechanical atomizers. A good example of the mechanical spray burner is the Korting.

The steam atomizers are divided into two groups, of which the Peabody and Warren are typical outside mixers; the Hammel, Kirkwood, Branch, and Williams, of the inside mixers. As far as results go, there is not a great deal to choose between mechanical and steam atomizers. Mechanical is preferable where feed water is difficult or expensive to obtain. The steam atomizer possesses the advantage of being more flexible, having greater range of capacity and of costing less to install, notwithstanding that it requires two lines of pipe—oil and steam—whereas the mechanical requires only the oil line.

The steam atomizer, moreover, is more readily installed or taken out of a coal burning furnace. It possesses the further advantage of requiring a lower oil pressure than mechanical burners. The steam required for atomization is from two to four per cent. of the output of the boilers.

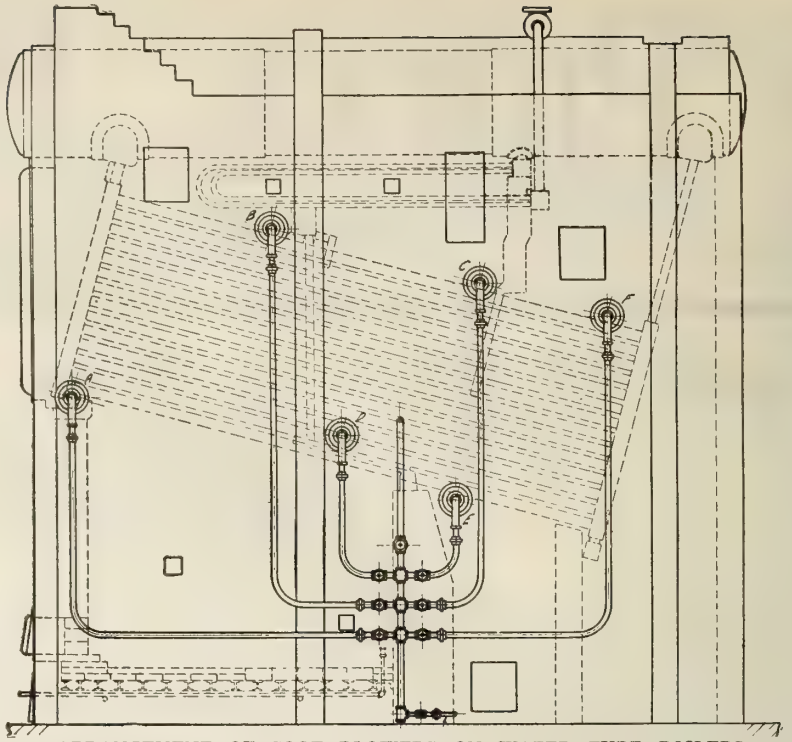
Notes on Operation.

Oil Pressure: With steam atomizers, oil pressures ranging from 25 to 50 lbs. are adequate. The mechanical burner, on the other hand, requires pressures ranging from 50 to 250 lbs.-200 lbs. being a favorite pressure. With all oil burners, a steady pressure is essential. With mechanical burners, it is so necessary that large air chambers are required on the oil line if pressure is obtained by means of duplex reciprocating pumps.

To overcome the use of air chambers, rotary and screw pumps are being used in the navy, these pumps giving a steady pressure of oil with little or no air cushioning.

Heating of Oil

The reason for heating oil is to increase its viscosity, and not for any thermal advantage. Steam atomizers will handle oil of greater viscosity than the mechanical atomizer. Hence, exhaust steam passed through coils will answer for this purpose. By this means the oil may be heated to 100 or 125 deg. F., temperatures which are usually satisfactory.



ARRANGEMENT OF SOOT BLOWERS ON WATER TUBE BOILERS.

With the mechanical burner, however, it is necessary that the viscosity of oil be reduced very considerably. Hence, the oil must be heated to a temperature of 120 to 280 deg. F. This requires a special oil heater.

Air Regulation

With oil, a very bright and intense white fire usually indicates that an excess of air is being used. It is best not to attempt to judge the fire by its color, but to regulate the air until a light brown haze appears at the top of the stack. It should be remembered that a clear stack gives no indication of excess air. It should further be remembered that the light brown haze at the top of the stack just referred to, can be produced by one or two burners, while all the other burners are using an excess amount of air. Probably the most satisfactory method to employ is that of automatic regulation of the air supply for the individual boiler. There are one or two very excellent systems now on the market for this purpose.

Lighting Fires.

In lighting fires, the first operation is to place a lighted torch directly under the burner pit, then turn on oil. The spray must never be started before lighting the torch. If this is done, the oil will be injected into a dark furnace and an explosive mixture may be formed which may cause serious damage if ignited.

Oil Feeding Systems.

In the usual feeding system, steam driven pumps installed in duplicate, draw the fuel from the supply tank and deliver it under pressure to the burner. The piping is by-passed so that either pump can be shut down and repairs made without interfering with the operation of boiler.

It is usual to use the exhaust steam from the pumps for the purpose of heating the oil before it is supplied to the burners. Care should be taken, however, that the temperature of the oil is not raised above the flash point or carbon deposits are very apt to form in the supply line. The suction line between the storage tank and oil pressure pump should be provided with a strainer to prevent clogging of burner with foreign matter. In order to prevent excessive pressures, a relief valve, set at a definite maximum oil pressure, should be placed between the pumps and the burners.

If desired, an oil meter can be installed for the purpose of taking the consumption of each individual boiler. As a matter of precaution, all oil piping should be installed in such manner that it can be drained back to the storage tank in case of necessity. In order to insure continuous operation under all conditions, strainers, heaters, meters, piping, etc., are installed in duplicate in many plants. The supply of steam is regulated by the pressure in a separate main, common to all burners, the pressure in the main bearing a certain, predetermined relation to the oil in the main. In most installations, the supply of steam and oil at the burner is regulated by hand, to meet the requirements of the individual burner.

Low pressure systems are ordinarily operated under standpipe pressures. The oil is drawn from the storage tank, usually located underground, by the steam pump, which runs continuously,

and always keeps the standpipe well supplied with oil. The oil flows from the standpipe under whatever head may be desired. When the boiler is not in operation the standpipe is drained back to the storage tank. This system is very simple and is an inexpensive installation.

Next month we will discuss furnaces for burning fuel oil, soot deposits with oil, and specifications for the purchase.

Furnaces for Burning Fuel Oil

The design of the oil burning furnace is more important than the type of burner. Incandescent brick work around the flame is desirable, but where this is impossible, the next best arrangement is that of using a flat, broad flame, burning close to a white hot checkerwork floor through which the air is continuously admitted. The path of flame in t furnace must be such as to insure a uniform distribution of heat over heating surfaces of the boiler without any direct flame impingement.

Under no circumstances should the flame extend into the tube. The best arrangement is one where the furnace is located under the first pass of the boiler. With this arrangement the heating surfaces of the boiler readily absorb radiant energy from the incandescent fire brick. Arches, target walls, and similar constructions are not satisfactory and may prove quite dangerous on account of localization of heat. This localization may cause the burning out of tubes, or bagging of shell, to say nothing of limiting the capacity of the boiler.

Soot Deposits in Oil Fired Boilers

The soot deposit resulting from the combustion of oil is in the nature of a pure carbon mixed with a slight amount of oil. It is somewhat fluffy in appearance and adheres to the tubes, but is easily cleaned and removed from the boiler under the operation of a steam jet. It is entirely different in character from the soot resulting from the combustion of coal on account of the absence of ash, etc., and the presence of greater or less quantities of unburned oil. which, going through the boiler, tend to deposit on the tubes in combination with the soot. If this formation is not removed at regular frequent intervals, it soon crystallizes or carbonizes on the tube and must be scraped off with rods or bars.

Soot deposits from oil fired furnaces have a much greater insulating effect than those occurring with coal fired furnaces. There are two reasons for this; first of all, the deposit is in the nature of a pure carbon which has greater insulating properties than various ash constituents found in soot from coal; second, the deposit being of a somewhat fluffy adhesive nature, is usually found to envelope the entire tube as compared with coal deposit, which usually consists of soot, dust and ashes building on top of the tube and leaving the underside more or less clean.

For some time after oil came into use for boiler furnaces, the impression prevailed that oil fired boilers did not require as frequent or as thorough cleaning as coal fired. The efficiencies of oil fired boilers were generally higher than those obtained where coal was used as fuel, due to more perfect combustion with a smaller quantity of excess air, and this improvement was for some time accepted on its face value as the best obtainable. With the increasing use of oil as fuel in the past few years, it was inevitable that detailed tests should be inaugurated of the performance of oil fired boilers with and without mechanical soot blowers.

These tests developed the fact that mechanical soot blowers are absolutely essential to the development of the highest efficiencies of oil fired boilers.

As an example attention is called to the results of the following test by the Pacific Gas and Electric Company:

Test Data Before Using Soot Blower

Time	Temperature		Load
A.M.	Stack	Sup. Steam	Meter
10.15	550	500	4.2
10.30	550	502	4.0
10.45	555	498	4.0
11.00	557	498	4.1

Test Data After Using Soot Blower

Time	Temperature		Load
A.M.	Stack	Sup. Steam	Meter
2.30	485	495	4.2
2.45	485	506	4.0
3.00	485	504	4.3
3.15	485	505	4.2

Test Results	Before	After
Load Meter	4.075	4.175
Steam Pressure Gauge ...	199.5 lbs.	200.75 lbs.
Per Cent. Rating	101.88%	104.38%
Superheated Steam Temp.	495.5 F.	502.5 F.
Stack Temperature	553. F.	483.75 F.

These results show that the soot blowing caused the temperature of the stack gases to fall from 553 degrees F. to 483.75 degrees F., making a difference of 69.25 degrees F. or 13.05 per cent.

"Also the temperature of the superheated steam was raised from 499.5 degrees F. to 502.5 degrees F., a raise of 3 degrees of 0.6 per cent.

"The direct effect of the use of Diamond Soot Blowers is saving in fuel of 3.9 per cent."

The Texas Company, Port Arthur. Texas, found a saving of 5.5 per cent. fuel by the use of mechanical soot blowers and as a result ordered equipment for thirty oil fired boilers. As this company is in the oil producing business, its action is particularly illuminating.

These tests were followed by others at some of the large Western central stations. On one of these, the boiler, a large Stirling, was taken off the lines and the tubes, superheater, etc., washed clean. The boiler was then fired up and an evaporation rate of 37,000 pounds of water per hour and 14 per cent C02 was maintained. At the end of twenty-four hours, the soot blowers were operated and were used for twenty-four periods for the remainder of the test, with the equipment. During these tests, readings were taken at fifteen minute intervals, of the water-rate. C02, draft, oil, and superheat. When using the blowers the flue temperature dropped to 525 degrees and rose to 540 degrees in about fifteen minutes. It ranged around 540 degrees for about sixteen hours and then gradually crept up to 590 degrees at the blowing period, when it again dropped to 525 degrees. This was the regular daily performance throughout the test while using the blowers.

At the end of a seven-day period the boiler was given a final blowing and thereafter operated under the usual plant conditions; i.e., without any cleaning at all. At the end of the first twenty-four hours' run the temperature had risen to 590 degrees, at the end of the week it had risen to 680 degrees, and at the end of ten days had risen to 720 degrees, at which point it seemed to hold. But they were not able to maintain the evaporation rate, which dropped to 34,000 pounds per hour. The saving effected by soot blowers amounted to 6 per cent.

Despite the war emergency, with the constant urge to speed, rather than to thoroughness, the Emergency Fleet Corporation made some very detailed tests of Diamond Soot Blowers before adopting them. These tests were conducted at Burlington, Iowa, under the direction of the Bureau of Mines.

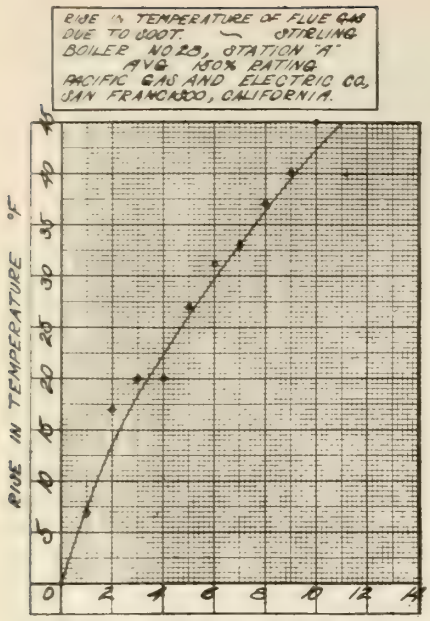
The boiler selected was the Foster Marine Water Tube, and was one of a large number then built by the Murray Iron Works of Burlington. Iowa, for the Power Specialty Company, of New York, for delivery to the Corporation. The tests extended over a period of a number of weeks and covered a wide variety of operating conditions and drafts.

In addition to proving the necessity of soot blowers to economical operation, the tests threw some important light on soot blower construction. For instance, in boilers burning fuel oil, draft conditions are very low, running from .02″ in the furnace up to .08″ in the uptake. If soot blowers were so designed that all nozzles emitted steam at the same time, a curtain or blanket of steam would be ejected into the boiler at high velocity, with the result that it would either put out the fire or materially interfere with the draft. The bad effects of interfering with the draft can hardly be overstated. As a result of such a condition, all of the factors in the operation of the boiler become unbalanced.

This applies to the feed of oil to the furnace, the maintenance of even steam pressure, and the injection of the feed water. In place of a normal, even operation a condition of ebb and flow takes place which may last for an hour or more before conditions again become normal. Necessarily, this entails additional work on the part of the fireman who finds the whole routine and operation of the boiler room upset.

In order to take account of this condition, the soot blower for hollow staybolt boilers is made up in vertical sections, each under the control of its individual valve. This arrangement permits of blowing three or four vertical rows of tubes at one time, thus avoiding all interference with the draft.

On stationary boilers of the horizontal


RISE IN TEMPERATURE OF FLUE GAS DUE TO SOOT. — STIRLING BOILER NO 23, STATION "A" AVG. 150% RATING PACIFIC GAS AND ELECTRIC CO. SAN FRANCISCO, CALIFORNIA.
RISE IN TEMPERATURE °F
0 5 10 15 20 25 30 35 40 45
0 2 4 6 8 10 12 14
NUMBER OF HOURS SINCE BLOWING
CHART SHEWING RESULT OF SOOT BLOWING.

water-tube type vertically baffled, and vertical boilers, where revolving soot blower units are commonly used, the use of oil for fuel calls for little change in construction. Care is taken in locating the units to be sure that they blow with the draft. In addition, it is sometimes found advisable to stagger or offset the blower nozzles so that they do not all blow in the same direction at the same time. The mechanical soot blower for oil fired boilers is here to stay, and the use of blowers on such boilers is fast becoming as common as the use of blowers on coal-fired boilers.

Specifications for Fuel Oil

The Bureau of Mines has prepared the following specifications for purchase of fuel oil, for the Government, which may, with some modifications, depending upon conditions, be used by engineers generally:

"1—In determining the award of a contract, consideration will be given to the quality of the fuel offered by the bidders, as well as the price, and should it appear to be to the best interest of the Government to award a contract at a higher price than that named in the lowest bid or bids received, the contract will be so awarded.

"2—Fuel oil should be either a natural homogeneous oil or a homogeneous residue from a natural oil; if the latter, all constituents having a low flash point should have been removed by distillation; it should not be composed of a light oil and a heavy residue mixed in such proportions as to give the density desired.

"3—It should not have been distilled at a temperature high enough to burn it nor at a temperature so that high flecks of carbonaceous matter began to separate.

"4—It should not flash below 140 deg. Fahr. in a closed Abel-pensky or Pensky-Martens tester.

"5—Its specific gravity should range from 0.85 to 0.96 at (59 deg. Fahr.); the oil should be rejected if its specific gravity is above 0.97 at that temperature.

"6—It should be mobile, free from solid or semi-soldid bodies, and should flow readily at ordinary atmospheric temperatures and under a head of one foot of oil, through a 4-inch pipe 10 feet in length.

"7—It should not congeal or become too sluggish to flow at 32 deg. Fahr.

"8—It should have a calorific value of not less than 10.000 calories per gram (18,000 B.t.u. per pound); 10,250 calories to be the standard. A bonus is to be paid or a penalty deducted according to the method stated under section 21, as the fuel oil delivered is above or below this standard.

"9—It should be rejected if it contains more than 2 per cent. water.

"10—It should be rejected if it contains more than 1 per cent. sulphur.

"11—It should not contain more than a trace of sand, clay or dirt.

"12—Each bidder must submit an accurate statement regarding the fuel oil he proposes to furnish. This statement should show:

"(a)—The commercial name of the oil.

"(b)—The name or designation of the field from which the oil is to be obtained.

"(c)—Whether the oil is a crude oil, a refinery residue, or a distillate.

"(d)—The name and location of the refinery, if the oil has been refined at all."

JENKINS BROS., LTD., NEW ADDITION

With its spacious interior transformed for the time being into a veritable fairyland of flags, streamers and bunting, the new machine shop for the iron valve division at the Jenkins Bros. plant, 103 St. Remi Street, Montreal, was recently the scene of a very enjoyable social entertainment. Gotten up by way of fittingly inaugurating the opening of this latest addition to the big valve manufacturing establishment, its success was noticeable both as regards the numbers in attendance and the excellent arrangements which characterized it throughout. Certain it is that the 400 or more couples participating, including the management, employees and invited guests, enjoyed every instant of the time from the moment of their arrival until their departure in the "we sma' hours."

Mr. W. F. Trimble, the managing director, after tendering the gathering a very cordial welcome, outlined the provisions made by the Company for the future welfare of the employees under the Group Insurance System, as well as a pension scheme. The hearty applause which greeted the conclusion of the speaker's remarks was evidence of the keen interest and whole-hearted approval displayed by those directly concerned.

A flashlight photograph was then secured of the entire assemblage, after which the festivities began in real earnest The fascination of the euchre tables attracted a goodly number of those present and throughout the evening vied with the dancing floor in the matter of popularity. The latter specially laid for the occasion, was all that the heart or feet of the most particular devotee of the "light fantastic" could desire, its attractiveness being still further enhanced by the stirring music of the Grenadier Guards Band.

Much interest was displayed by those present in a group of photographs showing the steady growth of the institution from the period of its establishment, in 1864 in the United States, and 1906 in Canada, up to the present day. With the increased manufacturing facilities which the new machine shop will afford the Iron Valve Division, the Company will be in a splendid position to handle their steadily increasing business.

At the refreshment counter everything that the inner man (or woman) desired was served in a most generous way. Full justice having been done these, dancing was again resumed and the hour of departure, 2.30 a.m., heralded by the strains of the National Anthem, brought the delightful evening to a close.

NOT THE SAME BARS

In the July 5th issue of Power House on Page 65. there appears an error in the wording of an advertisement of Leonard & Sons Connelly boilers, which although apparent at once to a technical man, might not be so obvious to the boiler purchaser. The error in question is the use of the word crow instead of crown in describing the constructional features of these boilers. The wording is at follows: "Simple in design, no flat surfaces, no stay bolts, no crow bars." This should be "no crown bars." A crow bar, though a useful tool in its place, has no place in the internal economy of a steam boiler.

L. D. Canfield, assistant district service manager at the New York Office of the Westinghouse Electric & Manufacturing Company, was appointed district service manager to succeed L. G. Richards, who has been transferred to East Pittsburg.

W. E. Freeman has been appointed director of commercial training of the Westinghouse Electric & Manufacturing Company.

The following appointments have been made in the Los Angeles district office of the Westinghouse Electric & Manufacturing Company: G. O. Noble, appointed special representative; G. B. Kirker, appointed manager railway division; R. A. Hopkins, appointed manager of the power and marine division.

The Standard Machinery and Supplies are the Canadian representatives of the Waltham Grinding Wheel Company of Waltham, Mass.; J. L. Goodhue Company, Limited, Danville, Que.; and the Clinton Metallic Paint Company of Clinton, N.Y., in addition to carrying large stocks of tool steels, machine tools and other supplies.

Common Sense in Engineering

A Lecture Delivered During the J. E. Aldred Lectures on Engineering Practice at John Hopkins University.

By WALTER M. McFARLAND

THE term "common sense" is used with great frequency, and yet, as you know, with different meanings. Indeed, it is sometimes said that common sense is really very uncommon. To avoid ambiguity, we will attempt a definition as follows: "Common sense" is the application to the solution of problems of one's best experience and judgment without prepossession or prejudice. The qualifying clause is most important, because innumerable cases have occurred where an erroneous decision was reached by men of great ability just because they allowed their judgment and experience to be overruled and biased by prepossession or prejudice.

Possibly the most striking case of this kind, which is known to everybody, is that of the unwillingness of the Syrian general Naaman to take the advice of the prophet Elisha in order that his leprosy might be cured. You remember that the prophet told him to wash in the River Jordan. Naaman's prejudices, however, made him object to this extremely simple cure, and he wanted to know why the rivers of Damascus would not be better. His servant had more common sense than the master, for, as you remember, he said to him that if the prophet had directed him to do some great thing he would have done it at once, and why not follow out this perfectly simple injunction? The common sense of the servant prevailed and the general was cured of his leprosy.

It should also be very thoroughly understood that so far from excluding all the benefits of education and intellectual training, the true meaning of "common sense" assumes these as vital factors. In other words, to praise and emphasize the importance of common sense does not mean to disparage education, but, on the contrary, insists upon it most strongly. On account of the native shrewdness sometimes exhibited by uneducated men there is occasionally a tendency to think that common sense is a gift which can compensate for the lack of education. In fact, the shrewdness displayed by the uneducated men when analyzed will be found to agree entirely with our definition above. They are really keen observers, and have, within their limit, good experience, so that the sound judgment which they display is really a good illustration of common sense. It would be found, however, on test that the field within their judgment could be exercised is very limited as compared with that of the highly-educated engineer.

In discussing the subject of our lecture I propose to follow what is called in the law schools the "case system"; that is, to develop principles by the examination of specific cases. This is usually clearer, more interesting and more satisfactory than to announce abstract principles and then attempt to elucidate them.

A striking illustration of common sense in engineering is the revolution in the use of steam brought about by James Watt, inventor of the separate condenser. The steam engine as invented and developed by Newcomen was doing useful work, but it was very generally realiezd that it was exceedingly wasteful. As you will remember, the engine worked at atmospheric pressure, steam being admitted from the boiler underneath the piston, which was slightly overbalanced so that it would then ascend to the top of the stroke. A spray of cold water was injected inside the cylinder, which condensed the steam, producing a partial vacuum. The pressure of the atmosphere caused the descending stroke of the piston. It seems to us now that it ought to have been perfectly evident that, as the cylinder was necessarily chilled in causing the condensation of the steam, there would inevitably be great initial condensation of the newly-admitted steam before the temperature could be raised sufficiently to permit the steam to fill the cylinder, and that, in consequence, it was almost obvious that the condensation should take place in a separate vessel. It was, however, not until the Newcomen engine had been used for nearly seventy years that this revolutionary change was made by Watt, who was led to it when making repairs to the model of a Newcomen engine at the University of Glasgow. It must not be supposed because Watt was an instrument maker that he was not a scientific man. He was a friend and pupil of Professor Black of the University, who is, perhaps, best known as the discoverer of latent heat, and it is probable that this scientific knowledge led him to the careful study of conditions which resulted in the invention of the separate condenser.

As you know, Watt made other great inventions connected with the steam engine, so that, speaking generally, up to the time of the invention of the steam turbine the improvements made by later inventors were almost entirely in matters of detail rather than of principle. It is very interesting to note in this connection that, in spite of his shrewd common sense in his earlier inventions, Watt's prejudices led him to oppose very strongly the use of high pressures. Doubtless it was because the success of his early work in connection with very low pressures that he was so prejudiced, but it illustrates the point that, notwithstanding his wonderful ability, he did not use common sense with respect to the higher pressures.

As we now look back over the further improvements in the steam engine, we are greatly surprised to find that it took so long to apply fully the principles which Watt had announced of endeavoring to keep the cylinder as hot as the entering steam. Of course, it is impossible to do this completely when the cylinder head and passages have just been in communication with the exhaust at a much lower temperature than the incoming steam. Nevertheless, it should have occurred to a careful analyst of the conditions that division of the expansion into two or more stages in separate cylinders would make the temperature variation in each particular cylinder very much less and would thereby conduce to economy. Long after the compound engine, with the expansion in two stages, had become quite common this point was not fully appreciated. Indeed, as late as 1880 Rankine's Treatise on the Steam Engine, then considered the best work on the subject, distinctly stated that, so far as economy in the use of steam is concerned, it made no difference whether the expansion occurred in one, two or a dozen cylinders. After the principle was thoroughly appreciated and when improved materials permitted the construction of boilers for much higher pressure, the introduction of the triple expansion and quadruple expansion engines came almost as a matter of course.

For a number of years I had the pleasure of frequent association with that great mechanical genius, George Westinghouse, the inventor of the air brake, while I was an officer of one of his companies, and on one occasion I heard him tell the story of the final step in his invention of the air brake, which is a splendid illustration of common sense. He was led to invent a power brake of some kind by his knowledge of the inadequacy of the means then employed, and his first idea was of one operated by steam. He fully realized the disadvantages due to condensation, but thought at first that these must be accepted. He had devised the brake cylinder and rigging under the car and was nearly ready to experiment. He was a reader of the "Scientific American," and one day the new issue contained a description of the mechanical features of driving the Mont Cenis tunnel under the Alps. This described the rock drills driven by compressed air, and incidentally stated that, at the time the article was written, the heading of the tunnel where the drills were working was about a mile from the air compressors outside the mouth, and that there had been no trouble on account of this distance between the generation and application of the compressed air. He at once realized that here was the ideal fluid for transmitting his power.

If it was satisfactory for the rapid-working pistons of rock drills at a distance of a mile from the compressor, it certainly would be satisfactory in the brake cylinders under the cars at a distance measured by hundreds of feet. Thus was born the air brake, which, with its subsequent developments and improvements, has probably done more for the safety of high-speed railroading than any other single invention ever made.

The first great improvement was again a beautiful illustration of common sense. In the beginning the idea was to apply the brakes on all cars practically at the same moment so as to stop all the cars at the same time. After this had been successfully accomplished and people began to rely thoroughly on the brake, an accident occurred when some cars broke from a train on an incline, which left nothing but the hand brakes to stop the descent of the detached cars. Up to that time, when it was desired to apply the brakes, pressure was admitted to the train pipe, and so to all brake cylinders. Common sense suggested to Mr. Westinghouse that if it could be arranged to keep pressure on the train pipe as the normal condition, with the release of his pressure to set the brakes, then if any cars became detached the brakes on the cars would be automatically set. To carry out this idea he invented what is known as the "triple valve," which, in connection with a reservoir of compressed air under each car, fully accomplished this purpose of complete safety. The triple valve fulfils the three purposes of filling the reservoir under the cars, admitting the air from the reservoir under each car to the corresponding brake cylinder for the application of the brake, and exhausting the air from the brake cylinder when the brakes are to be released.

Nearly all of Mr. Westinghouse's many inventions were illustrations of his splendid common sense, and they were evolved from existing methods to meet conditions which arose in the application of the mechanism. One of these inventions was made while I was with him, and I knew many of the details, so that the story will, I believe, interest you.

When Sir Charles Parsons had invented and developed the steam turbine until it became reasonably economical, Mr. Westinghouse secured the patent rights for the United States and proceeded to develop it chiefly in connection with electric applications. As the power and size of the turbines increased it was found that there were difficulties due to the expansion of the material accompanying temperature changes in such long structures. As you are aware, the Parsons turbine is of the "reaction type." De Laval, a Swedish inventor, had developed a different kind of turbine, known as the "impulse type." In this latter the steam is expanded in special nozzles before entering the blades so as to reach them with a very high velocity and greatly reduced pressure. Familiar as you are with the properties of steam, you know that this reduction in pressure is accompanied also by a reduction in temperature. Mr. Westinghouse was familiar with both types of turbines, and it struck him that the way to obviate the difficulty due to this expansion of the material was a form of compounding turbines somewhat analogous to what has been done in the steam engine. Consequently he bolted to the casing of the reaction turbine a small independent but connected casing containing a few rows of impulse blades and reduced the pressure from the initial figure of about 200 pounds to about 75 pounds when it entered the reaction blading. This smaller casing was free to expand without affecting the larger ones. Along with this he introduced what he called the "double flow" principle by practically puting two reaction turbines in the same casing with the higher pressures in the center and the exhaust connection at the ends. This solved the difficulty, and this method in various forms is the one now used in all the large turbines of to-day.

The Diesel engine is a most interesting subject for consideration by engineers on account of its remarkable thermal efficiency of some 30 per cent., which is about double that of good reciprocating steam engines. In fact, marine records of good average practice are one-half pound of oil per brake horse-power for the Diesel engine and about one pound of oil per indicated horse-power for a good reciprocating engine plant.

More than twenty years ago Dr. Diesel believed he had perfected his engine, and many engineers who had studied his work went so far as to say that the steam engine would be obsolete in a few years and would only be found in museums. For a considerable interval thereafter little more was heard of it until about ten years ago. Possibly it was because the basic patent expired at that time and possibly because the engine had been worked out commercially; but at all events the technical papers were full of accounts of Diesel engines being fitted to numerous vessels, and again there was the same prediction that the steam engine would soon be displaced. As a matter of fact, the extent of the use of the Diesel engine has been a great disappointment to its advocates, and at the present time relatively few are now being installed in new vessels.

As information was published of the details of these engines, it became apparent that they were all designed with a horse-power per cylinder which did not exceed 250 to 300. At first there were a great many vague statements that experiments were in progress with cylinders to give from 1,000 to 4,000 horse-power per cylinder. In one such experiment there was an explosion with serious consequences. At all events, for some time there has been no talk of these more powerful cylinders. It will be realized at once that if any prime mover is to be used for large powers it must be capable of construction in large units. The reciprocating engines of the SS. "Olympic" have cylinders of 4,000 horse-power each, so that a single four-cylinder engine develops 16,000 horse-power. A Diesel engine developing only 250 horse-power per cylinder would, of course, require sixty-four cylinders to give the same power. The enormous multiplicity of parts to be looked after and kept in adjustment, even if this were individually easy, would be sufficient to prevent such use, while, in fact, the Diesel engine requires unusual care and attention to keep it in good order.

The question naturally arises, "Why is it that the Diesel engine cannot be built in large sizes?" And here common sense gives us the answer quite simply. Like all other internal combustion engines, the Diesel engine requires that the cylinders be water-jacketed so as to keep the barrel sufficiently cool to permit the proper working of the pistons. The pressures carried are quite high, from 700 to 1,000 pounds per square inch, requiring a thick cylinder even for a power of 250 to 300 horse-power. The fact is that this thickness is evidently about the maximum which will permit the interior cylinder wall to be kept of a sufficiently low temperature for satisfactory working. It happens that cast iron is by far the best material which has ever been found for the cylinders of quick-moving reciprocating engines. If a material could be found which has all the fine wearing qualities of cast iron with several times its thermal condustivity, then we might expect Diesel engine cylinders of greater power; but until that comes, or there is some other radical invention, the nature of which is not now apparent, the Diesel engine seems limited to small powers.

There is another aspect of this case where that form of engineering common sense which we may call the "commercial side of engineering," comes in very prominently. Popular descriptions of Diesel engines have always laid stress on their elimination of the boilers, with a consequent saving in space. They have, so far as I know, carefully avoided a comparison of weights. Through the kindness of a friend who is a Chief Engineer of a large shipbuilding company, and who had made a very careful comparative study of Diesel engines and steam turbines for certain vessels, I have been enabled to secure reliable data on this point of weight. You will perhaps be surprised to learn that for about 3,000 shaft horse-power the Diesel engine installation weighs nearly double the steam plant, including turbines, bodilers and auxiliaries. As might be expected, there is also a very great difference in the first cost, the Diesel engine exceeding the steam plant by over 50 per cent. My friend made up a very careful comparison of the operation of the two vessels, identical except machinery, extending over a year, with the net result that the earnings based on first cost worked out to almost exactly the same percentage.

This discussion emphasizes the impor-

tance of remembering that thermal economy in an engine is only one of the factors to be considered in determining whether to be considered in determining the matter may be put in this way: every commercial enginering product must show a profit on the investment. This is just as important as high efficiency, adequate strength or admirable design. Failure to show a profit will offset the greatest merit in these other features.

A striking illustration of common sense in engineering came under my personal observation when I was in the naval service, and is worth careful study.

The early vessels of what was then called our "new navy," designed from, say, 1885 to 1890, were fitted with independent air pumps for the main engines. There were usually two air pumps driven by a small two-cylinder compound engine of the crank and flywheel type, the connecting rods of the pumps ataching to the same crank pins as the conecting rods of the engine. While an excellent design from the standpoint of a steam engine for ordinary purposes, there was a serious defect in these engines which was not realized until after they were put in use, due to assuming that an engine which would be satisfactory for ordinary purposes would be equally satisfactory for operating an air pump. In practice they proved very unsatisfactory. If they were given sufficient steam to handle a heavy load then they would run away with a light one. If they were adjusted for the light load then they would stop when a heavier load came on them. In practice this required a man to give them almost constant attention, which was very undesirable.

As soon as this trouble was recognized, the designers at the Navy Department and in various shipyards began to scheme methods of remedying the difficulty, and various methods were tried without success. Meanwhile, the makers of standard twin-cylinder air-pump work somewhat on the lines of their direct-driven water pumps, and this type of air-pump had proven a great success. It could be run at any desired speed, depending on the output of the main engine, and required practically no attention. After this pump became available it was used exclusively, but the older ships remained with the unsatisfactory air-pumps, and it was highly desirable, if possible, to correct the defect without replacing the air-pump engines. Finally Chief Engineer Bailey (now Admiral Bailey), then Chief Designer in the Bureau of Steam Engineering, took up the problem. I knew him intimately, and he gave me the details of his solution of the rifficulty.

Recognizing that the direct-driven air-pump was unsatisfactory, his first step was to find the points of difference between this type and the air-pump engines previously used. The compound engine had been designed with steam ports of the usual proportion, namely, 10 per cent. of the piston area. In the direct-driven type the ports were only about 3 per cent. of the piston area. In the direct-driven type the port opened wide at the very beginning of the stroke and stayed wide open until almost the very end. The valve gear of the compound engine was arranged, as is usual in such engines, to cut off at about three-quarters stroke; and, being driven by an eccentric, opened gradually and closed gradually, being wide open for only a short time. Mr. Bailey's conclusion was that the direct-driven pump builders had wisely decided to make the port so small that, if the load on the pump became very light and there was any tendency to run away, the steam would be wire-drawn by the small port enough to prevent any excessive speed. On the other hand, if a very heavy load came on the pump, the port being wide open would permit the steam pressure to come in to its full extent so that the piston could not stop. With the existing conditions of the older plant he must continue to drive the valve by an eccentric, but he knew a valve seat could be fitted with ports about 4 per cent. of the piston area, and a new eccentric and valve could be fited to work without lap or lead so that the port would open at the beginning of the stroke and would be open to some extent at all times. This change was made, and the result was complete satisfaction, as I can testify by personal observation from having been on a vessel where the change was made during my service. I consider this one of the best illustrations of common sense in engineering that I know. The change was not serious, was comparatively inexpensive, and it accomplished thoroughly the aim of the designer.

It was emphasized in the beginning of the lecture that common sense does not mean lack of education or absence of fine professional equipment. Indeed, these are vitally necessary, and the story which I am about to tell you will show that a well-equipped man is able sometimes to give an opinion which to the uninformed seems almost uncanny.

An accomplished naval engineer, who was one of my instructors at the Naval Academy, once told us of an amusing experience with reference to estimating the speed of a ship. He was attached to a vessel on the Asiatic Station, and during his service a new passenger vessel came out from England which was reputed to be very fast for those days. The two vessels happened to be in port together, and when passing the liner one of the officers remarked that the vessel could make sixteen knots. My friend looked at the vessel a little while and said: "That is impossible, and her speed is probably not over fourteen knots." He was at once asked how he could be so sure, and he replied: "I can tell by the size of the smokepipe." This led to jeers from some of the party, who really thought the answer was a joke. Those of you who have studied boiler design at all will probably know at once that there was a real foundation for his statement, and for the benefit of the rest I will give this analysis of the way in which he formed an opinion.

In a well-designed boiler installation there is a definite relation between the cross sectional area of the smokepipe and the grate surface. It was before the days of forced draft, so that he knew the amount of coal that could be burned per square foot of grate surface, and, with the average economy of the machinery, the horse-power which would result. He was a man who had made a careful study of the propulsion of vessels, and knew roughly about what horse-power would be needed to drive a vessel of the size in question at a speed of sixteen knots. He could estimate fairly the diameter of the smokepipe, and with this as a basis, a hasty mental calculation showed that the power which the machinery could develop was very much less than would have been necessary for sixteen knots. If any of you have had the opportunity to observe the trans-Atlantic steamers you will appreciate this point about the smokepipe by the actual conditions of some of the great liners of today. The SS. "Mauretania," which is a vessel of about 70,000 horse-power and twenty-five knots speed, has four huge funnels, while the White Star liners of nearly the same displacement have only two moderate-sized funnels, but they make only about 16 knots. So you see that a man who is well posted professionally in marine matters could really form a fair judgment as to speed of a vessel by the size of her smokepipe.

To be Continued

REMARKABLE ELECTRIC WELDING

One of the trickiest problems in welding is to join the ends of steel tape so as to form a continuous length for winding round electric cables to protect them against mechanical damage. This problem has been successfully solved by a British firm, which has devised an electrical machine for the purpose. One end of the tape is held in a fixed jaw and the other in a movable jaw, and when the weld is being made the two ends are brought together with a carefully controlled and increasing pressure up to the completion of the weld. Showers of sparks are thrown out as the metal burns away until the whole width of the join is in a plastic state: then the final pressure squeezes out all the burnt metal and makes a perfect weld. The thickened metal at the joint is either hammered flat or ground off.

Coal Board Issues Order.—The Railway Board at Ottawa has issued an order which prohibits the exportation of coal from any Atlantic, St. Lawrence River, or Gulf port of Canada, excepting to the United States or Newfoundland. The order becomes effective on and after August 1st, and was issued after the consideration of information gained from the United States Inter Commerce Board.

Developing High Overload Capacities

Particulars of Tests Run on Water Tube Boiler with Horizontal Baffling to Determine Efficiencies at High and Low Ratings.

Modern industrial boiler plant practice at present shows a marked tendency toward the use of larger and more efficient units in order to avoid the labor troubles, shut-downs, and standby losses experienced with low capacity and uneconomical equipment. In some instances, this is achieved by rebuilding the boiler house, installing up-to-date high duty boilers, and by introducing the proper machinery for handling coal, ashes and feed water.

In one of the largest textile mills, for example, five 950 H.P. horizontally baffled water tube boilers and superheaters set with underfeed stokers have been installed, to replace seventeen 250 H. P. and four 275 H. P., a total of 21 fire-tube boilers equipped with hand fired grates. The water-tube boilers have been in operation for about two years under conditions of unusually severe and continuous service and have fully demonstrated through satisfactory performance the advantages of units of this size and type. Whereas 10 firemen, 5 water tenders, 2 repair men and 1 foreman were required formerly, the present force consists only of two men, one to watch the boilers and the other to operate a coal crane.

The present paper describes briefly a series of four tests conducted on one unit of the installation to ascertain whether an arrangement of the horizontal baffling suitable for attaining high capacities would prejudice the efficiencies obtainable at lower ratings.

The tests were run under the usual working conditions prevailing in the plant in order to get results which would represent the commercial performance to be expected in industrial service from large stoker-fired boilers of this type. Nothing was "polished up" in order to get record-breaking results. At the time of the trial, the boiler tested had been in continuous service for three and one-half months.

All of the plant load, in excess of the capacity developed by the unit under test, was handled by three of the other boilers operated at moderate rating by the regular boiler room force.

The fuel burned was taken at random from the large tonnage in storage at the plant and comprising many deliveries from various sources. The results of analysis indicated that this was only a fair grade of low-volatile Pennsylvania coal, typical in quality of the vast quantities of similar fuel delivered to the New England mills during the past two years.

The boiler tested was a standard Heine horizontally baffled boiler set as shown Fig. 1. The arrangement of baffling should be particularly noted. It is simple and inexpensive to repair, replace or to change in location. Such modifications are often advisable if high efficiency is to be maintained with different furnace conditions resulting from a change of fuel or operation. The principal dimensions of the boiler are as follows:

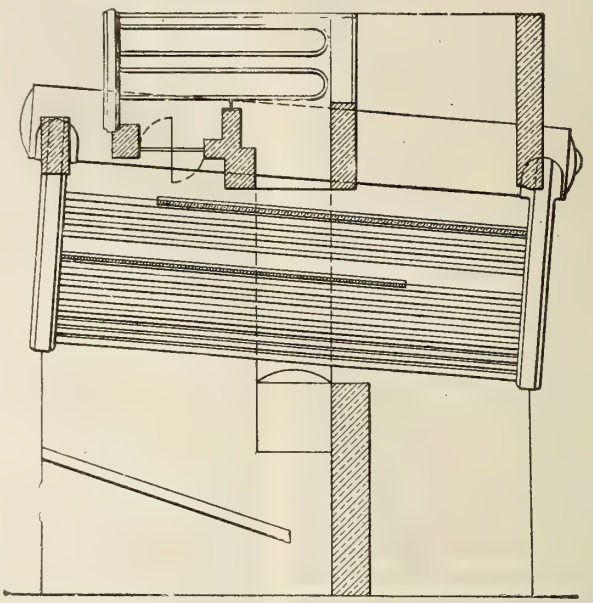


FIG. 1—950 H.P. HEINE THREE DRUM WATER TUBE BOILER EQUIPPED WITH SUPERHEATER.

No. of steam drums	3
Diameter of steam drums	42 in.
Length of steam drums	20 ft. 9 in.
No. of tubes	551
Diameter of tubes	3.5 in.
Length of tubes	18 ft.
Water heating surface	9,500 sq. ft.
Superheating surface	633 sq. ft.
Grate surface, including dump grate	147.4 sq. ft.
Ratio of water heating surface to grate surface	64.5 to 1
No. of Riley stoker retorts	0

A thorough examination of the boiler, superheater, setting and stoker was made before and after the tests were run. The boiler was found to be free of all leakage, and deposits of soot or slag on the heating surfaces. There was some scale in the tubes which increased in thickness from nothing in the upper tubes to 1/16 in. in the lower ones. The brickwork of the furnace, setting and superheater was in good condition. The baffling was intact and tight. The Riley Stoker was in excellent mechanical condition throughout the tests.

The method of conducting the boiler trials was that prescribed by the A.S. M.E. Code. All instruments and scales were compared with standards. The calibration of the water measuring tanks was checked by independent observors.

The coal was weighed by a sealed scale carrying an overhead hopper of 2,000 pounds capacity, from which it was transferred as required through a chute to the stoker hopper. The scale was provided with a self-registering beam. Duplicate tickets were made at each weighing. The coal analysis, Table 1,

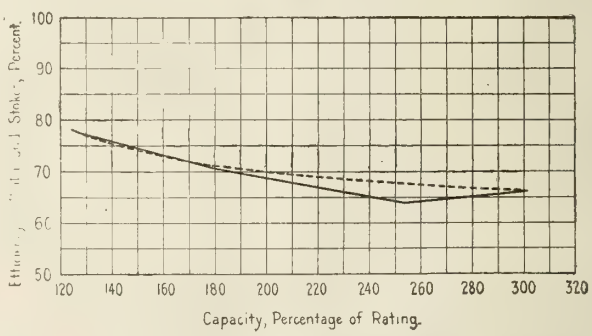


FIG. 2—EFFICIENCY CHARACTERISTIC OF BOILER AND STOKER

TABLE 1—COAL ANALYSES

	Sample 1		Sample 2	
	As received Lbs.	Dry Basis	As received Lbs.	Dry Basis
Weight all through 2 mesh screen..	1.6	.....	1.4	.....
Weight over 4 mesh screen	0.3	.....	0.2	.....
Moisture	2.20	.....	1.61	.....
Volatile matter	21.82	22.31	20.68	21.01
Fixed carbon	65.31	66.78	67.34	68.45
Ash	10.67	10.91	10.37	10.54
	100.00	100.00	100.00	100.00
Sulpher Separately determined	1.88	1.92	2.23	2.27
B.T.U. per lb.	13545	13850	13692	13917

	Sample 3 As received Lbs.	Sample 3 Dry Basis	Sample 4 As received Lbs.	Sample 4 Dry Basis
Weight all through 2 mesh screen..	*1.8	.....	1.7	.....
Weight over 4 mesh screen	0.3	.....	0.2	.....
Moisture	1.53	.....	2.29	.....
Volatile matter ..	20.15	20.46	20.70	21.19
Fixed carbon	66.28	67.31	66.08	67.62
Ash	12.04	12.23	10.93	11.19
	100.00	100.00	100.00	100.00
Sulpher Separately determined	2.19	2.22	2.44	2.50
B.T.U. per lb.	13373	13581	13480	13796

*All through ¾ in. screen.

were made from carefully worked down samples of 500 pounds, taken from the crushed coal during each test. All stoker siftings and samples were weighed back. The ash analyses, Table 2, were made

TABLE 2—ASH ANALYSES.

	Sample 1 As received Lbs.	Sample 1 Dry Basis	Sample 2 As received Lbs.	Sample 2 Dry Basis
Weight all through ¾ in. screen....	1.7	.....	2.0	.....
Weight over 2 mesh screen	0.3	.....	0.4	.....
Weight over 4 mesh screen	0.5	.....	0.9	.....
Moisture	14.94	.....	18.67	.....
Combustible	12.86	15.11	13.52	16.63
Earthy matter	72.20	84.89	67.81	83.37
	100.00	100.00	100.00	100.00

on samples representing the entire quantity of refuse as weighed worked down in the usual manner. At this point it may be well to direct attention to Tables 1 and 3, and to the discrepancy in the percentages of moisture in the coal for Tests 1, 3 and 4. The values given in Table 3. with the exception of that for Test No. 2, are correct for coal as fired. They were determined by drying representative samples of coal during the tests. No determination of moisture content was made during Test No. 2, but the analyzed percentage was accepted as correct. The samples collected for analysis, (Table 1) dried somewhat during the working down process. If a sample for Test No. 2 had been dried out, it probably would have shown a slightly higher moisture content than 1.61 per cent. This greater value would have increased the efficiency for Test No. 2, and raised it into line with the values for Tests Nos. 1 and 4, as shown by the dotted curve of Fig. 2.

Feed water was measured in three carefully calibrated tanks holding an aggregate of 9,128 pounds of water at 130 deg. F. The test boiler was provided with an independent feed pump and piping. Hot and cold water were available at the measuring tanks enabling the close maintenance of the feed water temperature.

Every precaution was taken in the feed and blow-off piping to insure the measurement of all water entering the boiler and to guard against any leakage.

The coal consumed and water evaporated were determined for each hour of the test to obtain the approximate rating developed. The rating was also observed by means of a General Electric indicating flow meter.

Readings of pressure, temperature, draft, etc., were taken at 15-minute intervals. Analyses were made for C02, C0 and 02 in the furnace flue gases.

Fires were cleaned one hour prior to starting all tests. Especial care was exercised to duplicate the conditions of the fuel bed at the beginning and end of all trials.

Tubes were blown every six hours during the 24 hour test.

The complete data for each test are given in Table 3. In judging the performance results obtained, several important factors should be considered. The coal burned was not a high grade selected fuel but had a fairly high ash content and produced a troublesome clinker at high rates of combustion. The results as obtained with this fuel should therefore be considered as most creditable. The uniformity of the test conditions was materially affected by the variable operation of the three other boilers in service, all supplying steam to a common system. The limitation of capacity performance was entirely due to the inability of the stoker to handle and dispose of the troublesome clinker produced.

The data show that high overload capacities can be developed with this type of boiler and arrangement of baffles. The efficiency characteristic of the boiler and stoker is drawn in Fig. 2. The point corresponding to Test No. 3 is open to question, because the coal used contained more ash than the coal of the other tests. Since the resulting clinker interfered noticeably with the management of the fire at the high rating obtained, this may well account for the low efficiency of Test No. 3. The dotted curve probably represents the true characteristic of the boiler when burning coal of the quality used as long as it can be worked through the stoker. If the efficiency of Test No. 2 were raised slightly by alteration of the moisture content, as mentioned previously, it would agree closely with the dotted curve. The excess temperature of the gases from the boiler as

Continued on page 360

Table 3. Summary of Data and Results

Date	Test 1 Sept. 30, Oct. 1, 19.	Test 2 Oct. 3, 4, 19	Test 3 Oct. 7, 19	Test 4 Oct. 10, 19
Duration	24 hrs.	21 hrs	3 hrs	3 hrs
Steam pressure gages	134.0	130.0	140.0	141.2
Superheat, degrees	136.2°	126.4°	99.2°	153.5°
Feed temperature	127°	127°	125.5°	129°
Flue temperature	541°	600°	670.8°	694°
Pressure in wind box	2.63"	4.3"	6.2"	6.46"
Draft in uptake	.293"	.75"	1.18"	1.25"
Total coal fired	92799	124569	28561	32270
Per cent. moisture in coal	2.89	1.61	2.33	2.56
Total water fed	825,605	1,032,301	209,391	243,208
Factor of evaporation	1.208	1.204	1.192	1.217
Coal fired per hour	3867	5931	9520	10757
Coal fired per retort per hour	386.7	593.1	952.0	1075.7
Dry coal per sq. ft. of grate surface per hr.	25.47	39.6	63.1	71.1
Water evap. per hour	34400	49157	69797	81069
Equivalent evap. per hour	41555	59185	83198	98661
Builders rated horse power	950	950	950	950
Boiler horse power developed	1207	1716	2411	2858
Per cent. rating, developed	126.8	180.6	253.8	300.8
Water evap. per lb. coal as fired	8.89	8.29	7.38	7.54
Equiv. evap. per lb. dry coal	11.0	10.14	8.97	9.41
B.T.U. per lb. dry coal	13850	13917	13581	13796
Per cent. ash dry coal	10.91	10.54	12.23	11.41
Per cent. combustible in ash	15.17	16.63	.....	.....
Combined efficiency	77.56	70.71	63.97	66.21

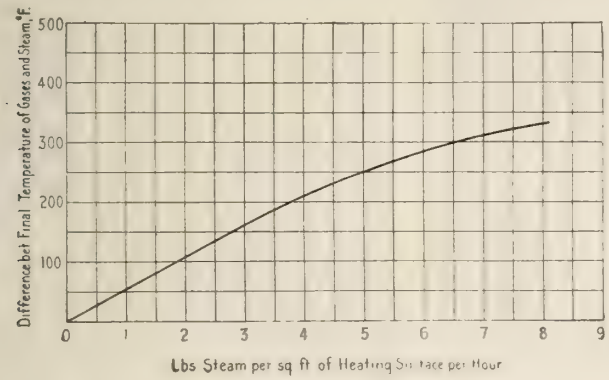


FIG. 3—CURVE SHOWING EXCESS TEMPERATURE OF GASES

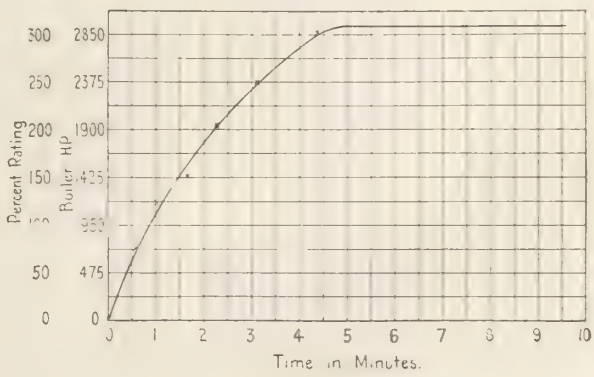


FIG. 4—CURVE SHOWING HOW RAPIDLY THE HEINE BOILER CAN TAKE UP AN OVERLOAD.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

THE elastic limit of the material has an important bearing on its performance in service. The Ontario regulations specify that the elastic limit must be not less than half the tensile stress, and the tensile stress is placed at between 55,000 to 65,000 lbs. per square inch. This means that up to a pull of 27,500 to 32,500 lbs., according to the ultimate tensile stress, the metal will resume its original shape after the load is removed. Above that amount of stress the metal will retain a permanent set, or in other words, will be stretched beyond its original length when the load is removed. In order that the material may possess sufficient ductility, the regulations require that a test piece 8 inches in length shall stretch 22% of its length before breaking.

That is $8 \times \frac{22}{100}$ or 1.76 inches.

Plates that are to be exposed to the action of the fire when in service will have a slightly lower tensile stress and a greater ductility than those which are not exposed to direct heat. The tensile strength is placed at between 55,000 and 65,000 lbs. per square inch, because that is about the limit of strength that can be obtained without sacrificing something of the elastic qualities of the material. The object of obtaining high tensile strength is, of course, to enable thinner plates to be used, which means a saving in first cost. There is, of course, some slight advantage in heat transfer, but it is so slight as to be negligible in the ordinary limits of plate thicknesses. The reduction possible in weight and therefore first cost of plates possible by using material of a higher tensile strength is more than offset by the other undesirable qualities which accrue, chief of which is loss of ductility due to a higher sulphur and phosphorus content. It is hardly within the scope of these articles to go into this question of the chemical analysis of steel, but the foregoing will suffice to give the reader a general idea of the qualities necessary in the material the plates of a boiler are made of.

We have seen that the cylindrical form of boiler is the next best that we can get to the sphere. As we cannot roll the cylinder all in one piece the next point to aim at is to make the joint where the two edges of the plate are joined together, as nearly as possible equal in strength to a solid plate. The working pressure of the finished boiler will be determined by its weakest part, and the object of the good designer is to get the strength of all portions nearly uniform. There have been many boilers built with a shell capable of carrying 100 lbs. per square inch, while the staying of the heads was only fit for a little over half that. The writer has come across many instances where the boiler seems to have been put together without any regard for design at all, and with a different capacity for resisting pressure at each constituent part. However, it is not possible now in Ontario to build these freaks, and some day a uniform law for all the provinces will come about.

The Starting Point

If you were suddenly requested by the owner of your plant, or a prospective plant owner, to give him the size of a boiler to evaporate a certain quantity of water per hour at a certain pressure, how would you proceed to answer him? Would you make a wild guess, or would you ask him to give you a few moments to figure it out? Would it then occur to you to enquire under what conditions this boiler had to evaporate this quantity of water, such as with natural or forced draught, hand or mechanical stokers, low grade or high grade coal, with feed heaters or without? Having got the information, what point would you start from to make your calculations? There is one factor that fundamentally governs the capacity of any boiler, and which is the logical starting point, and that is, the quanity of coal which can be burned per square foot of grate per hour. Upon that quantity everything else depends. If, owing to a restricted grate, or lack of draught, the necessary amount of coal cannot be burned, the evaporation cannot be obtained. If you have a properly proportioned grate and setting, for the requirements, it is then a question of operation to get the results. From this we can see that we have a starting point from which we can build up the complete apparatus.

Capacity of Boiler

The capacity of a boiler, of its ability to evaporate water, depends as we have seen, on the grate area. However, it is necessary to have a definite unit, to compare or to specify sizes. The recognized standard boiler horse power is the capacity to evaporate 34½ lbs. water per hour from and at 212 deg Fahr. This means water at 212 deg. Fahr. turned into steam at 212 deg. Fahr. This is a definite performance, and demands the absorption of a certain number of units of heat.* The Ontario Act gives the quantity of water as 34 lbs., but this is probably just to show that the authorities have a mind of their own. The accepted value, as laid down by the committee of the American Society of Mechanical Engineers, is 34½ lbs., and this is the figure generally used. However, in writing on examinations, always use the standard of the authority that is conducting the examination.

The rating of a boiler by heating surface is of little value as an indication of its capacity, but is useful as a commercial comparison. The standard laid down by the Ontario Act is 15 square feet of heating surface per horse power, for a horizontal return tube boiler, 12 square feet for locomotive boiler, and 10 square feet for water tube boiler. These figures are used in rating plants or certificates, and are useful for that. The only real measure of a horsepower is, nevertheless, the quantity of water evaporated, or in other words, the amount of heat absorbed.

If then, we are called upon to design a horizontal return tube boiler of 100 horse power capacity, we know we must figure on the evaporation of 34½ lbs. water per horsepower per hour from and at 212°. However, we must know some more details, as for instance the pressure the boiler has to work at, and also the average temperature of the feed water. We will assume that we are to use natural draught. To evaporate 34½ lbs. water from 212° to steam at 212° we must furnish 970 heat units per pound

If we have feed water at a temperature of 60° and steam at 125 lbs. gauge pressure we have a different number of heat units to furnish. We shall have to first raise the water from 60° to 212° and then furnish enough additional heat to make steam at the temperature corresponding to 125 lbs. gauge pressure. This is 353° F. so that we have to furnish the difference in temperature of 60° and 353° and also a certain quantity known as the latent heat, which we will explain fully when we consider steam. This for the pressure we are considering is 867 heat units so that we have to supply altogether 353 + 867—60 = 1220—60 = 1160. This is $\frac{1160}{970} = 1.195$ time the amount needed to change water at 212° to steam at 212°. Suppose now a feed water heater is to be installed that will raise the feed water to 200° before entering the boiler, we will have to add only 353+867 — 200 = 1220—200=1020, which is considerably less, in fact just $100 - \frac{1020}{1100} \times 100 = 12.1$ per cent. less.

We will proceed on the assumption that there is no heater, and that for each

pound of water evaporated we require 1160 heat units. The total number of units required for 100 horsepower at the standard measurement will be $100 \times 345 \times 970 = 3{,}346{,}500$ heat units. However, as we are to produce steam at 125 lbs. pressure this quantity of heat will make only $\frac{970 \times 3450}{1100} = 2884.9$ lbs. of steam per hour. This quantity of steam would supply a simple Corliss engine of about 100 h.p., or an automatic engine of about 70 h.p., a steam turbine of 240 h.p., or a compound condensing Corliss engine of about 130 h.p. From this you can see that a boiler of a certain rated horsepower may be able to drive an engine of much higher h.p. or unable to drive one of much lower horsepower, according to the consumption of steam per horse power per hour of the engine. This shows again that by measuring capacity of boiler in terms of evaporation we are on a solid basis.

We have therefore to consider supplying 3,346,500 B. t.u. per hour, to the boiler. To do this, we must have fuel, and we must know beforehand about what heat value the fuel possesses. This will vary with the locality it is obtained from, but we can be safe in allowing for a coal with heat value of 11500 B.t.u. per pound. If all this heat could be transmitted to the water it would be fine, but we know that with ordinary hand firing and natural draught conditions we shall do well if 60 per cent. of the heat is usefully employed. That means that each pound of coal is only good for $\frac{11500 \times 60}{100} = 6900$ B.t.u. per pound. We must therefore make provision for burning $\frac{3{,}346{,}500}{6900} = 485$ lbs. coal per hour. This is found, as can be seen, by dividing the total heat required by the heat value of the coal per pound, after making the correction for efficiency.

We can reach the same result in another way. We have seen that the total heat in a pound of steam at the specified pressure and temperature it 1160 B.t.w. The heat in a pound of coal, allowing for 60 per cent. efficiency is 6900. Then each pound of coal will make $\frac{6900}{1160} = 5.9$, say 6 pounds of steam. Now, as we must produce 2885 pounds of steam per hour to satisfy the rating, we must burn $\frac{2885}{6} = 480.8$, say 481 pounds of coal per hour. This evaporation corresponds to an evaporation per pound coal of 7.05 lbs water from and at 212°, for the ratio of heat required from and at 212° to that required for water at 60° to steam at 125 lbs. pressure is as 970 : 1160 which is 1.195, and this multiplied by 5.9 gives 7.05.

It is possible with good draught conditions to burn from 12 lbs. to 16 lbs. coal per square foot grate surface per hour. To allow for adverse conditions we will take the lowest figure. We must then have $\frac{480}{12} = 40$ square feet grate surface. Now, we have seen that for this type of boiler the heating surface is 15 square feet per horse power, or a total heating surface of 1,500 square feet. This gives a proportion of heating surface to the grate surface of 1,500 : 40 :: 37.5:1. This is a rather high proportion as some makers allow as low as 30 to 1, while it may range as high 40 to 1. We have allowed very conservative figures in our estimates of the heat value of coal, and efficiency of boiler, so that the grate surface we have arrived at is somewhat high, as compared with practice. In proportioning grate surface, however, it must be remembered that if coal is good and combustion conditions favorable, it is a simple matter to shorten the grate, but if the grate is too small to begin with, it is a difficult mater to enlarge it.

If we then decide to keep the grate area at 40 spuare feet, we can work from this to obtain our other dimensions. The square root of 40 is 6.324. We can therefore take 6 feet as the width of our fire grate, and dividing 6 into 40 we get 6.66, which is about 80 inches. This would require two sets of bars each 40 inches long. This is not too long a grate for easy working. Having determined tentatively that we have a grate six feet wide by 6 feet 8 inches in length, we can now go into the question of the size of boiler necessary to get the requisite amount of heating surface.

Heating Surface

The heating surface in a horizontal return tube boiler consists of half the shell, and the outer surface of all the tubes. The ligaments between the tubes in the heads are such a small percentage of the total area that they may be neglected as far as heating surface is concerned. We see therefore, that diameter of shell, length of shell, and diameter and number of tubes are the deciding factors governing the amount of heating surface. We can make a formula expressing this, as follows:

$$\text{H. S.} = \frac{D \times 3.1416}{2} \times L + d \times 3.1416 \times n \times L$$

$$\text{or H.S.} = \frac{L\ D\ \pi}{2} + \pi\ d\ n\ L$$

where D = Diameter of shell feet
L = Length of shell feet
d = Outside diameter of tube
n = Number of tubes

Our firegrate is 6 feet wide, so we can assume this diameter for the boiler. The tube area in a horizontal boiler is usually taken as about 1-7 the grate area, though if the fuel to be burnt is anthracite, a smaller amount will do, from 1-9 to 1-10. If we allow 1-7 tube area to grate area, we shall require $\frac{40}{7} = 5.714$ or nearly 5¾ square feet. We can use 3-inch, 3½-inch or 4-inch diameter tubes, as may be convenient. The inside diameter of a standard 3-inch boiler tube is 2.732 inches, of a 3½-inch tube 3.26 inches, and of a 4-inch tube 3.732. The internal areas in square feet are respectively .0422, .058 and .076. Then the number of 3-inch tubes required would be $\frac{5.75}{.0422} = 136$. The number of 3½ tubes would be $\frac{5.75}{.058} = 99$ and of 4-inch tubes would be $\frac{5.75}{.076} = 76$.

The size of tube used is a matter of the individual designer's taste. Some claim that a smaller tube and a greater number allow of a better distribution of the gases, and thus a better transfer of heat, while others claim that small tubes are more difficult to keep clean, and do not allow of such good circulation as a less number of larger tubes. The tendency is to use a larger tube, and in boilers of the size we are considering the 4-inch tube is generally favored. We have thus arrived at an approximate number of tubes of a certain diameter, and must now determine the length. A tube should not exceed 60 times its length in diameter, which in this case is 60x4= 240 inches, so that our boiler must not be more than 20 feet long.

The heating surface as we have seen is equal to

$$\frac{L\ D\ \pi}{2} = \pi\ d\ n\ L$$

We have now D = 6 feet, d = .3 feet and n = 76, so we can substitute figures and the equation becomes

$$\begin{aligned} 1500 &= L \times 3 \times 3.1416 + 76 \times .3 \times 3.1416 L \\ &= L(3 \times 3.1416 + 76 \times .3 \times 3.1416) \\ &= \pi L(3 + 76 \times .3) \\ &= \pi L(3 + 22.8) \\ &= \pi L 25.8 \\ L &= \frac{1500}{\pi 25.8} \\ L &= 18.5 \end{aligned}$$

So we get a length of 18.5 feet, which we may accept as being pretty nearly correct. We have, therefore, arrived at the leading dimensions of our boiler, which we may use in the meantime, although it may be necessary to make some modifications when we come to lay it out. As a boiler of this size is required to have a manhole in the front head 12x16 inches clear, we may have to leave some tubes out to allow for this. However, we shall at present, go into the question of the size of plate and type of joint of which the shell must be formed, and after that is settled, we can lay out the tube plate and settle finally the pitch and number of tubes and location of the stays in the head. We will take up the subject of strength of shell and riveted joints in the next issue.

*The British thermal unit is the amount of heat required to raise one pound of water one degree Fahrenheit at its maximum density. Latent heat is the heat required to effect a change of state of

a body. Water at atmospheric pressure and 212° temperature, requires the addition of 970 B.t.w. to turn it into steam at atmospheric pressure and 212° temperature. These 970 do not show on the thermometer or in any way except in changing the nature of the water, and are therefore called the "latent heat." Heat which can be measured is called sensible heat.

CATALOGUES

We have received Bulletin No. 6 of the Norwalk Iron Works, describing and illustrating their refrigerating plants. The bulletin shows motor, belt, gasoline engine driven and chain driven sets. The sizes illustrated are from quarter ton to one ton capacity. These machines are specially suitable for stores, warehouses, etc., where perishable goods are stored. The quarter ton machine is delivered with a full charge of ammonia, and under proper operating conditions the cost of ammonia should not reach more than $5 a year. The same manufacturers furnish a machine for domestic refrigeration, these machines being electrically driven, and so arranged that the same valve which turns on the condensing water supply, also operates the starting switch. This means that it is impossible to start the machine without having the water on. The act of stopping the machine also turns off the water. The space required by the machine is 36 inches by 18 inches by 26 inches in height.

The Buffalo Forge Company have issued Catalog No. 700, describing their heating, ventilating, and humidifying apparatus. This is a most interesting publication, as it is not only a catalogue, but a valuable text book on these subjects. Examples of psychometric charts and humidity charts are given, besides considerable information on the theory of heating and ventilating. Illustrations of different installations in schools and public buildings are included, as well as industrial establishments including pulp mills, railway round houses and food storages. The apparatus itself is clearly described and illustrated. The book will be found a valuable one for the chief engineer to have at hand for purposes of reference when heating problems occur.

The Yarnell Waring Co., have issued a folder describing their Yarway Pipe Joint and Yarway Holtite Pipe Clams, which shows clearly the method of applying these accessories. A price list is included, and particulars of a trial offer. The booklet will be supplied to anyone interested by the Yarnall-Waring Company, Chestnut Hill, Philadelphia.

The Westinghouse Electric & Manufacturing Co., have issued a miniature catalogue 9-A-2, which deals with industrial heating apparatus. This includes footwarmers for men employed in outside capacities, where they are more or less stationary, such as gatemen, police officers, etc. Water heaters, hot tables, glue pots, etc., all electrically operated are included. Formulae connected with heating of buildings is given a place in the booklet, thus making it of practical use to the engineer.

UTILIZING COAL DUST

The latest contribution to the universal problem of fuel economy is a British invention for efficiently utilizing waste coal, peat, lignite, and other low-grade solid fuels. The material is made into blocks of any desired shape or size, each block being composed of a number of layers. When the mass is burning it tends to separate along the layers, thus exposing a large area for complete combustion and giving a result similar to the burning of raw coal. Licenses have been granted to many British collieries to work up coal dust into this form. The cost of production is stated to be nearly one-third less than that of briquetting in the ordinary way, and the resulting fuel can be sold at only 10s. per ton less than the price of raw coal. The regular form of the blocks facilitates the storing of the fuel on board ship

FUEL ECONOMY TRIALS IN GREAT BRITAIN

Important experiments have recently been made in Great Britain with power alcohol as a fuel for motor propulsion on vehicles. The trials were made with mixtures of alcohol and benzol, and the results were very promising. Certain modifications were made to the engine and its accessory parts to suit the new fuel, and the experiments will be continued with ether as well as alcohol. There is good prospect that British engineers will soon be able to achieve, by an adapted form of engine, very high efficiencies with fuels which can be manufactured in large quantities from cheap and abundant vegetable sources.

BETTER THAN CASTING

The good that comes out of evil is illustrated by the fact that during the recent moulders' strike in Great Britain many engineering firms, unable to obtain castings, were stimulated to develop alterantive methods of producing the parts they required. One large firm, for example, was in urgent need of large pipes, and it set to work to build up pipes of the required shape from steel plates by welding together suitably-formed pieces. Excellent results were obtained, even with complicated shapes, the surface being as smooth as a fine casting. The expense proved to be much about the same as casting, but in the case of special work the labor and material involved in making patterns (which might never be used again) were saved.

HYDRO-ELECTRICS IN GREAT BRITAIN

Owing to the high cost of fuel and the demand for increased production, many British mill-owners are installing water turbines to use moderate heads of water and are using steam plant as an auxiliary. Both plants generate electricity, the hydro plant taking the constant load and the steam plant dealing with additional demands in the busiest hours. The arrangements which several of the leading British electrical firms are making to carry out complete hydro-electrical installations of every size will encourage this movement towards power economy.

THE LATEST AT GREENWICH OBSERVATORY

Once every year a rather quaint ceremony is observed at Greenwich Observatory. An inspection of the Observatory is made by a "Board of Visitors" to whom the Astronomer-Royal presents a report on the work of the preceding twelve months. The latest report shows that although the Observatory was founded centuries ago, at the very dawn of scientific navigation, it keeps in line with the latest developments. A new aerial has been erected to extend the range over which wireless time signals can be received. These signals are now received regularly from the Eiffel Tower, Nauen, and Annapolis. The Observatory also controls the operation of time-balls in different parts of the country. These time balls are hoisted on a prominent mast and released at specific hours by an electric signal from the Observatory. The accuracy of the operation is checked by a return signal from the distant time-ball. Greenwich also controls "Big Ben," the famous clock of the Houses of Parliament.

DEVELOPING HIGH OVERLOAD CAPACITIES

Continued from page 357

affected by the rate of driving is given in Fig. 3. Fig. 4 shows that the boiler starting from a banked fire can take up a 300 per cent. overload in 4 minutes, 23 seconds. From the excellent performance of this boiler at high overloads,—overloads which were limited only by the fusing of the clinker in the low and fair grades of the coal used—it would appear advisable to consider the desirability of using larger grate areas than is customary.

The results further established that the arrangement of baffling which is especially suitable for obtaining maximum capacities does not affect adversely the efficiencies obtained at lower ratings. High overloads could have been readily maintained for indefinite periods if a higher grade fuel had been available.

The combustion results obtained were consistently good. The flue gas temperatures were not extreme considering the capacities developed. The condition of the heating surfaces after tests was found to be good with little accumulations of soot and with no deposits of slag.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

EVERYONE is familiar with gravitation and has at least some working knowledge of its effect upon the world in which we live. A somewhat similar force very closely allied to electricity exists in magnetism. The two, electricity and magnetism, are in many cases related as cause and effect and for the proper understanding of dynamo electric machinery an outline of the nature of magnetic force will be given. The mariner's compass is one familiar type of magnetic instrument and in every electric generator and motor magnetism is utilized.

If we take an ordinary horseshoe magnet sold in the stores and place it under a piece of paper and then gently sprinkle fine iron filings on the paper a pattern will be formed much as is shown in Fig. 16. The filings will bunch up around the ends of the magnet and will be thinner the farther away we go from the ends.

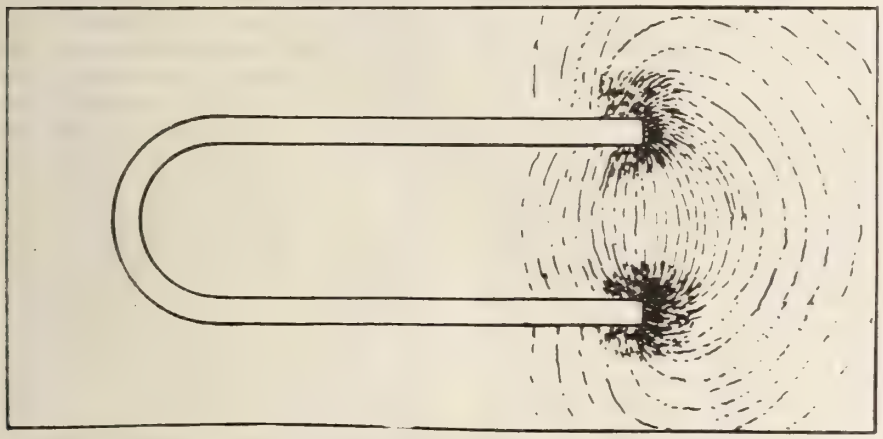


FIG. 16—FIELD OF FORCE AROUND THE POLES OF A HORSESHOE MAGNET AS SHOWN BY IRON FILINGS.

To the ends of a magnet the name of poles is given and it will be seen that the filings arrange themselves in lines from pole to pole much as if something was leaving one pole crossing the intervening space and entering the next. By general agreement the paths traced out by this magnetic force are called lines of magnetic force or lines of force.

A magnet does not have to be U or horseshoe shaped to exhibit the property of magnetism for if we take any hard steel object such as a chisel, a penknife, etc., it can readily be magnetized. If a bar of hard steel is taken and magnetized and iron filings be taken and dusted over paper placed on top of it a pattern similar to Fig. 17 will result. The filings will not bunch completely at the ends but some will be seen to adhere along the sides and will suggest a flow of force out of the bar along its sides as well as at the end. Their concentration will be greater at the poles than at the end suggesting the fact that the magnetic force is greater there. It will also be seen that the lines of force return upon themselves making a complete circuit through the surrounding air and the magnet itself.

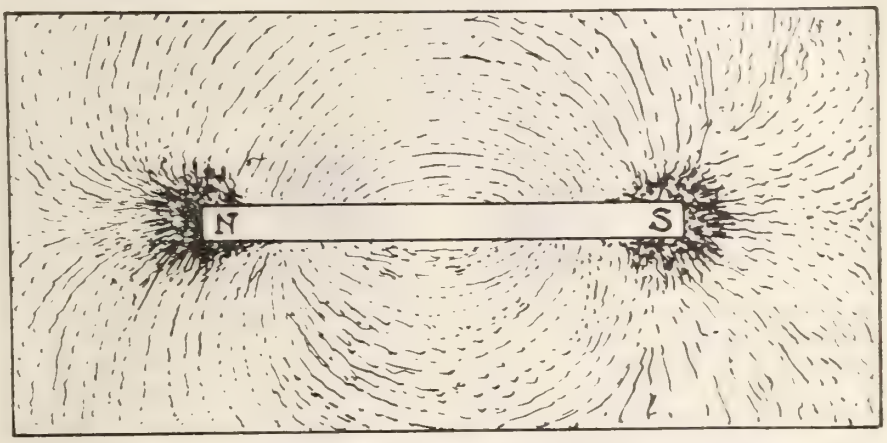


FIG. 17—FIELD OF FORCE AROUND A PERMANENT BAR MAGNET SHOWN BY IRON FILINGS.

Next, if two bar magnets be placed end to end and covered with a sheet of paper a pattern can be made with iron filings similar to either Fig 18 or 19. In one case there will be a suggestion of the lines of force leaving one magnet, jumping across the intervening space and entering the other magnet. While in the other case it would seem as if two fields of force opposed each other and leaving each magnet the lines of force are bent more or less sharply around and return to the other end of their respective magnets.

From the above it may be surmised that the two poles of a magnet are unlike and that they exhibit opposite characteristics. This is true and a further experiment will show that like poles oppose each other and unlike ones attract. The two magnets may be held end to end in the hands and by trying them out it will be found that they will adhere strongly together in one position, while if one of them is reversed they will oppose each other.

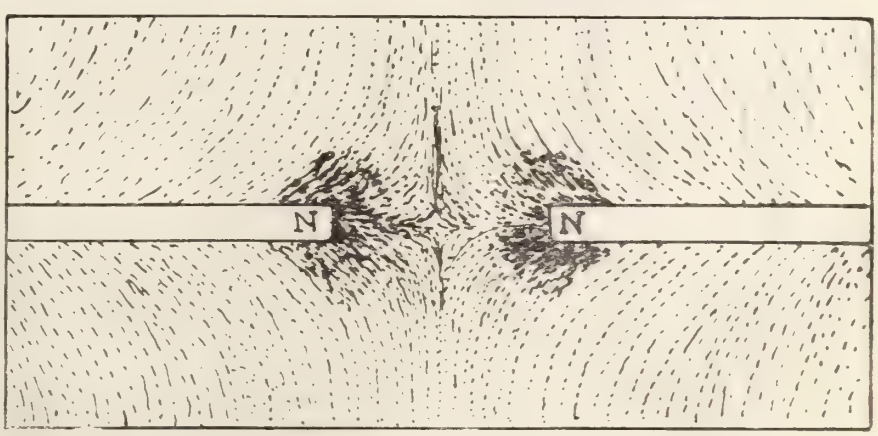


FIG 18—FIELD OF FORCE CAUSED BY TWO BAR MAGNETS WITH LIKE POLES TOGETHER.

The Compass and the Earth as a Magnet

If a bar magnet be tied to a string or other light suspension and be left free to turn about the string as an axis, it will be found to take up a position pointing almost due north and south. If it should be turned end for end and left free again it will turn around and the same pole as before will take up its old position. To this pole, the one pointing north, the name north pole is given, and to its counterpart on the other end, the name of south pole.

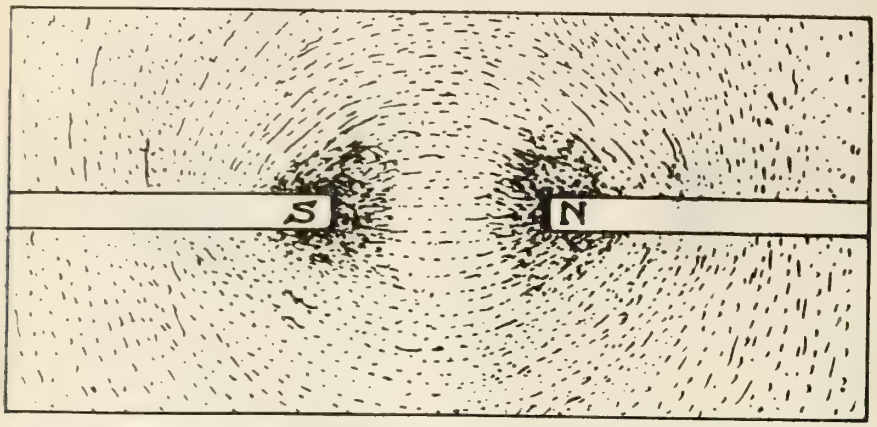


FIG. 19—FIELD OF FORCE CAUSED BY TWO BAR MAGNETS WITH UNLIKE POLES TOGETHER

The compass is merely the scientific adaptation of this fact to the needs of mariners and incidentally it is very old, having been in use by the Chinese for centuries. Fig. 20 will make the action of the compass clear. The earth is nothing more nor less than a huge magnet itself and has two poles, a north magnetic pole and a south magnetic pole. These do not coincide exactly with the geographical ones but lie some distance away.

The lines of force as will be seen from the illustrations are assumed as a matter of convention to leave the south pole of the earth, travel through the intervening space and enter at the north pole. The bar magnet takes up such a position that the lines of force flowing through it and in and out at the ends parallel those of the earth's field and flow in the same direction. This makes the north pole of the magnet the one out of which the lines flow. Note the distinction—while the lines of force are assumed to flow into the north pole of the earth they flow out of the north pole of the earth and that the two are not of the same polarity, but unlike. The difference can always be clearly kept in mind by thinking of the north pole of a magnet as the north-seeking pole.

The lines of magnetic force in the figures shown are merely the stream lines of magnetic flux. A conception of magnetic flux may be secured by using as illustration a simple analogy first given in "Kapp: Dynamos and Transformers."

Suppose we have a tube a few inches long within which is mounted a force pump which, when in operation, will draw in a fluid at one end and expel it from the other. While this small pump is in operation let the tube be immersed in a tub of water all through which are saw-dust particles. After steady conditions have become established, observe the liquid. The whole volume is in motion, within the tube and near its ends the liquid has high velocity, but out in the tub the motion is slow. The saw-dust particles are marking out stream lines in the fluid and the stream lines are continuous in closed paths. The same stream which passes down the tube returns in much wider paths to the other end by way of the whole volume of fluid. The amount of water moving through the tube per second is the same as the amount returning to the other end outside the tube. Here is a picture of the magnetic flux. While this analogy fails at some points, it can be much elaborated and is very useful in picturing the real facts relating to magnetism. There is then a magnetic flux whose stream lines we call lines of magnetic force; this flux pases through the magneto and on around, completing a magnetic circuit. The same total flux is found at every part of a magnetic circuit; the same flux goes all the way around.

The analogy has been used further for impartial explanation of the attractive and repulsive forces between magnets. Suppose we put two tubes with their enclosed force pumps under the water. Each will have its own effect in producing currents. If certain ends are brought together the tubes, by means of these currents, repel each other. If one tube is reversed, by the same means they attract one another and if we name the ends out of which the currents flow north poles, the behavior is exactly the same as for magnets.

Permeability

Not all substances are magnetic; iron, cobalt, nickel and some other metals and alloys are, while the remainder of the elements and compounds are not. Substances are said to be magnetic when they are attracted by a magnet of any kind and this simply means that they are a better conductor for magnetic flux than ordinary materials. Aside from the few exceptions like iron, cobalt, nickel, etc., all other substances have practically the same conductivity and are said to have a permeability of 1. Permeability simply means the conducting power of a material for magnetic flux. Wrought iron and cast machinery steel have about the same permeability; cast iron about half as much. The permeability of soft wrought iron may easily be 1,200 or 1,500.

Permanent Magnets.

Hard cast steel possesses the property of retaining magnetism and the old

FIG. 20—THE EARTH AS A MAGNET.

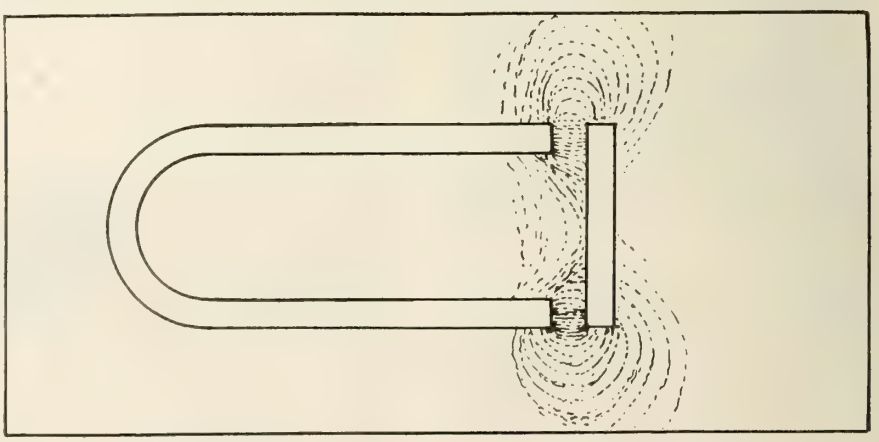


FIG. 21—THE EFFECT OF A KEEPER ON A HORSE SHOE MAGNET.

horseshoe magnet finds considerable use today in magnetos, measuring instruments, etc. It has been advanced by some scientists that each separate molecule of the steel forming the magnet is a magnet in itself and when the bar of steel is magnetized from an outside source these molecules all line up with north to south poles.

They are then supposed to retain this alignment. If the steel be soft they are not capable of retaining it, but return to their former arrangement.

The effect of the varying permeability of various substances on the lines of magnetic force is illustrated in Fig. 21. Here a piece of iron or steel has been brought close to the two poles of a permanent magnet and if by means of a sheet of paper and some iron filings the flux disposition be ascertained it will be found that the major portion of the lines of force forsake the surrounding air and travel through the iron bar or keeper. If the bar be placed tight against the poles it will again be found that nearly all the lines pass through it and very few through the surrounding air.

The next article of the series will deal with the relations between magnetism and electricity.

TRADE ANNOUNCEMENT

The Combustion Engineering Corporation announces the appointment of Mr. Henry Kreisinger formerly of the United States Bureau of Mines, as Engineer of Research.

Mr. Kreisinger was probably the best known man in the Bureau of Mines in connection with such work, having compiled a large proportion of the Government pamphlets on fuel and combustion problems, and his years of experience in Government service will be of incalculable value to the clients of the Combustion Engineering Corporation.

Mr. Kreisinger will conduct investigations for the Combustion Engineering Corporation of a similar nature to those that he conducted for the Government, and the results of his work will not only be available to the clients of that corporation, but will also be supplied to the Government. This branch of the corporation's business is entirely aside from any commercial consideration, and its activities governed by precisely the same fundamental principles that underlie the operation of the Bureau of Mines. The only difference is that Mr. Kreisinger will have a broader field for his studies because of his being able to apply then to practical situations, and further, there will be less financial limitation.

A recent issue of "Coal Age" contained the following story of Mr. Kreisinger's work:

"Mr. Kreisinger was born in the town of Radnice, in what is now known as Czechoslovakia, but at the time of his birth the town constituted a part of Bohemia. He came to America in 1891 at the age of fifteen. In 1900 he entered the University of Illinois, and four years later received the degree of Bachelor of Science. Continuing his studies, he graduated as Mechanical Engineer in 1906.

"After gaining the latter degree he entered the Technological Branch of the U.S. Geological Survey, which had quarters in the St. Louis Exposition grounds. Here he was assigned to the fuel-testing plant, in 1910, when the Bureau of Mines was created, and took over the work of the fuel-testing department of the Survey. Mr. Kreisinger severed direct connection with the Government and became fuel engineer for the Clinchfield Fuel Co., of Spartanburg, S.C.

"While with the Clinchfield Fuel Co., Mr. Kreisinger was frequently consulted on combustion problems by the Bureau. The acquaintance formed and opportunities offered by the Bureau of Mines for research work were so attractive to him, however, that in 1913 he returned as head of the fuel department of the Pittsburgh station. When the Bureau Home in Pittsburgh was changed from the old Arsenal buildings on Butler Street to the new million dollar buildings in the Oakland district, Mr. Kreisinger was given increased opportunities for the research work of which he is so fond. As a designer of fuel-testing apparatus he has perhaps no peer. The result has been that the fuel-testing laboratories of the Pittsburgh station are the most complete of their kind to be found anywhere."

While connected with the Combustion Engineering Corporation as research engineer, Mr. Kreisinger will make his headquarters at the Bureau of Mines station in Pittsburgh. By this arrangement a closer co-operation between the two institutions will be maintained. The first problem upon which Mr. Kreisinger will centre his efforts will be a thorough testing of the powdered coal plant of the Bureau of Mines at Milwaukee, Wis.

While engaged in this work he will have under his direction four men from the Bureau of Mines fuel-testing laboratories and fifteen others who will be carried on the pay-roll of the corporation. These men will be chosen from newly-graduated engineers and men who will be seniors in college next year. He will be allowed the full and unrestricted use of any equipment or apparatus owned by the Bureau.

Mr. Kreisinger is a member of the Sigma XI engineering fraternity, the Coal Mining Institute of America, the American Society of Mechanical Engineers, and the American Society for the Advancement of Science.

The Canadian Engineering Standards Association have informed us that a stock of the most important publications of the British Engineering Standards Association are now available for distribution. Of ccurse a nominal price must be charged for these publications. Below is a description of some of these books.

Requests for copies should be addressed: Secretary Canadian Standards Association, Room 112 West Block, Ottawa, Ont.

10-1904. British Standard Tables of Pipe Flanges.—This report gives the British standard dimensions for pipe flanges for steam and water piping for low pressures and high pressures, dimensions of welded-on flanges for pipe lines, for working steam pressures of 125, 225, and 325 lbs. per square inch, dimensions for short flanged bends and tees of cast metal for pressures up to 325 lbs. per square inch, and dimensions for long bends of wrought iron and steel. 25 cents net.

46-1909. British Standard Specifications for Keys and Keyways.—The specification covers material, tests, definitions and tables of dimensions for three classes of key: (a) Parallel Sunk Key; (b) Taper Key; (c) Taper Sunk Key. 25 cents net.

21-1090. Report on British Standard Pipe Threads for Iron or Steel Pipes and Tubes. (Revised November, 1909).—This report gives definitions and tables of dimensions for British standard pipe threads. In this system the Whitworth form of thread is employed, but fine pitches are used, and both parallel and conical screw ends are provided for. 25 cents net.

95-1919. British Standard Tables for Use in Engineering Workshops, Giving Corrections to Effective Diameter Required to Compensate Pitch and Angle Errors in Screw Threads of Whitworth Form.—This important paper gives the necessary information in convenient form for correcting threads of Whitworth form from 28 per inch to 2½ per inch. 25 cents net.

BOOK REVIEWS

The McGraw Hill Book Company Inc. 239 West 39th Street, New York, have just issued four new publications bearing on practical electricity. These books cover a very wide field, and will be found of great assistance to those interested in the different lines. The books are by well-known authors, and provide a welcome addition to the literature of the electrical science. They are "Armature Winding and Motor Repair," by Braymer, which has been very well received, the first edition being sold out in less than one month. The second is a new and revised edition of Croft's Wiring for Light and Power. It contains all the rules for wiring contained in the National Code of U.S. "Direct Current Motor and Generator Troubles," by Gandy and Schacht, tells all about tracing, preventing and remedying the troubles that the direct current machine is heir to. The last one is Lauer and Brown's "Radio Engineering Principles," which is an authoritative work on the developments in radio made during the war. It is supported by the signed recommendation of the Chief Signal Officer of the U.S. army, Major-General Squier. These four volumes cover a very wide field, and should be welcomed by the electrical profession in general.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, AUGUST 5, 1920 No. 15

PRINCIPAL CONTENTS

Power Plant Management—Combustion of Fuel Oil 349
Common Sense in Engineering 353
Developing High Overload Capacities 356
A Course of Instruction 358
Theory and Practice of Electricity 361
Editorial 364
Progress in New Equipment 366
Operators' Point of View 368

Editorial Versatility

IT IS hard to realize just how much wealth and days of work are shot to pieces during the course of a strike. an editor. The query is, "To settle a dispute, would you be so kind as to allow me to ask in your 'Knotty Points' column why the funnels on almost all steamers are painted with colors red, white, and black? Thanking you in advance, I remain, yours truly, Reader."

To which the busy editor replies: "The colors are most conspicuous."

While not disputing the fact that such a combination of colors is conspicuous, it would seem to us that the editor's lack of knowledge of the real reason was only equalled by his willingness to oblige the reader. This is, as every seafaring or shipping man knows, to identify the company the steamer belongs to. In the old days of the sailing ship, every line had their own house flag, and the hulls of the ships were painted with a particular color scheme. For instance, one large English sailing ship company made a rule of painting their ships white, from truck to water line, blocks, yards, masts and every fixture conforming to this color. They were known as the white ships. An Italian line of sailing ships was known by its fluted masts, the masts themselves being white, with the flutes picked out in light blue. Another line would have a white hull, with painted ports. With the introduction of the steamer, the funnel lent itself to distinguishing marks, and these were made as near as possible the same colors as the house flag, though of course this was not always the case.

For instance, the red funnel and black top, in conjunction with a square red flag carrying a golden lion and globe, is the symbol of the Cunard Line, while a cream-colored funnel with black top and a red swallow-tail flag with a white star on it signifies the White Star Line. The Allan Line and the Dominion Line both used a red funnel with a black top and a white band, the distinction being in the position of the band. In one case it was close up against the black, while in the other there was a band of red between the white and the black. Every line of any note has its own particular marks.

The reason the Hamilton reader concluded that red, white and black was the favorite color of the seas, is probably because a red funnel, with a white band and black top is the distinguishing mark of the Canada Steamship Lines, and in the thriving ocean port of Hamilton these are probably the most frequent visitors. We imagine our editorial friend, from his familiarity with nautical matters, must have just returned from reporting the America Cup races. While on the subject of funnels, we would like to ask him if a ship with two funnels goes faster than a vessel with one, or vice versa?

Our $4,000 Legislators

DURING the debate on the Government's proposals to finance the building of foreign ships in Canadian yards by the endorsement of the purchaser's notes, some airy persiflage was introduced by our high-priced legislators. Mr. Duff, one of the members from the Maritime Provinces, was opposing the proposals, and Mr. Morphy asked him if the inclusion of the wooden shipbuilding yards would cause him to look more favorably upon them. Mr. Duff answered that the Government should not pick out any particular industry for their favors. Mr. Morphy again put the direct question that if the Government had included the wooden shipbuilders, would Mr. Duff have given the Government his support? Mr. Lalor chimed in with, "Come on, that's the second time." To this Mr. Duff answered in cryptical fashion, "Pork and beans make a very good meal if there are no stones in them, as the honorable member should know." Here the Deputy Speaker asked the members to assist the Speaker to preserve the dignity of the house. Mr. Duff thereupon asserted that the shipbuilders of Nova Scotia had not asked for assistance, and believed in standing on their own feet. Mr. Morphy asked if the wooden shipbuilders would refuse assistance if offered them. Mr. Lalor again interjected "Come across." Mr. Duff again answered by his former allusion to pork and beans, and Mr. Lalor came back, "You have enough wind. You do not need any beans."

Such is the high level at which the debates are kept by our parliamentary representatives. However, probably $4,000 a session is not so very much to pay them for exhibiting such a pretty talent in patter. Look at the money Charlie Chaplin makes, and he is not so very much funnier, and probably not as vulgar.

What Strikes Cost

IT is hard to realize just how much wealth and days of work are shot to pieces during the course of a strike. We have come to look upon strikes as part and parcel of our industrial life, while it is time that we started to regard many of the strikers as thieves and robbers that go about putting their hands in the pockets of the workers, taking out many times what they ever replace. For instance, strikes in Pennsylvania during 1916-17-18-19 meant 10,179,243 days' work lost, and wages lost amounting to $28,664,871. These figures do not take in coal or steel strikes.

Report on the New England Coal Situation

DEPENDING, as we do in Canada, to such a large extent on the United States for our coal supply, the situation in the Eastern States has a personal interest to us. A report has just been made covering the first quarter of the year, from April 1, 1920, to July 1, 1920, showing the distribution of coal from the Southern fields. This is addressed to the Governors of the six New England States, and is signed by the Lieutenant-Governors and State Fuel Administrators of the same States

The first paragraph states emphatically that unless granted quick and effective relief the New England States will be facing the worst coal crisis in their history, and that it will be "much worse and more dangerous than during the war."

The requirements of New England for the twelve months are set down, conservatively, at 25,000,000 tons, this assumes a winter of just ordinary severity. At the end of 1918 there was a reserve of about 1,000,000 tons, while figures for 1919 are not to hand, there having been no fuel administrator at this time. The movement of coal for the first quarter of this year means that if there is no improvement there will be a shortage of 6,500,000 tons. This means that after hospitals and public utilities are provided for, New England factories will have to go on half time or less. A point which the report does not mention is the suffering to the employees of these factories by having their earnings cut in half at the time of year when living conditions are most onerous. The report states that the whole problem is one of transportation only. It claims that there is plenty of coal and plenty of miners to supply all normal needs of the Eastern States, but that the coal they should be receiving is being shipped for export at fancy prices. The salt water piers at Hampton Roads, from which the New England States draw the greater portion of their surplus, have been working to capacity, but have been shipping all their supply to foreign customers, to the detriment of those at home. New England cannot get this coal because the foreign buyers are out to get the coal no matter what the price that is asked.

In order to get some measure of relief, the representatives of the suffering states have asked the Interstate Commerce Commission to divert a portion of this export coal to them. They point out that this would not injure any other part of the country. No more coal or cars would be used than used at present, if the New England consumers were granted half a million tons a month out of the coal now being shipped through Hampton Roads.

Being unable to get coal from the Southern fields, these buyers turn to the Pennsylvania fields. This is the field that we in Canada draw large quantities of coal from, and conditions there interest us. The report points out that the influx of all these new buyers to the Pennsylvania market results in one bidding against the other, and contracting for more coal than the field can supply. The operators then give coal to these new buyers at high prices, and neglect their old customers. These in turn get alarmed, and try to secure coal to cover their requirements and soon, in the words of the report, "everybody is trying to buy two tons to get one."

All this is bad enough, but the report claims that the coal owners operating through the Coal Operators' Association, which is a powerful organization having large offices in Washington, are deliberately issuing propaganda to mislead the people in the States as to the true situation. The abnormal profits to be made out of exporting coal will not be lightly relinquished by these coal operators. Further, they take the view that as long as profiteering is conducted at the expense of the foreign buyer, the U.S. Attorney-General will not bother them. The authors of the report state that it has more than once come to their knowledge that operators had refused to sell coal at their own price when they found it was for an American port. In the light of this statement, the hopeful outlook of a Toronto paper that the United States would not let Canada go short seems optimistic, indeed.

In the report the attitude of the British Government, which firmly restrains all coal export till the home market is provided for, is noted. They point out that much as Great Britain needs the export business to restore the balance of trade, they show no intention of starving the home market in order to serve export. In the meantime, the United States operators are making hay while the sun shines. The result of all this is that recently a cargo of coal in Boston Harbor sold for $22.30 a ton. This is $8 a ton higher than the highest price in 1917, the year the States went into the war. Before the war, Virginia coal sold afloat in Boston at an average price of $4.50 per ton. The railroad reserves in the New England States are fast dwindling away, and the probabilities all point to a general breakdown in transportation facilities during the winter.

This is by no means a cheerful outlook, and it is an outlook in which Canada has a vital interest. We know that there was a serious shortage here just a few weeks ago. It is doubtful if there is any great reserve in Canadian factories, at least in Eastern Canadian factories. This is a time for economy and preparation for the winter that will too soon be with us. Every man who is in charge of a steam plant, or who has anything to do with the burning of coal, should look carefully into his daily operations and stop all waste. We could get along very well on little more than half the coal we use if it were used efficiently. The money that would be saved could be put into extensions of factories and to the development of our own coal resources. As long as we depend on importation for our fuel supplies, so long will we be at the mercy of just such situations as the present. It is not a comfortable position to be in.

BROWNED ALUMINUM

To protect aluminum and aluminum alloys from corrosion, L. von Grotthuss has tried the experiment of browning the metal electrolytically. The aluminum is suspended in an electrolyte consisting of a sulphur compound of molybdenum and zinc is used for the anode. The cell is maintained at a temperature of 60 deg. to 65 deg. C. The aluminum is soon covered with a dark brown coating. The metal may be bent or rolled without cracking the coating. A piece of aluminum thus coated was immersed in a salt solution for two months without showing the slightest traces of corrosion.—Abstracted from Metal and Iron.

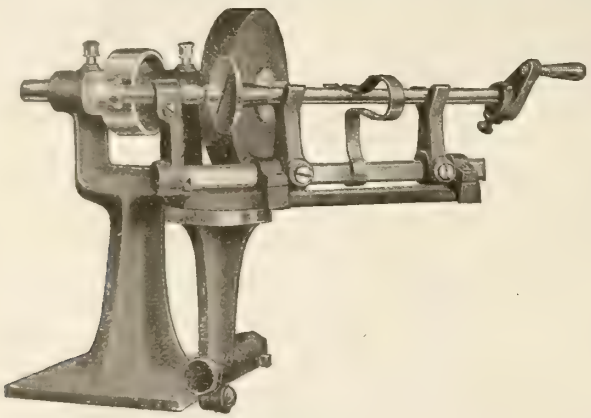
An automatic wireless call device was recently described by Major Basil Binyon before the Wireless Society of London. By means of an aerial which had been erected, Major Binyon was able to give a practical working demonstration of this novel piece of mechanism. Pre-arranged messages were received from the wireless station at Slough, and the selector mechanism proved beyond doubt that it would respond only to signals for which it was set to receive. By the use of this apparatus it is only necessary to employ one operator on board ship, since during the less busy hours of the day the automatic call device may be left to take incoming signals. On the receipt of a message giving the call signal of the ship in which it is installed, or the distress signal S.O.S., a relay is put in action, a bell rung, and the operator called to his instruments.

Progress in New Equipment

GRINDER FOR VALVE FACING

D. F. Dunham, 830 West 37th Street, Los Angeles, Cal., supplies us with the following information of his valve grinder which he has placed on the market:

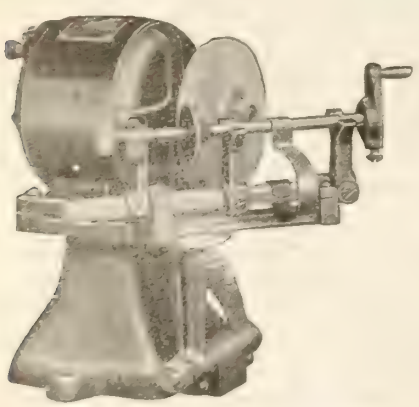
The machine, as illustrated, is arranged to face valves of any size and angle, and if the valve centre has been mutilated it makes no difference, as an adjusting screw with a ball and socket joint overcomes this defect. The valves are ground true with the stem and not with the centre.



ILLUSTRATING THE BELT TYPE MACHINE.

A spring stop can also be arranged for grinding valve seat reamers.

The valve is worked back and forth on the face of the wheel, the valve being revolved meanwhile. The arm on the machine is graduated from 30 to 60 degrees, and the strong, rigid construction can be clearly noted. Three models are made Nos. 1 to 3, the first a motor grinder, the second a belt-driven grinder, and the third a grinding attachment, as shown.



THE MOTOR DRIVEN MACHINE.

DIRECT-CURRENT SERIES-WOUND MOTORS

For severe intermittent varying speed service where heavy starting torque is required, such as for cranes and hoists, the Westinghouse Electric & Manufacturing Company has recently brought out the type "HK" direct-current, series-wound motors. These motors are especially designed for use where the load consists of a series of starts, stops and reversals, the motor being idle for only short periods of time.

These motors are of enclosed construction with small openings in the lower part for ventilation. Covered openings in the top half of the frame give access to the brushes and the commutator. The most prominent feature of this motor is its compact construction, giving small overall dimensions, light weight and great mechanical strength.

The motor has a forged open-hearth steel frame and solid forged-steel feet. The motors above three h.p. rating are equipped with commutating poles so that high momentary loads can be carried without series sparking, and long life of commutator and brushes thereby insured. All field coils are thoroughly insulated and impregnated. The brackets are strong and rigid, each complete with oil well and bearing housing. Oil ring lubrication is used. The brush holders are clamped to insulated rods mounted on the front bracket which are dowelled in place. The position of the brushes is thereby fixed for both directions of rotation.

Armature coils are form-wound and thoroughly insulated and impregnated before being placed in the slots. A blower is placed in the rotor which effectively ventilates both armature and field windings. This allows a smaller diameter armature to be used, resulting in low flywheel effect, consequently little energy is required to start and stop the motor, thereby reducing to a minimum, wear and tear on bearings and brakes.

Electrically-operated shoe-type brakes are supplied when ordered. They are bolted to the machined lugs on the motor bracket, making a compact unit of motor and brake. The brake is simple and rugged, and provision is made for adjusting for wear of parts.

The company states that the ability of any motor to do its daily work, as far as its temperature rise is concerned, is determined by the continuous rating it will carry at a safe temperature. A ventilated motor has a larger continuous rating than a non-ventilated motor of the same short time rating. A ventilated motor rated 7½ h.p., one-quarter hour, has about 30 per cent. more continuous capacity than the non-ventilated motor rated 7½ h.p. one-half hour.

GENERAL VIEW OF MOTOR.

The freezing of some water which had leaked into a cast-iron column carrying a footpath produced an unexpected effect in Philadelphia. The column, according to the Engineering News Record, was open at the bottom, but fitted so well on its base that it gradually filled with water through leakage at the top. The water froze during the winter, and in expanding squeezed out at the bottom of the column, which was lifted, together with the pavement, about 8 in. The column was 16 ft. high, and was not damaged. The ice was melted out, and after the column was settled down again it was made water-tight at the top.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	....

Standard Lapweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base	$7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	10%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	15
Stove bolts	55
Wrought washers	25
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal	2 00
Whiting, plain, per 100 lbs	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

The Operators' Point of View

RUPTURED TUBE IN WATER-TUBE BOILER

Regarding Mr. Wright's ruptured tube, my guess is that the water came over from the other boilers in the battery as the result of the rupture stopping the delivery of steam from the crippled boiler. This guess is on the assumption that the crippled boiler was not the only one delivering steam into the header.

It is pretty well known that with high water the sudden opening of the safety valve will cause a rise in the water level and at a point below the valve outlet there will be a piling up of the water to such an extent that the valve will discharge water. If the boilers were equipped with non-return valves as they ought to be the lowering of the pressure in the crippled boiler would have caused the non-return valve to close and thus reduce the tendency of the other valves to prime.

The shape of the rupture indicates that the metal was soft at the time of rupture. This is a condition which is very apt to occur in tubes inclined at such an angle as are those in Mr. Wright's boiler if the rate of evaporation is high, due to the reduced heat-absorbing quality of the mixture of steam and water with which the tubes are filled and the higher the rate of evaporation the more steam and less water there will be.

This risk is increased if the headers are of the sinuous type instead of the box type.

R. McL.

BOILING POINT OF AMMONIA

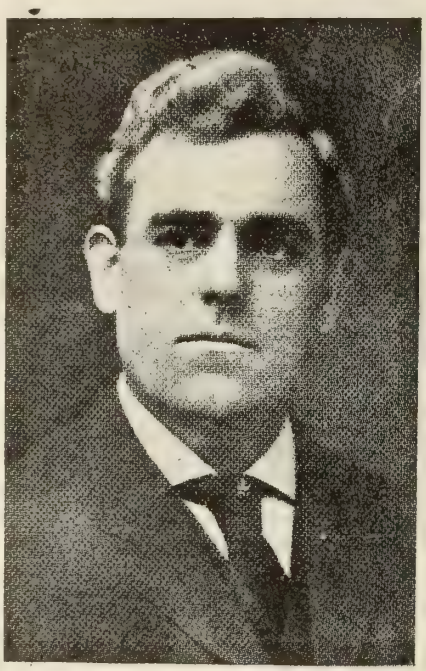
Editor Power House:

Dear Sir,—A little more detail than shown in your note on "The Boiling Point of Ammonia," on page 44 of July 5th issue of Power House may be of interest.

"The boiling point of a liquid is the temperature at which, under application of heat, the liquid changes into vapor without further increase in temperature, the pressure remaining constant. It also presupposes that the vapor is of the same substance as the liquid from which it rises. Water commences to boil at approximately 212 deg. Fahr. at atmospheric pressure, forming steam, or water vapor, and will continue to boil at that temperature as long as any water is left. But with the aqua ammonia a different condition exists. Aqua ammonia is merely a solution of ammonia gas in water. If heated, the temperature starts to go up, and very shortly the solution commences to give off bubbles of ammonia gas, depending in quantity on the strength of the aqua. The bubbling increases and the temperature continues to rise, and does not become stationary until the boiling point of water is reached, when the solution no longer contains any ammonia, but is only water. Different strengths of aqua ammonia will commence to give off gas bubbles at different corresponding temperatures, but these can hardly be called the boiling point of aqua ammonia.

Anhydrous ammonia, on the contrary, will have a definite boiling point for a given pressure, since the condition merely exists between the liquid and vapor forms of ammonia itself. Its action is precisely that of water, though at a different temperature, this being 28.5 deg. Fahr. below zero at atmospheric pressure and about zero at 15 pounds gauge pressure. In fact the analogy between ammonia and water is quite strong in several ways. Ammonia can be frozen, melted, and vaporized just as water can, and in liquid form will dissolve many substances that water does, again depositing them upon evaporation."

"W. C. KLOTZ."



The Late W. C. McGhie

To Make Briquettes.—The $400,000 appropriation jointly voted by the Federal and Saskatchewan and Manitoba Governments for the construction and operation of a lignite briquetting plant at Estavan has been increased to $600,000.

WANTED—CRANES and CUPOLA

Cranes—Two 40 ft. x 20 ton, 3 motor electric travelling cranes.

Cupola—One modern grey iron cupola about 42 in. inside lining with fan and equipment.

Apply E. Leonard & Sons, Limited, London, Canada.

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

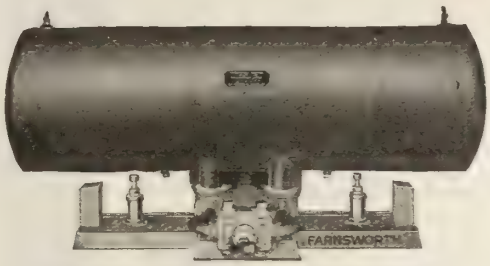
HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

A Real Canadian Boiler Feeder

THE BEST IN THE WORLD

Ask the Canadian Farnsworth Company about these machines for your steam plant. We build boiler feeders from 20 to 1,000 H.P. each.

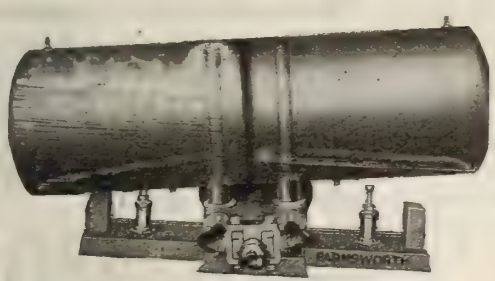


The Farnsworth "Duplex"

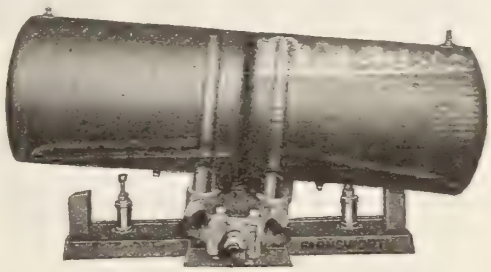
Our Engineers will give you expert advice on boiler feeding and condensation problems. No plant too large.

This Machine is the Product of Canadian Brains and Skill—Made in Canada by Canadian Engineers—the Last Word in Efficiency.

Study the Construction of this Machine.
Have you ever seen a Simpler Machine for the Purpose?
Everything designed for simplicity.
Least moving parts of any boiler feeder on the market.



No springs—No levers—No weights—No check valves to give trouble. Nothing to adjust. No necessity for adjustment. No trumnions, or bearings to bind and stop the action, or leak, and mess up your boiler room.



No open vents to waste your steam—A mechanically perfect Duplex steam valve—Can't leak and can't stick—No renewing of faulty discs.

Study the action of this machine—You have seen the common Return Trap in action—You have seen it "Hold up" the return lines—You have heard it "Pounding" and seen it blow steam through the open vent.

An open vent will waste at 50 lb. pressure about 15 H.P. per hour of your steam—Surely an expensive proposition.

Our Duplex boiler feeder or pump can't waste steam—It's a complete closed loop system, impossible with the common return trap.

Gives a continuous flow to boilers—Continuous drainage from heating apparatus—Continuous equalization between boiler and apparatus.

THE

Canadian Farnsworth Company

1-24 Hillingdon Avenue, TORONTO, Canada

W. H. ROSE, Gen. Mgr.

BEACH 825

NEW MOTOR FUEL NOW USED IN NATAL

Report to Admiralty Says it Has Been Found Possible to Produce It in Large Quantities

London, July 1.—After a series of trials in motor boats, the British Admiralty has just made a confidential report on the far-reaching possibility of using a new motor fuel—"Natalie"—in naval vessels.

This substitute for gasoline which has been used successfully three years in Natal, South Africa, the fuel manager of an automobile association said to-day, is a mixture of alcohol and ether and other things, and is made cheaply in South Africa, where there are large tracts of waste vegetation, from which power alcohol can be extracted.

It is manufactured in some places as a by-product of the sugar industry.

PLATE-WAYS FOR MOTOR TRAFFIC

At the recent annual meeting of the British Science Guild Lord Montagu of Beaulieu made an interesting suggestion regarding new roads for fast motor traffic. He proposed that "plate-ways," consisting of iron plates or concrete two feet wide should be laid down to form an efficient bearing surface for the wheels of motor vehicles. Properly constructed, such plate-ways would halve the tractive effect required to propel a vehicle, as compared with what is necessary on a first-class macadam road. He reckons that the cost of construction would be half that of a single line of railway and that the expense of operation would be very much lower.

The manufacturers of concrete pipes by the "Hume" centrifugal process—Hume Pipe Company, South Africa, Limited—is described in a paper by Mr. W. Wolstenholme recently read before the South African Institution of Engineers. The materials employed with the cement are crushed stone from the mines in the Witwatersand area, and, for reinforcement, discarded winding ropes, of which large quantities are available. The ropes which are slowly rotated, are cut into suitable lengths, annealed, and unstranded, and then woven into cages which are placed in the pipe moulds first. The concrete is thrown into the moulds until the required amount is furnished, the machine is gradually speeded up, and the centrifugal force causes the material to be evenly distributed throughout the length of the moulds; water is also driven out by this method. Six 4-in. or 6-in. diameter pipes can be completed in eight or nine minutes, and four 15-in. or 18-in. pipes in fifteen minutes. Larger sizes up to 60 in. diameter can be finished in about twenty minutes. Sizes up to 9 in. diameter will withstand a working pressure of from 300 to 350 lb. per square inch, while larger sizes have been tested up to 210 lb. per square inch. When subjected to excessive pressure these pipes become a mass of pores, and have cracks which allow the pressure to escape. The pipes do not, therefore, fail in the manner of a cast iron pipe.

A NEW FILLING METAL

There are frequent calls for a filling material to repair cracks and small holes in very light castings, which cannot well be welded. Various methods have been used for this purpose, but the latest is in the nature of a metal having a very low fusion point, and a comparatively high tensile strength. The new metal is known by the name "Metaloid." The composition of the metal is a trade secret, but in appearance it is about the color of solder, but is remarkably light in weight, being of less specific gravity than aluminum. In making a repair, the casting is heated to a temperature of 200 degrees Fahrenheit, and the bar of "Metaloid" is rubbed over the part to be repaired. It adheres closely to the casting, and makes a strong and satisfactory repair. The "Metaloid" requires no heating, and it also provides a guide to the correct temperature of the casting. If the latter is too hot, the "Metaloid" will give off a blue flame when applied to it. If too cold, the "Metaloid" will not run at all, while at the correct temperature it flows quite readily with no sign of burning. Holes in castings have been filled, and the casting afterwards subjected to 300 lbs. per square inch water pressure, the Metaloid showing no signs of leakage. The new metal has been largly used in the repairing of crank cases and radiators of automobiles, and should be of great use in the general engineering field. At the present time it is being tested out by the engineering department of a large Canadian sulphite mill with a view to determine its acid resisting qualities.

"Metaloid" is handled in Canada by Messrs. Kennedy & Kennedy, Tyrell Building, King Street E., Toronto.

PERSONALS

T. E. M. Murphy, who for many years has been in business for himself, is now associated with the Gates Engineering Company, Limited, 348 St. James St., Montreal.

John W. Gates, formerly president and general manager of the Gates Refractories, Limited, has resigned his position with this firm and has opened an office at 348 St. James St., Montreal, where h will carry on business under the name of the Gates Engineering Company, Limited. The new organization will be under the direct supervision of Mr. Gates, and will specialize in boiler settings, special furnace brick work, and general contracting for power plant furnace installations. Mr. Gates has had a life-long experience in this line of work and is the patentee of the Gates boiler furnace blocks. He has supervised some of the largest boiler setting installations in Canada.

Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long trap is automatic and requires no valves except those which control the admission of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds. Being open at starting, it cannot become air bound this doing away with air cocks or vents—Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one-inch pipe.

The Long Trap may be applied to drain steam mains jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to

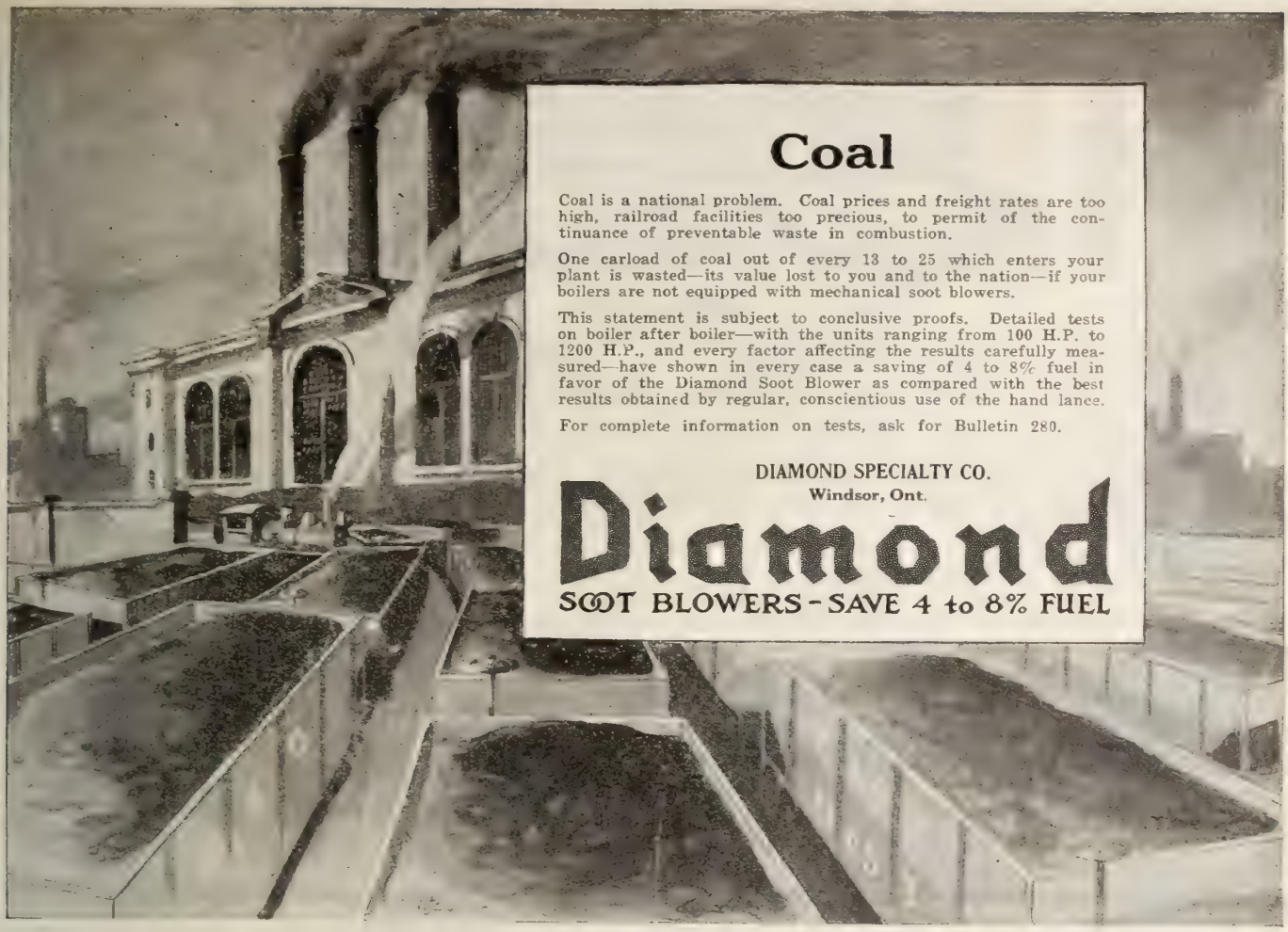
J. T. LONG
84 Adam St.
MONTREAL, CAN.

If your dealer does not sell it, write direct. No. 2

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.



Coal

Coal is a national problem. Coal prices and freight rates are too high, railroad facilities too precious, to permit of the continuance of preventable waste in combustion.

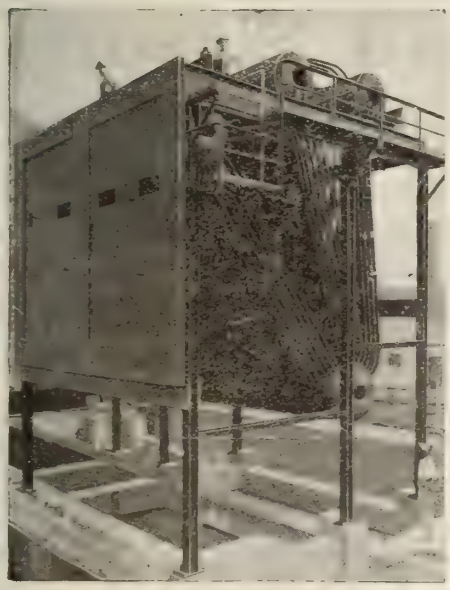
One carload of coal out of every 13 to 25 which enters your plant is wasted—its value lost to you and to the nation—if your boilers are not equipped with mechanical soot blowers.

This statement is subject to conclusive proofs. Detailed tests on boiler after boiler—with the units ranging from 100 H.P. to 1200 H.P., and every factor affecting the results carefully measured—have shown in every case a saving of 4 to 8% fuel in favor of the Diamond Soot Blower as compared with the best results obtained by regular, conscientious use of the hand lance.

For complete information on tests, ask for Bulletin 280.

DIAMOND SPECIALTY CO.
Windsor, Ont.

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL



Connelly Water Tube Boilers (Fatented U.S. & Canada)

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. Leonard & Sons Ltd. Head Office & Works
LONDON, CANADA

Branches:
1790 St. James St., Montreal, Que. 62 Water St., St. John, N.B

AGENTS
E. J. Philips & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. Johns, Nfld.

ESTABLISHED 1834

LEONARD

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

Turbo Generator Units

25 Cycle

1—8000 K.W. Normal rating Allis Chalmers Turbo-Generator, 3 phase, 4 pole, 6600 volt, rotating field, condensing high pressure 175-lb. gauge at throttle, 28-in. vacuum. Will not exceed 18-lb. dry steam per K.W. when working under full load. Condenser: 16,000 sq. ft. surface condenser with auxiliaries, will sell with or without condenser.
1—6000 K.W. General Electric-Curtiss Horizontal Turbo Unit, 3 phase, 6600 volts, 1,500 R.P.M. non-condensing, with exciter, expansion joint, etc., 170-lb. steam pressure.
1—3500 K.W. General Electric turbo Unit, 3 phase, 6600 volts, with Byer Baromatric Condenser.
1—2500 K.W. Westinghouse-Parsons Turbo Unit, 3 phase, 2200 volt, 1500 R.P.M., 150-lb. steam pressure.
1—2500 K.W. Westinghouse 3 phase, 2400 volt, 1500 R.P.M., 2 pole Condensing, 150-lb. pressure dry and saturated steam 28-in. vacuum.
1—2000 K.W. General Electric-Curtiss Vertical Turbo Unit, 3 phase, 2200 volt, 750 R.P.M., 4 pole, 150-lb. steam pressure. 6750 sq. ft. Worthington Surface Condenser with Auxiliaries.
2—1250 K.W. Westinghouse Condensing Turbo Unit, 3 phase, 6600 volt, 1500 R.P.M. 2 pole 140-lb. at 28-in. vacuum. With Condenser and auxiliaries.
1—850 K.W. Westinghouse-Parsons, horizontal Turbo Unit, 3 phase, 380 volt, 1500 R.P.M., 150-lb. pressure, 3000 sq. ft. Surface Condenser with auxiliaries.
1—750 K.W. Westinghouse Parsons, mixed pressure Turbo Unit, 3 phase, 380 volt, 1500 R.P.M. steam conditions,
1—750 K.W. Westinghouse Turbo Unit, 2 phase, 440 volt, 15.5-lb. absolute, 28 in. Vacuum with condenser.
—750 K.W. Westinghouse Turbo Unit, 2 phase, 440 volt, 1500 R.P.M., Condensing. With Condenser and Auxiliaries.
1—500 K.W. Westinghouse-Parsons Horizontal Turbo Unit, 3 phase, 2 pole, 370/400 volt, 1500 R.P.M., Condensing 150-lb. steam pressure, no superheat. With Condenser and Auxiliaries.

MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, Seattle Plants: Lincoln, N.J., and Linden, N.J.

Buyers and Sellers of New and Used Machinery

A Continent-Wide Service

CRANE FLANGED FITTINGS

CRANE

LIMITED

HEAD OFFICE & WORKS
1280 ST PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices: Halifax, Quebec, Ottawa, Calgary.

Head Fireman Wanted

Extensive experience on Taylor and other types of underfeed stokers. 7,000 horse-power plant. Give age, experience, reference and wages.

Box 72220

WE WELD EVERYTHING

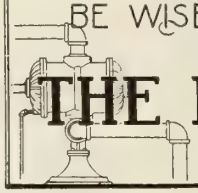
Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

The Under-Feed Stoker Co.

OF CANADA, LTD.

Sole Manufacturers in Canada of the Jones Under-Feed Stoker

81 Victoria St., - - TORONTO

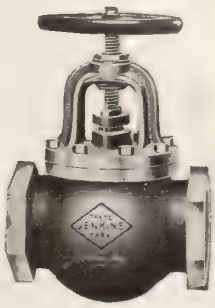
Write for complete Catalog.

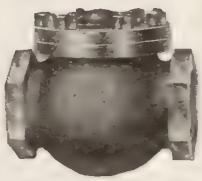
56 Years Record of Success Throughout The World

TRADE JENKINS MARK

The Jenkins Diamond Trade Mark is a Seal of Guaranteed Service

Jenkins Bros





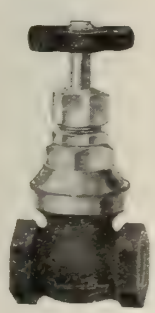
The Trade Mark That Says "This Valve is Dependable"

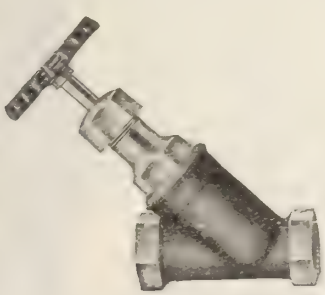
That is just what the Jenkins Diamond Trade Mark signifies—**absolute Valve Dependability.** It is cast upon the body of every genuine Jenkins Valve; put there as a protection against inferior imitations and a guarantee of lasting service under every condition of usage.

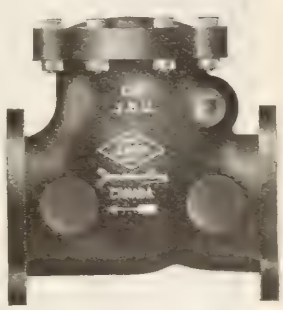
In every line of industrial endeavor—in power houses, water works, railroad shops, factories, office buildings—wherever good valve service is vital Jenkins Diamond Trade Marked Valves are giving a service in keeping with their 56 years reputation.

Catalog No. 8, free on request, pictures and describes the complete line—A Valve for every purpose.

Obtain Jenkins Valves from dealers everywhere.







Jenkins Bros.

LIMITED

TRADE JENKINS MARK Jenkins Bros

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal, can.

EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG.

Agencies in all the Principal Countries of the World

REGISTERED COPPUS U.S. PAT. OFFICE

In Glass Works

In the Glass Division Power Plant of the National Lamp Works out in Cleveland, Ohio, they burn gas coal screenings and producer tar — difficult fuel to burn economically. Yet with the 4-18" COPPUS Tubo Blowers which they operate, full steam pressure is maintained in their 4-250 H.P. Stirling Boilers—and cheap fuel is efficiently burned. Without these Blowers, one of which is shown above, additional boilers would have been necessary last fall. With their aid, however, the heavy plant load is easily handled.

Before the National Lamp Works installed COPPUS Blowers a careful investigation satisfied them that for efficient operation, low steam consumption, and sturdy dependability, COPPUS Blowers stand in a class by themselves. And after practical proof that COPPUS Blowers are all that is claimed for them, Mr. Bretz, Plant Superintendent, expresses himself as "highly pleased with them" In the National Lamp Works, as in thousands of plants in every industry, COPPUS Blowers have proved profitable investments.

Why not find out exactly how and why "COPPUS EQUIPMENT CAN SAVE YOU MONEY." Write us and our engineers will help you solve your combustion problems. If you haven't a copy of Blower Catalog write for one to-day.

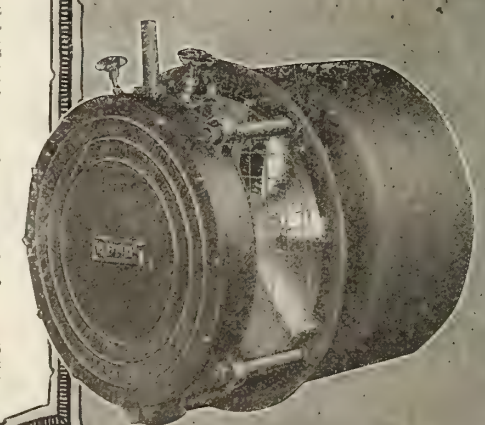
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng., Co., 135 Dalhousie Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary.



COPPUS TURBO BLOWER

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

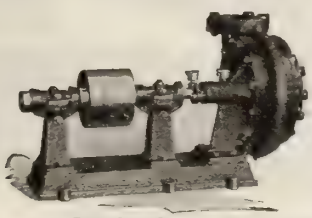
Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

AMERICAN-MARSH PUMPS

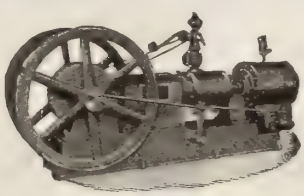
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

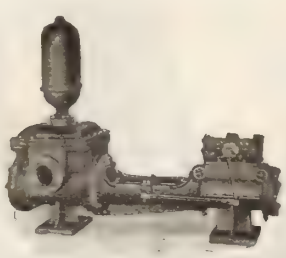


The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY
BATTLE CREEK, MICHIGAN

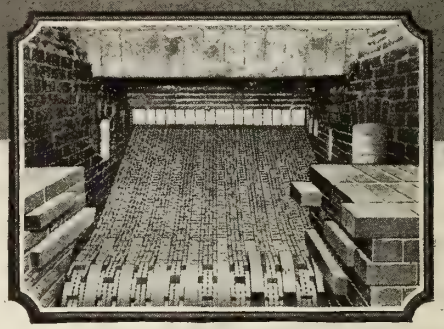


CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

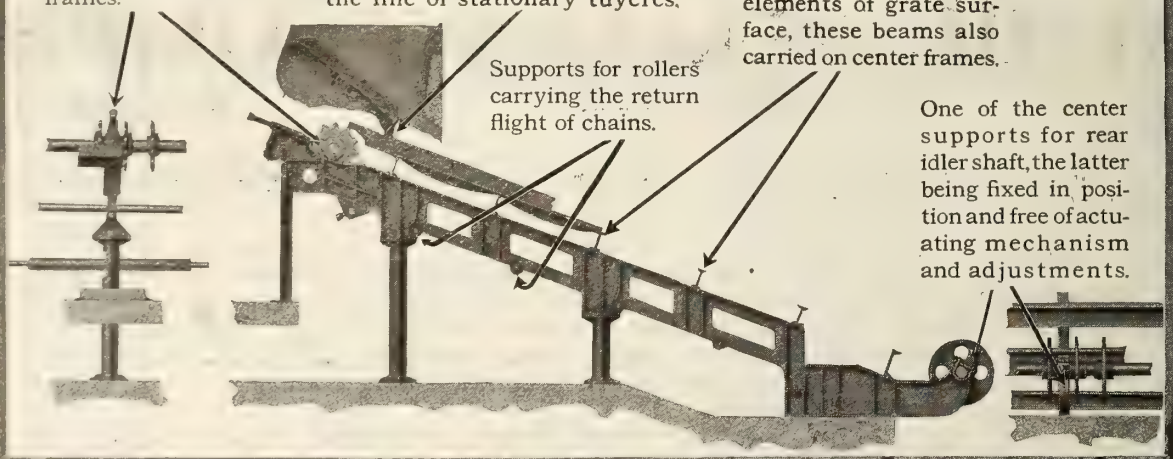
THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit



Detail of Center Frame


Adjustable sprocket shaft box carried on center supporting frames.
Hopper plate support for wide stokers, carried by center frame through the dead plate that starts the line of stationary tuyeres.
Supports for rollers carrying the return flight of chains.
I-beams supporting all elements of grate surface, these beams also carried on center frames.
One of the center supports for rear idler shaft, the latter being fixed in position and free of actuating mechanism and adjustments.

LACLEDE

A BUSINESS INSTITUTION

A Single Stoker for Units up to 1500 H. P.

Think of being able to supply your 1500 H. P. Boiler with a forced-draft, conveyor-feed stoker in *one* large unit!

It means doing away entirely with the high maintenance of a center wall, which fills up furnace space and necessitates two stokers to a boiler.

THE STOWE STOKER is built in *single units* for boilers up to 1500 H. P. rated capacity, producing an actual capacity of 300% rating.

This is possible because of the simple, common-sense method of supplying air to the Stowe Stoker, and because of the efficient use of *center supporting frames.*

The illustration across the page shows the detail of one of these sturdy center frames. Three of them are used on a Stowe Stoker 20' 9" wide, making in all five supports for all cross members such as idler shaft, sprocket shaft, hopper plates, tuyere supports, and lower rollers.

Note that the center frame is carried down to the foundation. This is the last word in massive, durable construction, and contributes much to the success of the *forced-draft, conveyor-feed* Stowe Stoker.

We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices:

CHICAGO, 1366 Peoples Gas Bldg. PITTSBURGH, 901 Oliver Bldg.
NEW YORK, 504, Fifty E. 42nd St.

Agents:

PHILADELPHIA, PA.
A. C. Warner Co.,
Bulletin Bldg.

KANSAS CITY, MO.
Thermal Efficiency Co.,
1210 Scarritt Bldg.

CHARLOTTE, N. C.
J. R. Purser,
406 Com. Bank Bldg.

DENVER, COLO.
Schwarz Eng. Co.,
310 Mack Bldg.

WINNIPEG, CAN.
Wm. A. Goold,
701 Merch. Bk. Bldg.

MONTREAL, CAN.
John C. Russell,
109 Place D'Youville.

D132

CHRISTY

FOUNDED 1844 ST. LOUIS

SURE, YOU KNOW

Dependable Furnace Linings insure dependable boiler furnace operation. You know that the more joints there are in your settings the more chance there is for destructive influences to act upon them. You know how quickly ordinary fire brick linings "come down." As surely as you know these facts you should know the facts about

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

that forms a seamless one-piece setting of high refractory materials of great tensile strength, and in which expansion and contraction have been neutralized. This one-piece construction assures a permanent boiler furnace lining.

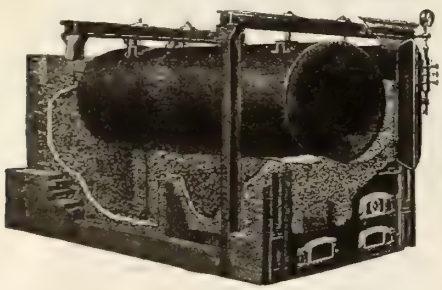


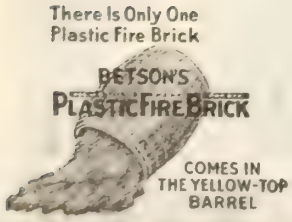
Illustration shows Betson's Plastic Fire Brick Lining, including fire box, front wall of arch, furnace side walls, bridge wall, combustion chamber walls and rear arch.

Betson's Plastic Fire Brick can be used to construct entire linings in place of fire brick, or to repair and replace defective linings of ordinary brick. It is practical for all types and makes of boilers. Also baffles can be built of any size, shape or slope, for horizontal or vertical type boilers of any make.

Easy to lay up—no special tools needed—shipped ready for use—from warehouses in many cities. Backed by a service record of over 20 years.

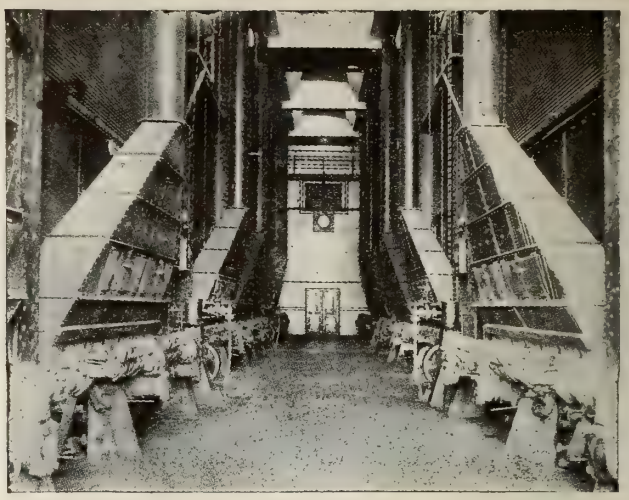
If it's "Plastic Fire Brick" it's Betson's. If it isn't Betson's it isn't "Plastic Fire Brick."

Write for our informing Booklet to-day.



Betson Plastic Fire Brick Co., Inc.
P.O. Box 386-6, Rome, N.Y.

Canadian Distributor:
International Chemical Co.
44-6 Lombard Street - Toronto, Ont., Canada



YARWAY
Seatless Blow-Off Valves

In Massachusetts

In the United Electric Light Company's plant at Springfield, thirty-six **Yarway Seatless Blow-Off Valves** have been in continuous service since October 1, 1916.

The simple and durable construction of these valves guarantees faithful service and long life.

In operating shoulder S on plunger V engages the follower gland F, compressing packing P above and below the port, and making an absolutely tight valve.

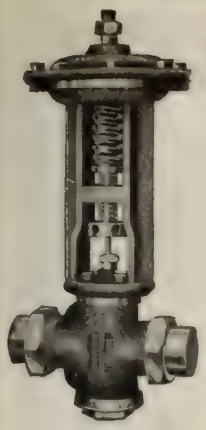
Full details and list of well-known users on request.

Yarnall - Waring Company

7604-20 Queen Street
Chestnut Hill Philadelphia
Representatives in All Principal Cities

"No Seat to Leak"

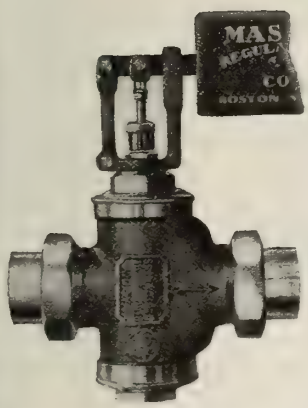
MASON No. 55 PUMP
PRESSURE REGULATOR



MASON STANDARD
REDUCING VALVE
IRON BODY

MASON STANDARD
REDUCING VALVE
BRONZE BODY

(NOTE THE
TRADE MARK.)

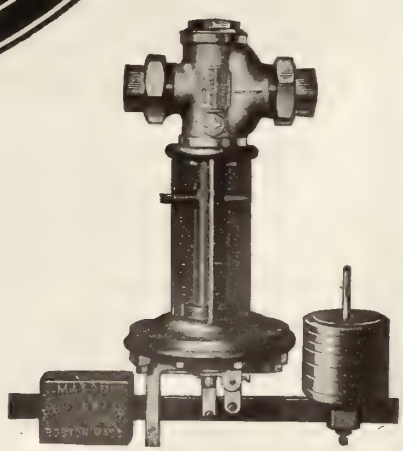


MASON BALANCED
VALVE. WEIGHT AND
LEVER STYLE

SERVICE
RELIABILITY
POSITIVE ACTION

GET THE GENUINE

OUR TRADE-MARK IS YOUR GUARANTEE



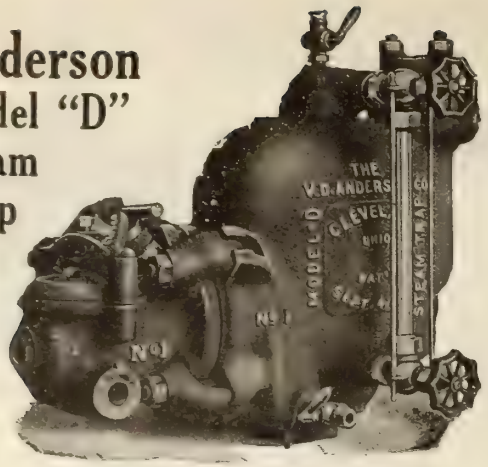
MASON LEVER-STYLE
REDUCING VALVE

THE MASON REGULATOR CO.,
BOSTON, MASS.

MADE IN CANADA BY

THE MASON REGULATOR & ENGINEERING COMPANY LIMITED
MONTREAL TORONTO

Anderson Model "D" Steam Trap



Different —and Better!

In the Anderson Model "D" Steam Trap you have the answer to your condensation problems. Its unique construction fits it for use anywhere. It automatically disposes of the condensation as fast as it accumulates and adjusts itself to any varying amounts within its capacity.

To change from high to low pressure or vice versa, all that is necessary is to change the valve and valve seat. This can be done in five minutes without disturbing or unscrewing a single joint or pipe connection.

The valve seat is always sealed with at least three inches of water, making the escape of live steam impossible, which means not only a saving in time and trouble, but what is more important, a great saving in coal.

Special features of the Anderson are, a self-contained strainer, an outside gage glass, self-contained by-pass and complete accessibility to all parts.

Install one on that 120-lb. main—to protect the engine; on these 60-lb. coils in the vacuum pans; on those big exhaust heaters under the drying ovens, anywhere where there's condensation to handle.

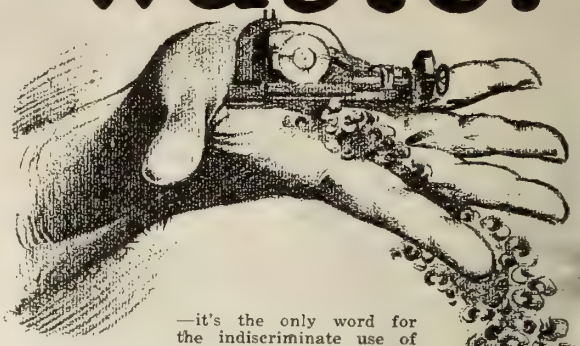
Booklet and prices on request

The V. D. Anderson Co.

1935 West 96th St.

CLEVELAND - OHIO

-waste!



—it's the only word for the indiscriminate use of rotary cutting-off saws. The heaviest Starrett Hack Saw is but .065 inch thick. Compare its "kerf" with that of a half-inch rotary, often used for the same work. Send for free copies of the Starrett Hack Saw Book and Catalog No. 21 "C.D."

You need the Starrett Hack Saw Chart — sent free on request

The L. S. Starrett Co.

The World's Greatest Toolmakers

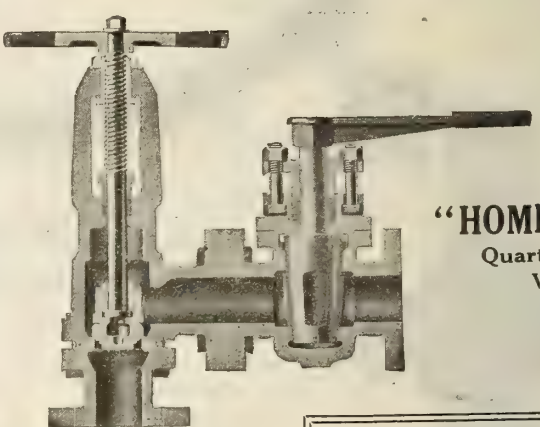
Mfrs. of Hack Saws Unexcelled

Athol - Mass.

42-55

STARRETT HACK SAWS CUT QUICKER LAST LONGER — STARRETT TOOLS

Starrett Hack Saws



"HOMESTEAD"
Quarter-Turn Valve

"HOVALCO"
Renewable Blow-Off Valve

Leak Proof!

A Reliable Combination

This absolutely dependable combination consisting of the "Hovalco" Blow-Off Valve and the "Homestead" Quarter Turn Valve ends every blow-off trouble.

The **"Hovalco" Blow-Off Valve** is made with an extra heavy semi-steel body. Both the valve disc and the seat are made of a special alloy. The removal of four bolts gives perfect access to every part.

The **"Homestead" Quarter Turn** will stay tight under any specified pressure and is easily opened or closed by one quarter turn of the lever.

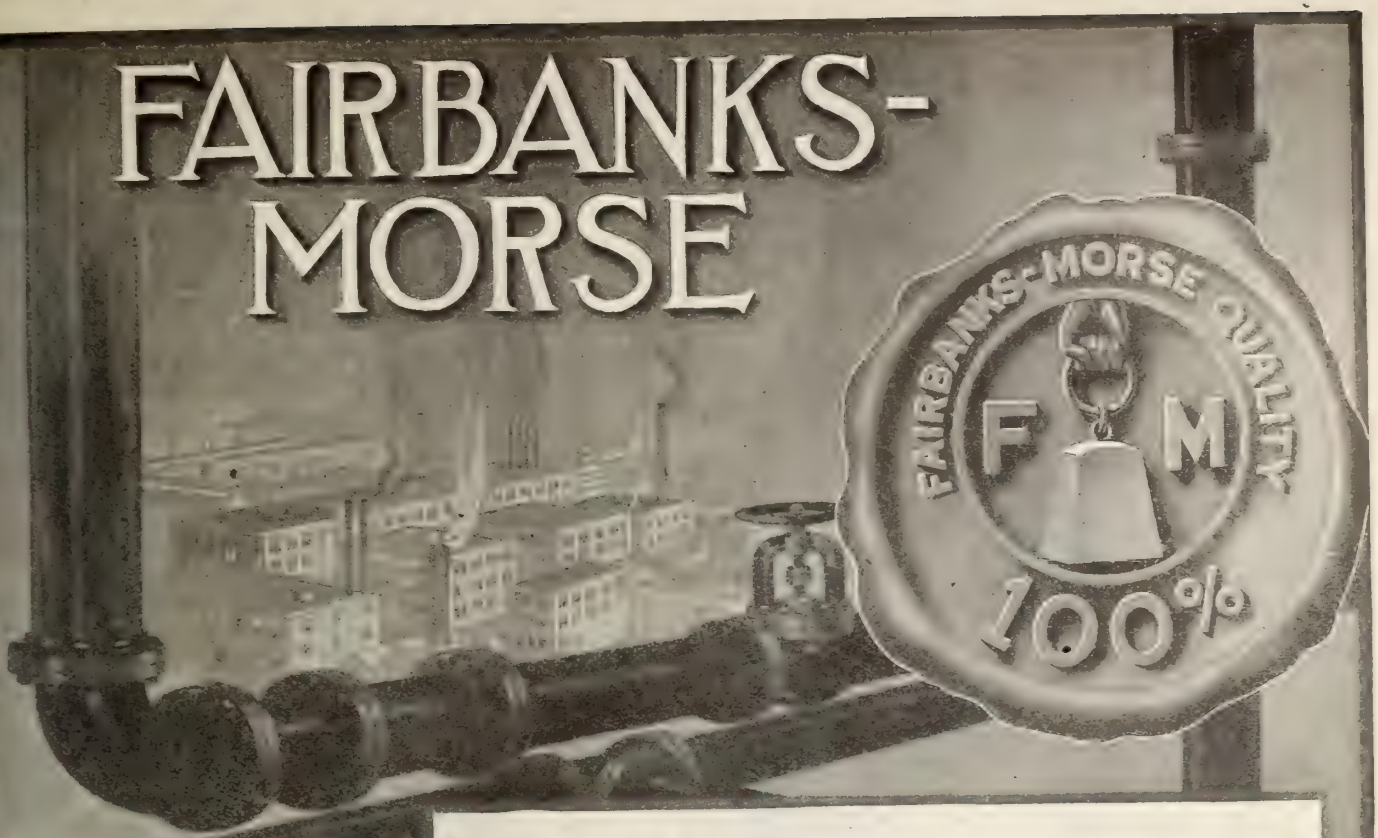
Bulletins on request.

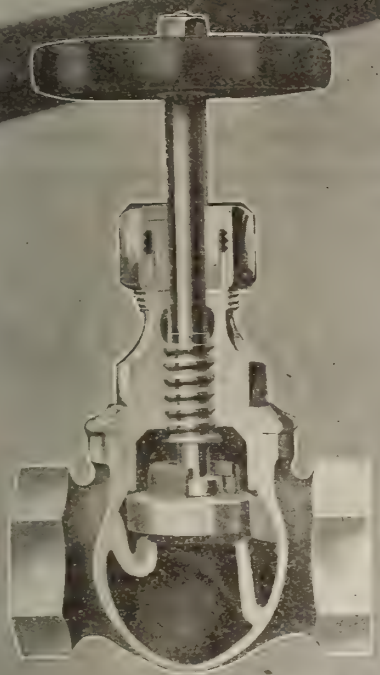
Homestead Valve Mfg. Co.

PITTSBURGH, PA.

Works: Homestead, Pa.

FAIRBANKS-MORSE





An Achievement in Mechanics

EACH individual department of The Canadian Fairbanks-Morse Company, Limited has given industrial Canada a new conception of achievement in mechanics. Each department has established a 100% quality and service standard. This is what enables Fairbanks valves to stand pre-eminent wherever valves are used.

When an engineer specifies Fairbanks valves, he knows that he has selected not only quality of material but workmanship that guarantees perfect operation.

He is satisfied with the reputation and service of the institution that stands behind them. He acknowledges an achievement in mechanics.

Wherever pipe lines are laid—in Canada's great industrial plants—in her immense water systems—in mines and mills—Fairbanks valves are giving a service that is marked by the 100% seal of quality, the standard of The Canadian Fairbanks-Morse Co. Limited.

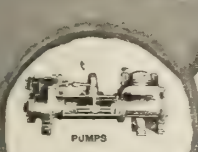
Our nearest branch will give you the benefit of this service, Our experts will help you in selecting valves and everything mechanical that you require. Make our catalogue your buying guide.

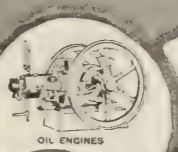
The Canadian Fairbanks-Morse Co.
Limited

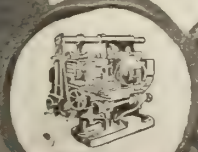
Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

5







Valves That Can't Dish

High pressures and hot water quickly wreck the best rubber valves. Ask any engineer.

Voorhees Rub-Steel Valves

are rubber, too, but the rubber has a steel "backbone" enveloped in it. They stand up under extreme pressures and give the perfect seating that prevents slippage. Every piston stroke returns full value.

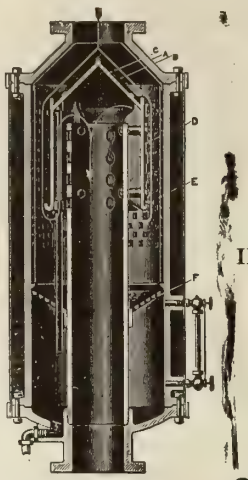
Try Them for Boiler Feeds
Two Tough and Resilient Faces

The Canadian Fairbanks-Morse Co., Limited

Exclusive Canadian Agents for

Voorhees Rubber Mfg. Company
Jersey City, N.J.

III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

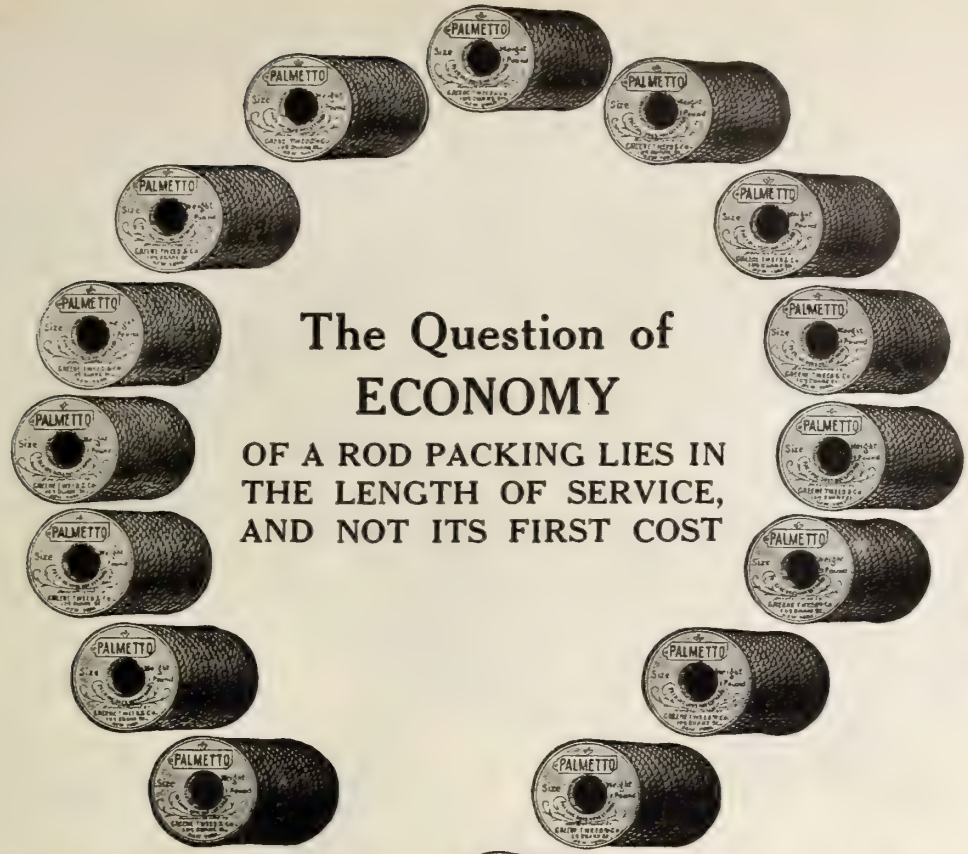
Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA



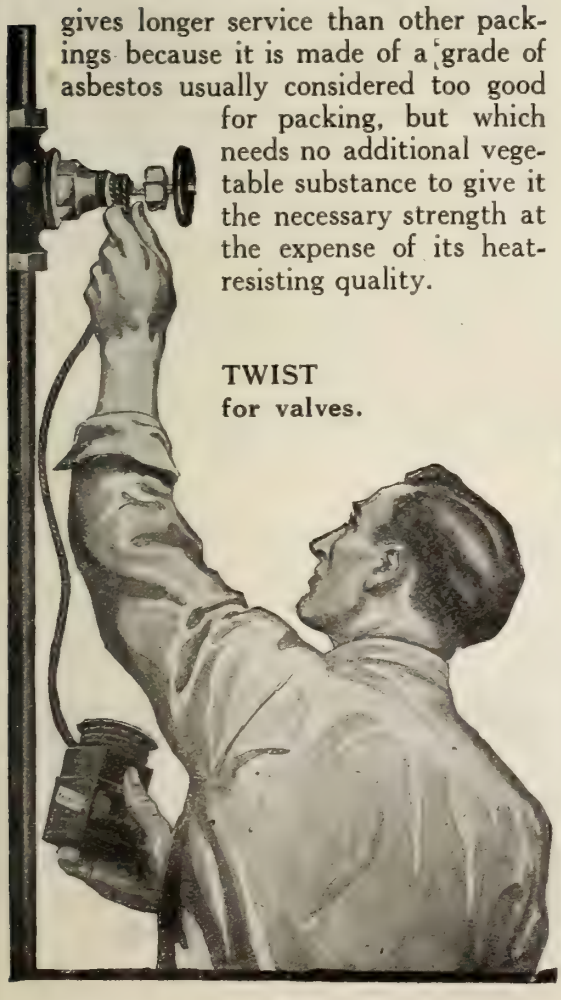
The Question of ECONOMY

OF A ROD PACKING LIES IN THE LENGTH OF SERVICE, AND NOT ITS FIRST COST

"PALMETTO"

gives longer service than other packings because it is made of a grade of asbestos usually considered too good for packing, but which needs no additional vegetable substance to give it the necessary strength at the expense of its heat-resisting quality.

TWIST for valves.



"PALMETTO"

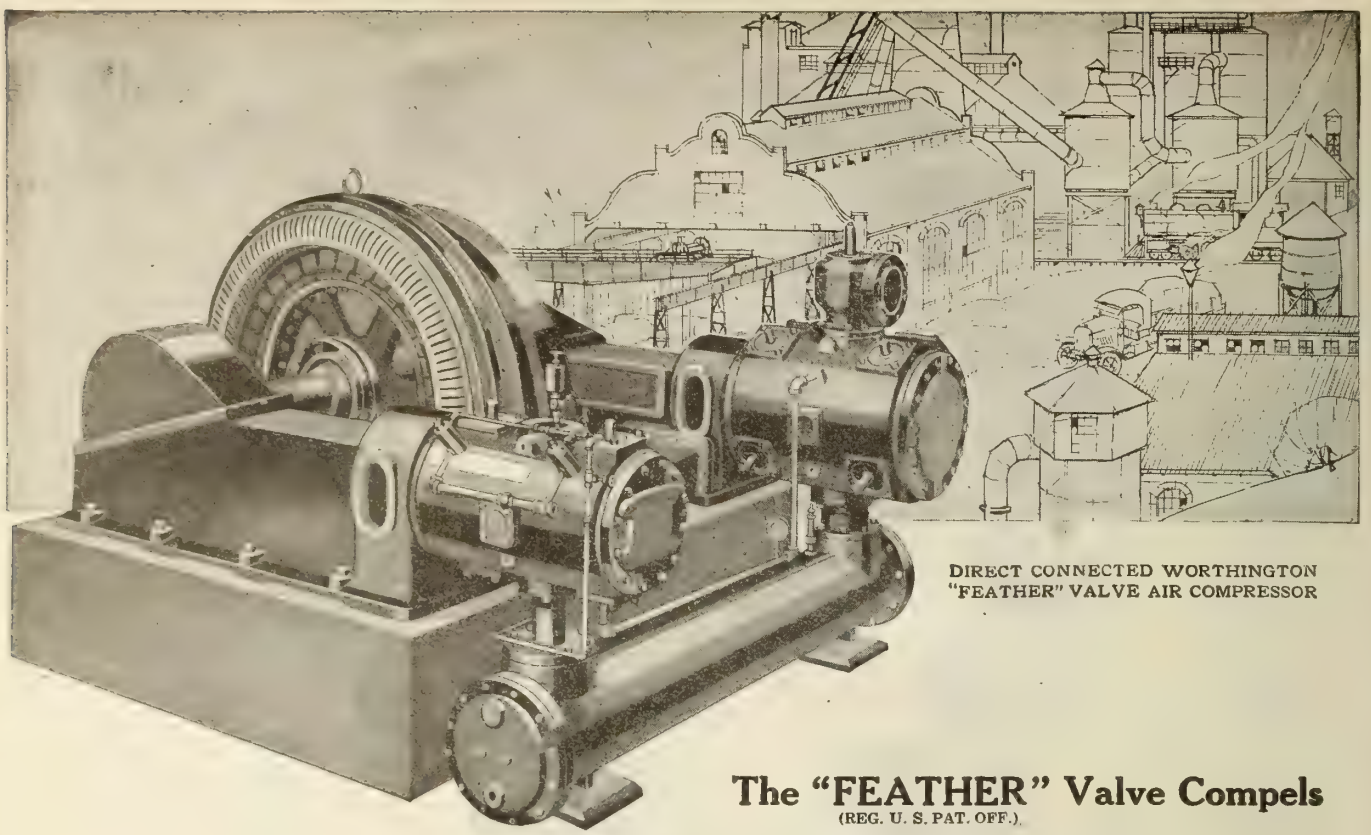
does not become hard like other packings, because each single strand has lubricant forced into it before braiding, which lubricant not only keeps it soft but so lubricates the rod as to prevent friction and wear of both rod and packing.

BRAIDED for rods.

Let us send you sample of both braided and twist to test—no charge.

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited
Montreal Ottawa St. John Toronto
Winnipeg Calgary Saskatoon
Victoria Vancouver

GREENE, TWEED & CO.
109 DUANE STREET, NEW YORK
Sole Manufacturers



DIRECT CONNECTED WORTHINGTON
"FEATHER" VALVE AIR COMPRESSOR

The "FEATHER" Valve Compels
(REG. U. S. PAT. OFF.)
Dependable Air Service

AIR Compressors and Compressed Air Services have been rendered sure, safe and reliable by Worthington "FEATHER" Valve. This valve has but one moving part, weighs less than one ounce and functions without friction or hammering action. It is a strip of ribbon steel—strong and long lasting—that seats tightly on ground face slotted seats and allows air or gas to pass by bowing against slotted curved guards, the ends remaining in contact with seat at all times.

All Worthington Air Compressors are "FEATHER" Valve equipped, and are built by Worthington, whose service has attained world dimensions through 80 years' building, designing and improving Pumps and Pumping Machinery for all uses and purposes.

Other Worthington Products:
Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

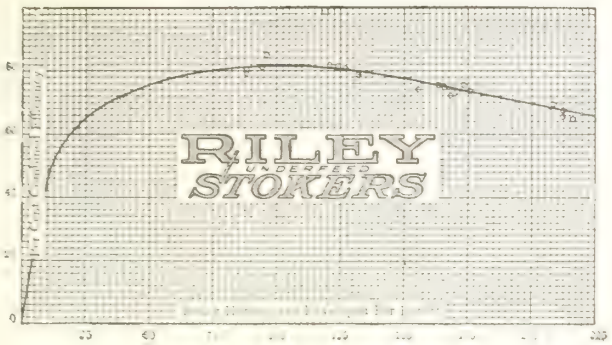
WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

High Efficiency



The continuous high efficiency of the Riley Stoker is due to the moving grates. These moving units not only keep the fuel bed open, porous and free from clinkers, but automatically discharge the ash and refuse.

Because of the moving grates, Riley Stokers have that faculty of operating continuously at high efficiency and capacity. Fuel-saving is a mechanical certainty. There can be no waste.

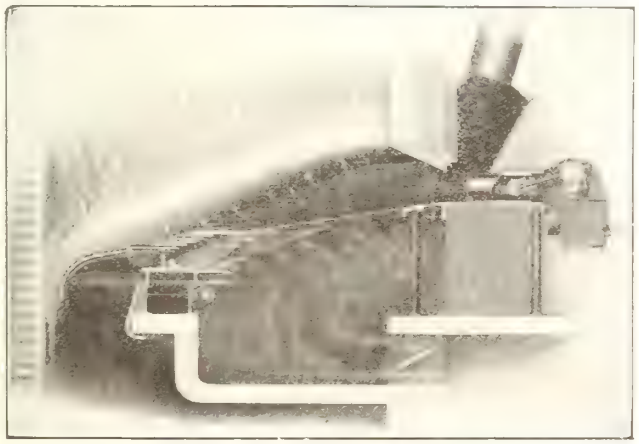
The efficiency curve shown above is typical of Riley Stoker performance. This curve is plotted from a series of tests conducted on a 16-retort Riley Stoker installed at the Essex Station of the Public Service Electric Company, Newark, N.J. Why not duplicate these results in your plant? You can do it with Riley Stokers.

Riley Stoker catalog HR-8 sent on request.

For information on the Murphy Automatic Furnace for smaller boilers, see last month's advertisement, or send for Murphy catalog HM-8.

Sanford Riley Stoker Co.

Worcester, Mass.



"Jack—why don't you save yourself work and save the boss money by using

PRATT & CADY RENEWABLE VALVES"

You'll be an enthusiastic booster for these 20th-century valves if you give them just one trial.

They save work for the men, because they don't have to be ripped out of the pipe line and replaced with a new one when they wear and begin to leak. New seat rings, or a new disc, can be inserted in a few minutes.

This makes the old valve as good as new at about 10% of its original cost. That saves the boss 90% of the cost of a new valve—saves the time of men removing an old valve from line and putting in a new one—and often saves shutting down part of the plant while a new valve is being put in.

P & C Renewables are made in both Gate and Globe Valves, for every purpose. May we send booklet?

PRATT & CADY CO., Inc.

Manufacturers of Valves, Asbestos Packed Cocks, Feed Water Heaters, Hot Water Generators, Hot Water Service Heaters and Power Pumps

Boston	Minneapolis
Chicago	Philadelphia
Cleveland	Pittsburgh
Detroit	San Francisco
Hartford	New York

P&C CO

Representatives in all large cities.

"MEAD-MORRISON"

CANADIAN MM C

CANADIAN MM C

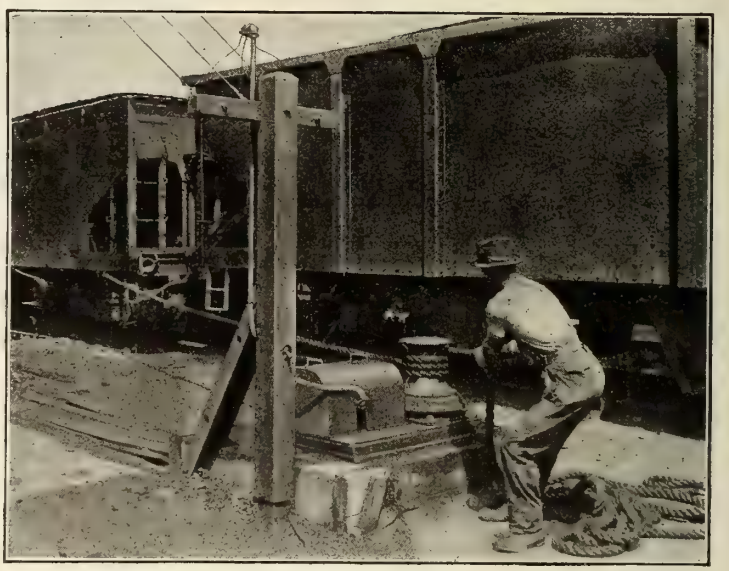
Electric Car Puller

How long does it take you to spot that car ?

How do you get the empties back on the other siding ?

This ***Car Puller*** requires only ***One Man***.

The capacity of the Puller is a Rope Pull of 3,500 pounds at a rope speed of 60 feet a minute.



GETTING ALONG WITHOUT THE SWITCHING LOCOMOTIVE

Furnishes ***Dependable Service***
under all conditions

PUT YOUR PROBLEM UP TO US !

Agents: Kelly Powell, Winnipeg; Howard Turnbull, Toronto; Robert Hamilton, Vancouver

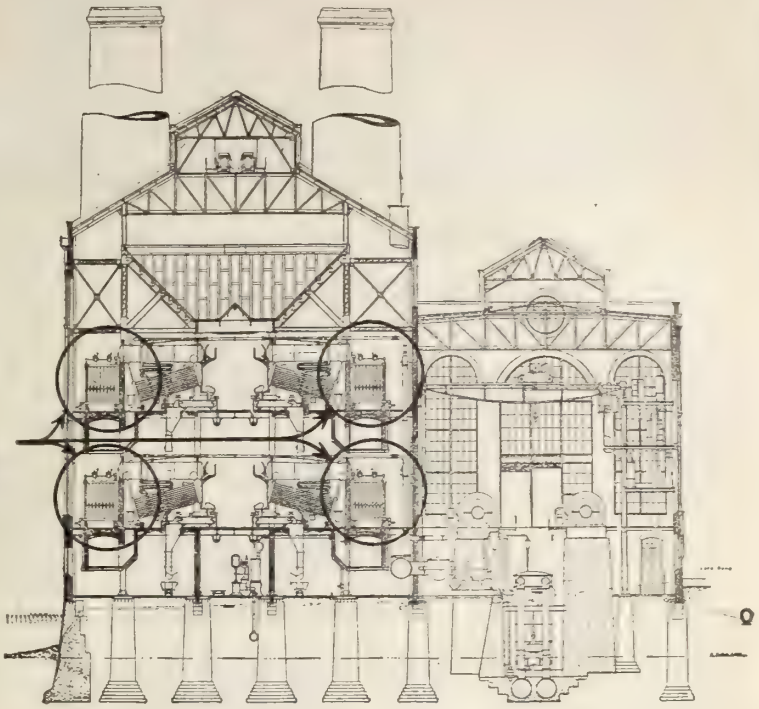
CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS: WELLAND ONT.

The Largest Installation in the World

Green's Economiser installation in Chelsea Station, London, England is the largest of its kind in the world—about 15,000 tubes. Wherever steam is generated by stationary boilers, especially in the great industrial centres, you will find

GREEN'S ECONOMISERS

The merit which is sending them to take their place at the head of world competition is yours at home. Just as in Europe, South America, Japan and China, firms large and small can bear witness of their value as fuel savers.



Chelsea Station, Underground Electric Railways Co., London, Eng.

GREEN'S ECONOMISER, LTD.
TORONTO

Our engineers will be glad to submit data showing the saving possible to you by installing economizers.

ECONOMY AND EFFICENCY

DON'T PUT IT OFF TOO LONG

This is the time to turn your Heating over to the "COLE" way.

Send for a free copy of the second addition of our book entitled "STEAM CONDENSATION"

GEO. W. COLE LIMITED
Engineers and Manufacturers

2002-4 Dundas St. W. **Toronto**

Winnipeg, Man. Vancouver, B.C. New Glasgow, N.S. Montreal, Que.

IN THE STEAM PLANT.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E. S. MANNY Co

27 COTE St. MONTREAL, QUE

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

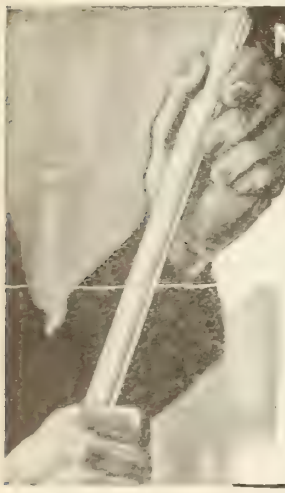
OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*



MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

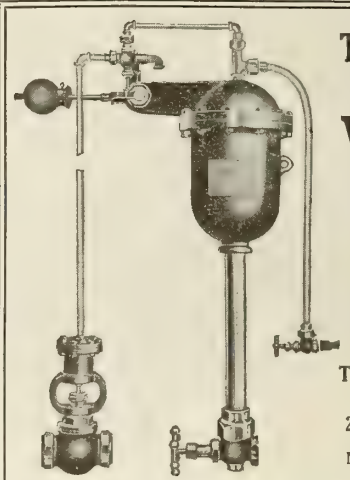
A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotland

Canadian Representative:

W. J. WALL, 134-136 Bleury St., Montreal



THE REGULATOR THAT MEANS SECURITY

VIGILANT

Feed Water Regulator

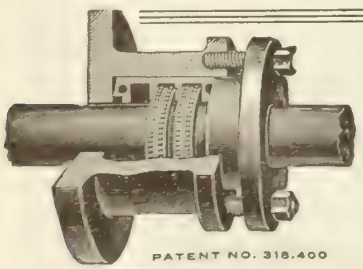
Safeguard against explosions. It cannot fail to operate and keep the boiler supplied with water as long as there is any water to feed.

Catalog will be sent on request.

The Chaplin-Fulton Mfg. Co.

28-34 Penn Ave., Pittsburgh, Penn.

Manufacturers of the Fulton Pump Governor



PATENT NO. 318,400

PAT. NO. 829,118
" " 846,510
" " 864,103
" " 878,238
" " 894,537
" " 895,791
" " 896,068
" " 905,103
" " 934,629
" " 974,208
" " 1000,176

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS

BOILERS & TANKS, WATER FILTERS THERMOMETERS, GAUGES

E. J. Philip & Sons, Engineers, 57 Queen Street, West Toronto, Canada

DEPARTMENT OF LABOUR

Ontario Government

Minister: Hon W. R. Rollo — Deputy Minister: W. A. Riddell, Ph.D.

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

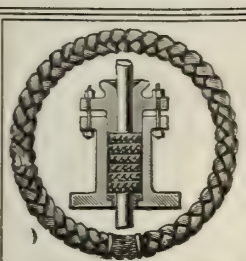
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

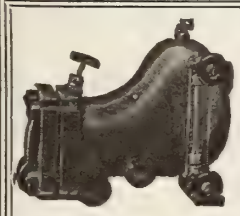
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal



McDANIEL IMPROVED STEAM TRAP

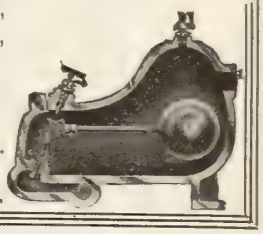
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



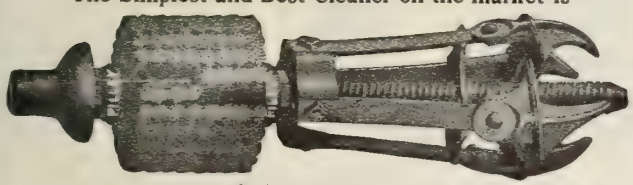
THE GARTH COMPANY

26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.

No. 146 N. 7th Street, PHILADELPHIA, Pa.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

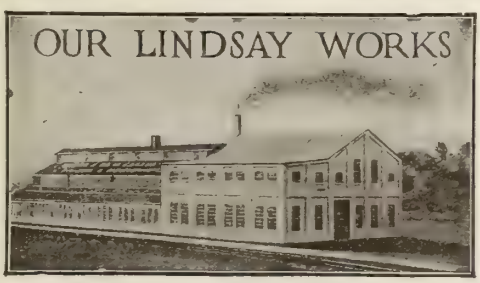
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

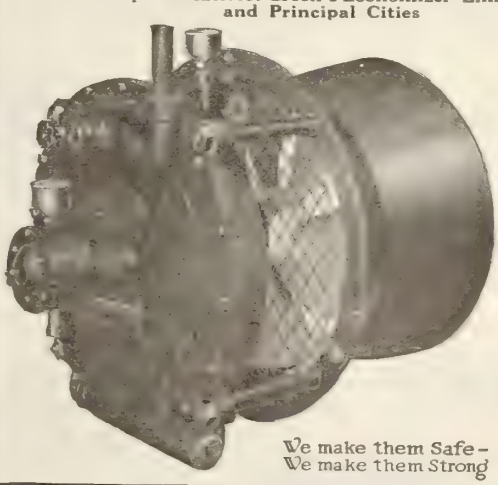
Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY

Engineers and Manufacturers WORCESTER, MASS

Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,

Centrifugal Blowers and Exhausters,

Small Power Turbines,

Damper Regulators and Grates

We make them Safe—
We make them Strong

Showing ease with which Plibrico is laid in place.

PLIBRICO Increases Boiler Efficiency

PLIBRICO is a plastic refractory that makes a solid one-piece furnace lining without joints. PLIBRICO also is unexcelled for baffle construction and repairs.

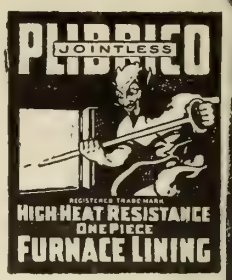
It will increase the efficiency of your boiler 15 per cent. It will make your furnaces gas and air tight and greatly reduce the cost of upkeep. Can be used wherever fire brick is used. Will outwear any fire brick made.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.
Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

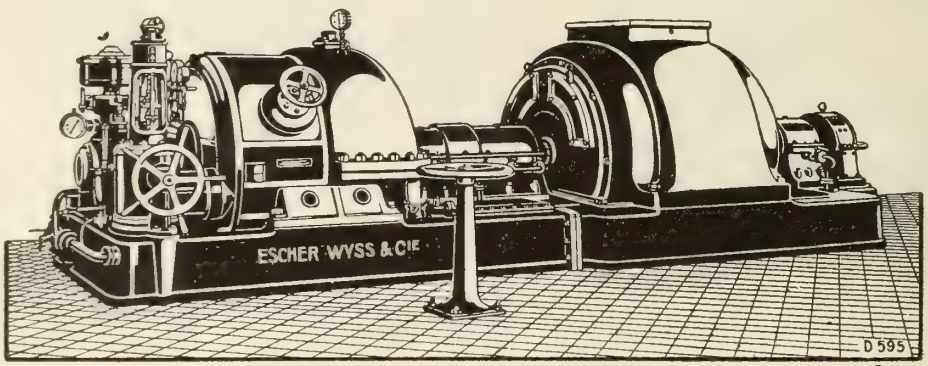


Trade Mark
Reg. U.S. Pat Office.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

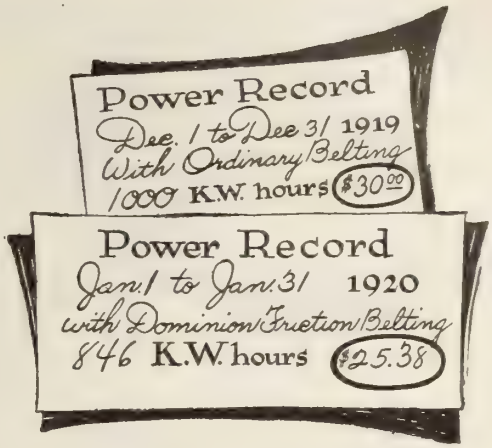
BUSCH-SULZER DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.



Decrease Your Operating Cost

Efficient transmission equipment is an important factor in keeping down operating costs. Each repair you have to make to your belting equipment means delays and idle employees—the total cost of which is often greater than you would pay for better belting.

Dominion Friction Surface Belting

is built for "service first." Through its long life and continuous performance it practically eliminates the necessity for repairs and replacements. It eliminates delays and needless waste of time.

At your convenience, our belting experts will be glad to analyze your transmission equipment and prove that you can put in the profit column most of the losses created through transmission troubles.

All you need to do, is 'phone, wire or write our nearest service branch.

Dominion Rubber System Service Branches

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbrige,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

DOMINION RUBBER SYSTEM — CANADIAN CONSOLIDATED RUBBER CO. LIMITED — AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the same High Standard as Dominion Friction Surface Belting.

91

Continuous service and low maintenance cost due to the self-cleansing seat

LUNKENHEIMER "DURO"
BLOW-OFF VALVES

Remain tight under the most severe operating conditions because the self-cleansing seat feature eliminates the cause of most of the wear to which Blow-off Valves are subjected.

This self-cleansing seat feature,—exclusive in Lunkenhiemer "Duro" Blow-off Valves, functions automatically when the valves close by cutting off the inlet and allowing only a fine spray of water to pass, thereby removing foreign substances which may have lodged on the seat during the blow-off period.

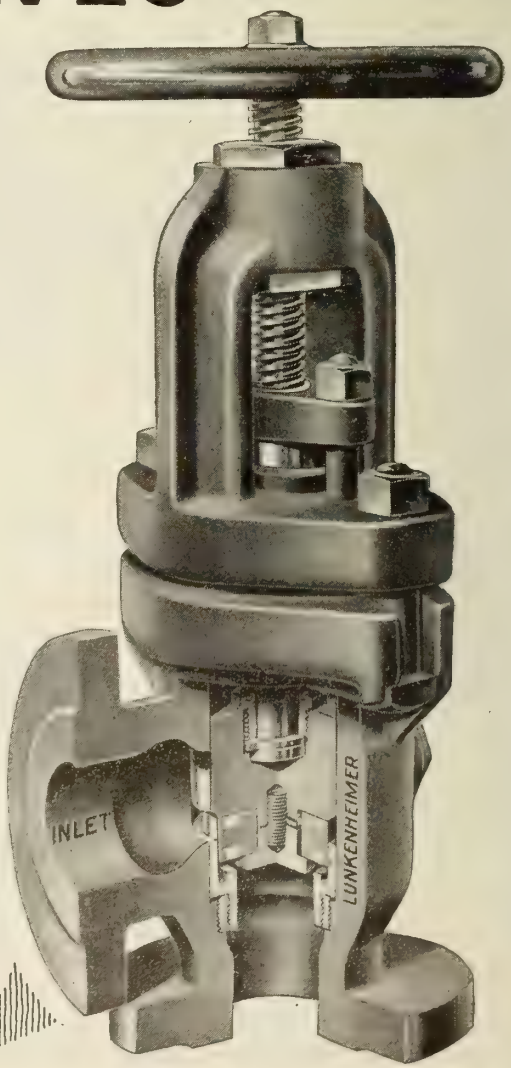
In addition to the self-cleansing seat feature, the disc is reversible and has seat faces made of a durable alloy which readily accomodates itself to any irregularity in the seatring insuring tight though easily operated valves.

To further enhance their durability as a whole, all the parts are renewable.

Lunkenheimer "Duro" Blow-off Valves have proved their merit in service and are specified where boiler mountings of the better grade are desired.

All standard sizes, in material combinations to suit a wide range of pressure and temperature conditions.

Your local dealer can furnish them; if not, write us.
Write for descriptive booklet No. 515-DC



THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

AMERICA'S BEST
LUNKENHEIMER
—QUALITY—
SINCE 1862

One sixteenth — one eighth —and more

NOT true?

Yes, it's an absolute fact when you compare ordinary rubber sheet packing with Seigelite.

Suppose you've made up a joint with sixteenth inch flange to flange distance. What thickness rubber sheet did you use? Eighth inch, of course, and squeezed it down to a sixteenth.

For the same job you could use sixteenth inch Seigelite and have a better, tighter joint in the bargain. You'd have a gasket that wouldn't rip or squeeze out—that would far surpass rubber on water service—that could be used against gasoline, benzene and other solvents where rubber or rubber substitutes would absolutely fail.

Other Johns-Manville Power Plant Materials: — Asbestos and Magnesia Pipe and Boiler Insulations, to reduce radiation and heat loss from uninsulated heated surfaces in power plants, public institutions, private residences, etc.; Packings for engines, pump and valve rods and pipe joints, to prevent steam leakage and power loss; Steam Traps to collect condensation without leakage of steam; Refractory Cements to lengthen the life of boiler settings and prevent setting leakage; and many other power plant maintenance materials.

Canadian Johns-Manville Co., Limited

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa Windsor

Give these facts a thought the next time you start to order rubber sheet — for water, oil or gasoline service — and change it to Seigelite, the thinner packing for better service. Seigelite is dense but resilient before it is squeezed between flanges.

Through—
Asbestos
and its allied products
JOHNS-MANVILLE
Serves in Conservation
Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE
POWER PLANT MATERIALS

KELLOGG CHIMNEYS

Kellogg represents the most advanced idea in chimney construction.

Tests have proven that the adhesion between mortar and Kellogg Corrugated Brick is 62½% greater than between mortar and ordinary straight or plain-sided brick.

Molding Kellogg Bricks with vertical perforations permit thorough burning, thus increasing their density and strength, and decreasing their weight.

Kellogg chimneys are the logical selection for your power plant. Their stability and permanence offer a great advantage over other chimneys.

You should be thoroughly familiar with the many features of Kellogg Chimneys. Let us send you full details.

Recently Completed

Canadian Woollens, Limited, Peterboro, Ont.—145′ x 5′.
Wayagamack Pulp and Paper Co., Baptist Island, Que.—250′ x 10′.
Peterboro Milk Products, Peterboro, Ont.—90′ x 4′.
Prest-O-Lite Company, Toronto—110′ x 5′ 6″.
Ames-Holden Tire Co., Kitchener—175′ x 7′.
General Motors, Inc., Oshawa—175′ x 7′ 6″.

Canadian Agents:

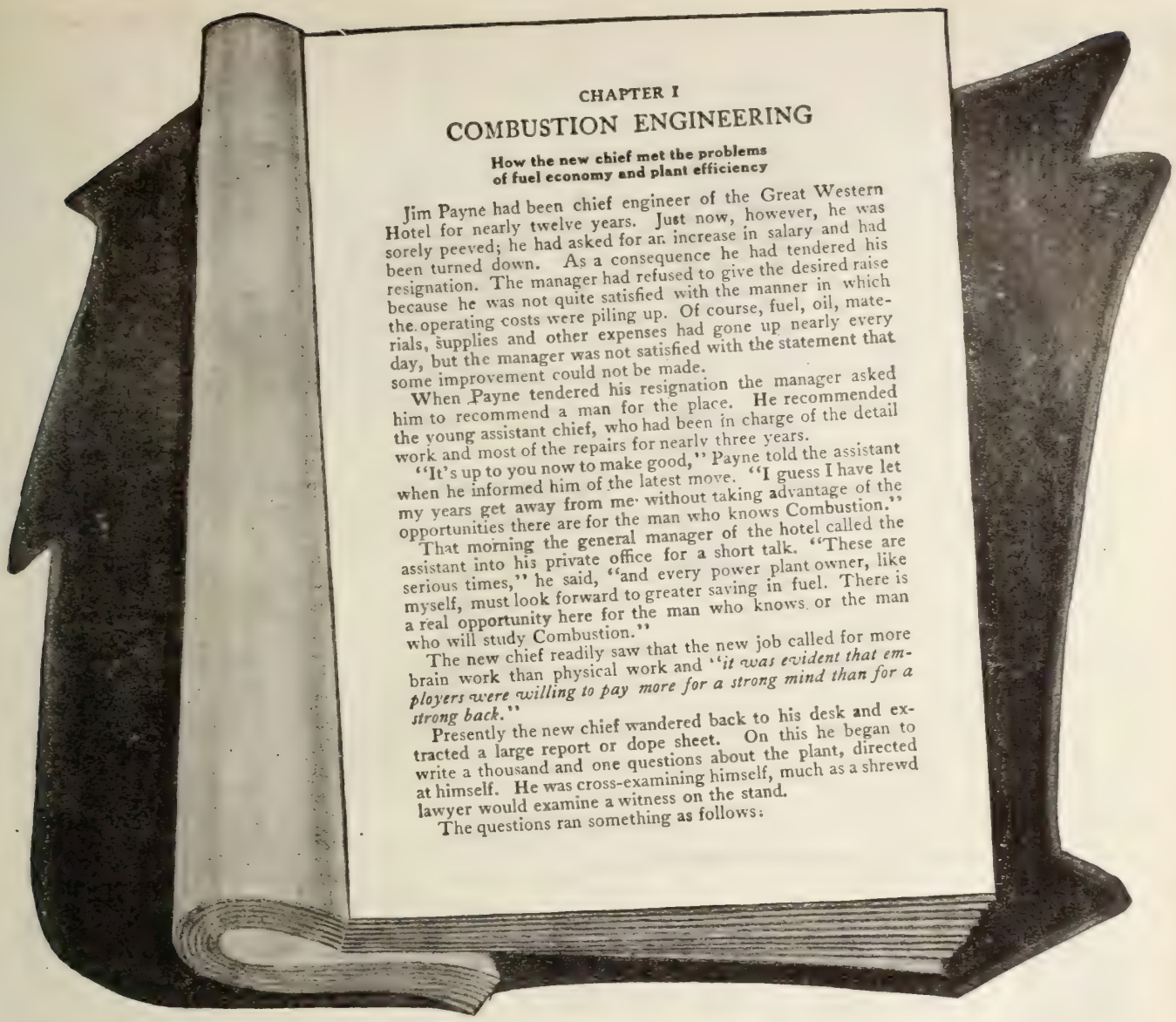
The Arthur S. Leitch Co.

1002 Kent Building

Toronto

Just Completed

Kellogg Radial Brick Chimney, 145′ x 5′, Canadian Woollens, Limited, Peterboro, Ont.



CHAPTER I

COMBUSTION ENGINEERING

How the new chief met the problems of fuel economy and plant efficiency

Jim Payne had been chief engineer of the Great Western Hotel for nearly twelve years. Just now, however, he was sorely peeved; he had asked for an increase in salary and had been turned down. As a consequence he had tendered his resignation. The manager had refused to give the desired raise because he was not quite satisfied with the manner in which the operating costs were piling up. Of course, fuel, oil, materials, supplies and other expenses had gone up nearly every day, but the manager was not satisfied with the statement that some improvement could not be made.

When Payne tendered his resignation the manager asked him to recommend a man for the place. He recommended the young assistant chief, who had been in charge of the detail work and most of the repairs for nearly three years.

"It's up to you now to make good," Payne told the assistant when he informed him of the latest move. "I guess I have let my years get away from me without taking advantage of the opportunities there are for the man who knows Combustion."

That morning the general manager of the hotel called the assistant into his private office for a short talk. "These are serious times," he said, "and every power plant owner, like myself, must look forward to greater saving in fuel. There is a real opportunity here for the man who knows or the man who will study Combustion."

The new chief readily saw that the new job called for more brain work than physical work and "*it was evident that employers were willing to pay more for a strong mind than for a strong back.*"

Presently the new chief wandered back to his desk and extracted a large report or dope sheet. On this he began to write a thousand and one questions about the plant, directed at himself. He was cross-examining himself, much as a shrewd lawyer would examine a witness on the stand.

The questions ran something as follows:

WHAT are your chances for real success?

Do you realize the opportunities that a knowledge of Combustion offers to the man who wants to be more than merely the average?

It is not so much a strong back today as it is a strong mind that counts!

The man who knows Combustion can state his own salary and his services are always in demand.

Would you like to have the opportunity of getting a thorough knowledge of Combustion and Boiler Room Management in your spare time and at a very small cost, payable monthly if so desired? Jos. W. Hays, author of the Course and Educational Director, formerly Consulting Combustion Engineer of the U. S. Navy; W. L. Abbott, Chief Operating Engineer of the Commonwealth Edison Company; Fred R. Low, Editor of "Power"; Prof. S. W. Parr, Department of Chemistry, University of Illinois; Joseph Harrington, formerly Administrative Engineer, U. S. Fuel Administration; David Moffat Myers, formerly Advisory Engineer for the U. S. Fuel Administration; Arthur L. Rice, Editor of "Power Plant Engineering," and I. E. Moultrop, Bureau of Construction, Edison Electric Illuminating Co., have now made it possible for you, thru the Hays Course in Combustion Engineering and Boiler Room Management, to obtain a thoro knowledge of Combustion in your spare time without interfering with your present work in the least.

This Free Book

will tell you some interesting pointers that the average power plant and boiler room man should know, particularly about Combustion Engineering

The coupon will bring to you, without any expense whatever, a copy of this interesting book, covering power plant and boiler room management. It tells you how other men like yourself have, thru the Hays Course, achieved real success and how the same can be made possible in your case.

If you are determined to get out of the ordinary class and to push ahead where your services will be worth much more than they are today, get your copy of this book at once. It will help you from the time you receive it. It will interest and inspire you because it shows a better way toward bigger things. It also shows how, thru the Course, in addition to obtaining a knowledge of Combustion, you get, as well, a liberal education, paving the way for real executive ability.

Your request for this book will obligate you in no way whatever—merely clip the coupon below and return it today with your name plainly written or typed. Promptly upon receipt of the coupon the book will be sent you—absolutely FREE.

Send for Free Book—"Opportunities for the Combustion Expert."

Name .....

Address .....

City ..... State .....

Position .....

With .....
(Name of Company)

Hays School of Combustion

190 North State Street, CHICAGO, Ill.

P.H. Aug. 5-20

You Buy the Highest Type of Electrical Protection

in any circuit when you install Economy Renewal Fuses - made in both ferrule and knife-blade types in all capacities.

Accurate rating, practical, safe fuse construction and a dependability which has been proved for years in thousands of industries, large and small, make Economy Fuses first choice where efficiency is the first consideration.

Ferrule type with Economy "Drop-Out" Renewal link.

ECONOMY *renewable* FUSES

Knife-blade type with Economy "Drop-Out" Renewal link.

And You Cut Fuse Maintenance Cost 80%

compared with the maintenance cost of any "one time" fuse equipment.

Only the "Drop Out" Renewal Link is destroyed when the fuse blows.

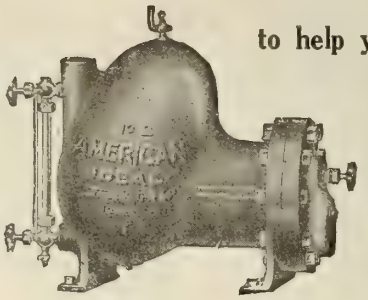
Both ferrule and knife-blade types are easily and quickly restored without expensive delay in service.

Economy was the first line using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be APPROVED IN ALL CAPACITIES by the Underwriters' Laboratories.

Sold by all leading electrical jobbers and dealers

Economy Fuse & Mfg. Co.
of Canada, Limited
Unity Bldg., Montreal, Canada

Get an American Ideal Steam Trap



to help you SAVE COAL

One trial will convince you of its ability to save for you as it is saving in hundreds of other plants.

Its TIGHT WATER SEALED VALVE
Its POWERFUL LEVERAGE
Its HEAVY FLOAT
} Insure EFFICIENCY and ECONOMY

Write for "Specification" booklet.

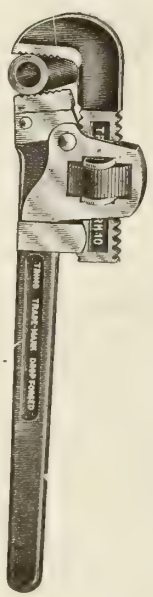
Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

TRIMO

THE WORD TRIMO



Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston,) Mass., U.S.A.

The
Disposal Board have

STOCKS

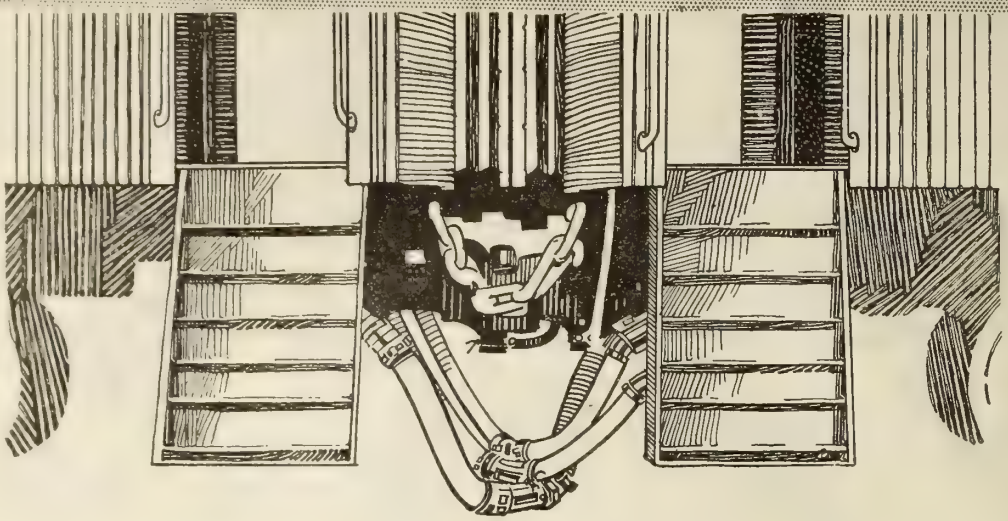
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."



Industry Needed *Better* Hose —and Goodyear Built It

GOODYEAR Industrial Hose is built to meet modern industrial needs. Built as though hose had never been built before.

Breaking away from accepted but antiquated methods of hose building created Goodyear Industrial Hose —a hose that gives longer, more satisfactory service under present-day industrial conditions, and costs less in the end.

Water, Air Drill, Pneumatic Tool, Steam, Fire Hose—Goodyear studied and created a particular hose to meet the most exacting standards of each of these.

In the case of Steam Hose, Goodyear has done away with the inconveniences due to wire-winding—a choked hose due to bent wire, bulges and blisters under pressure; a racked tube and weakened fabric; the inconenience of cutting into shorter lengths, the utting of the hose by the wire.

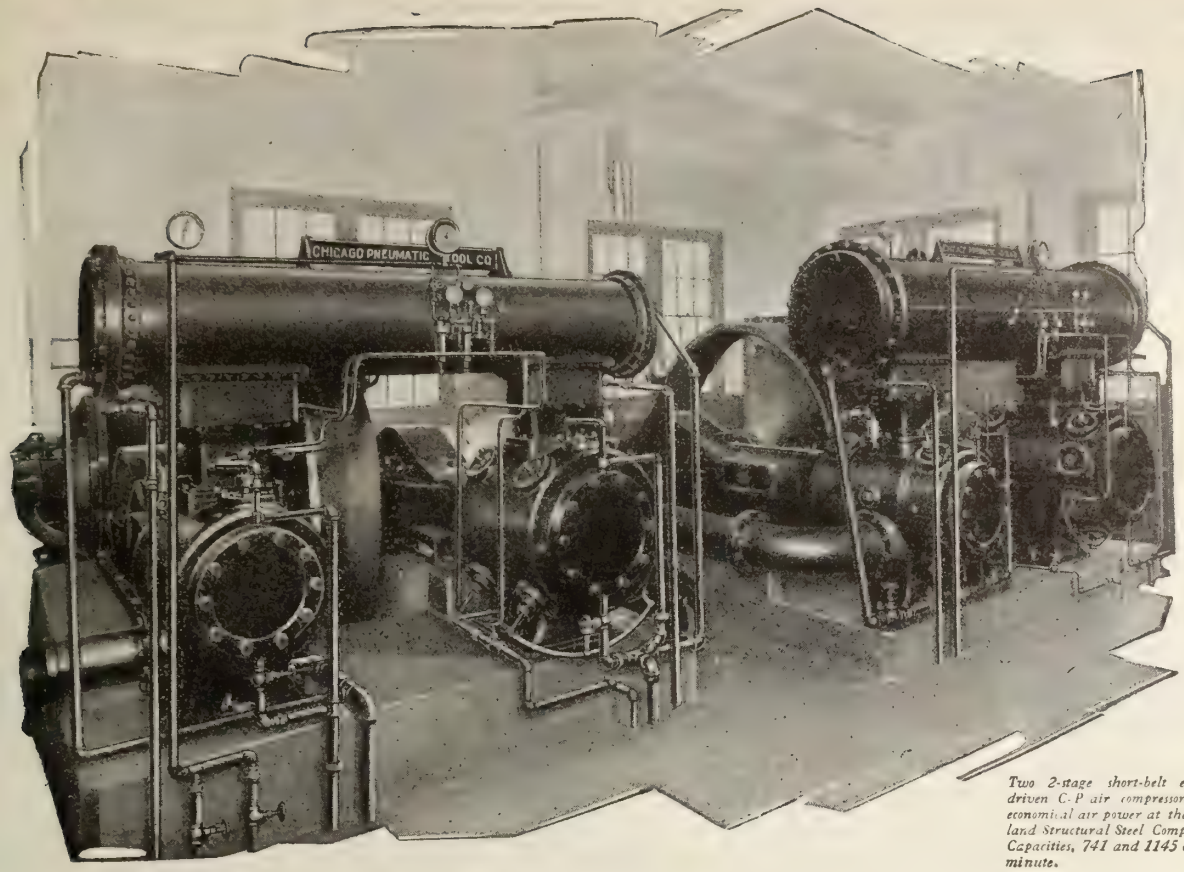
Goodyear has made wire-winding on steam hose unnecessary, by developing a hose fabric strong enough to resist high pressure without the addition of wire. Compounded an inner tube capable of withstanding the effects of high-pressure steam. Fitted the hose with a tough, durable cover. Created a steam hose that will meet the severe conditions under which it is used—at a very low final cost.

Let a man trained by Goodyear in hose problems call and explain them to you. No obligation. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches: Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in other cities.

GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE



Two 2-stage short-belt electric motor driven C-P air compressors, delivering economical air power at the New England Structural Steel Company's plant. Capacities, 741 and 1145 cubic feet per minute.

Does your compressor work against a vacuum?

NOT if it's a Chicago Pneumatic Stage Type Compressor!

With no auxiliary valves, cylinders, chambers or valve gearing, the unloading system of these machines provides *economical operation from full to no load.*

Under all load conditions the cylinder ratio is unchanged, insuring constant power economy.

Under no load, the inlet valves are held open, permitting *free passage of air.* A distinct power saving is thus obtained over compressors using a "choked intake," with consequent power losses due to the partial vacuum against which they must operate.

If your compressor is unloaded ouly one minute every hour, this *one* exclusive Chicago Pneumatic feature will save you many dollars monthly.

Know *all* the money-saving features of the "Compressor with the Simplate Valve." Ask for Bulletin 400.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-54-H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

Depend upon that Name

ROBB

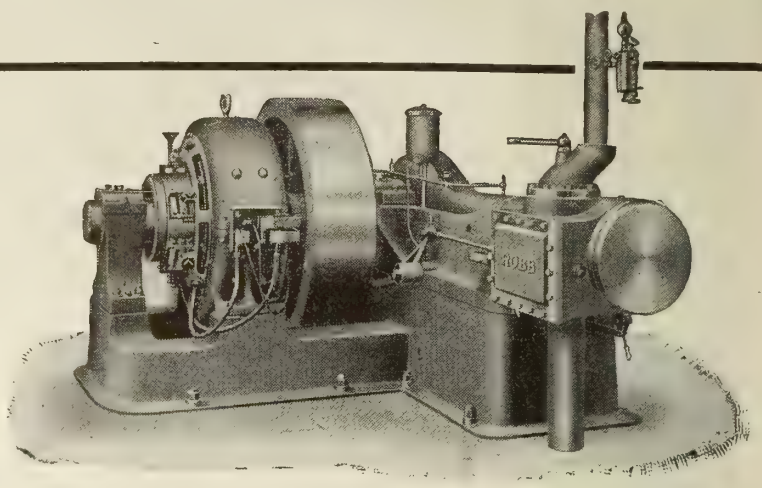
For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

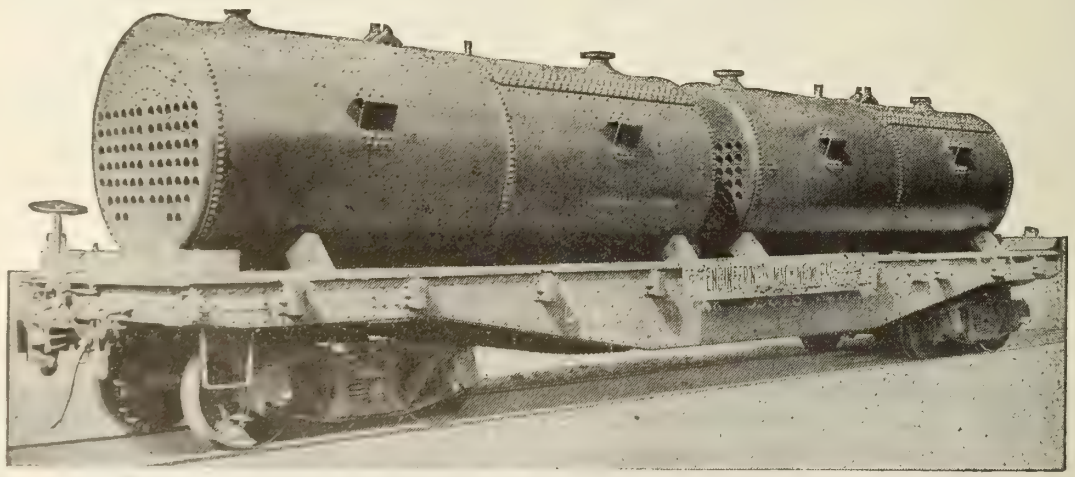
Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

Need a New Boiler—Now?

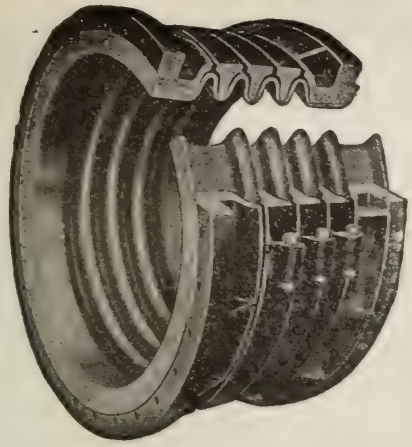
We offer prompt deliveries on following—sizes 125 and 150 lbs. pressure, 72″ x 18′, 72″ x 16′, 66″ x 16′, 66″ x 14′. Our facilities and experience are such that we KNOW you will be pleased with our work.



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



BADGER
SELF-EQUALIZING EXPANSION JOINTS

These are good joints,—made on honour, of seamless copper tube, they will correct all your pipe line troubles due to changes in length.—

Write to-day and find out why—

E. B. BADGER & SONS CO.

PITTS ST., BOSTON

101 Park Ave. New York

616 S. Michigan Ave. Chicago

Canadian Agents:

FRASER & CHALMERS OF CANADA, LIMITED
Beaver Hall Hill, Montreal, Canada

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

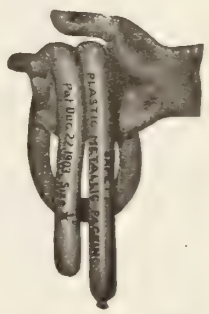
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

SAFE and EASY VALVE CONTROL *from the floor*

Every hard-to-reach, overhead valve made easily, quickly and safely accessible—from the floor. Just a slight tug on the chain of the

Babbitt
—Adjustable—
SPROCKET RIM *with Chain Guide*

and—presto!—valve is under instant control. No ladder needed. No danger. No lost time. No useless labor or trouble incurred.

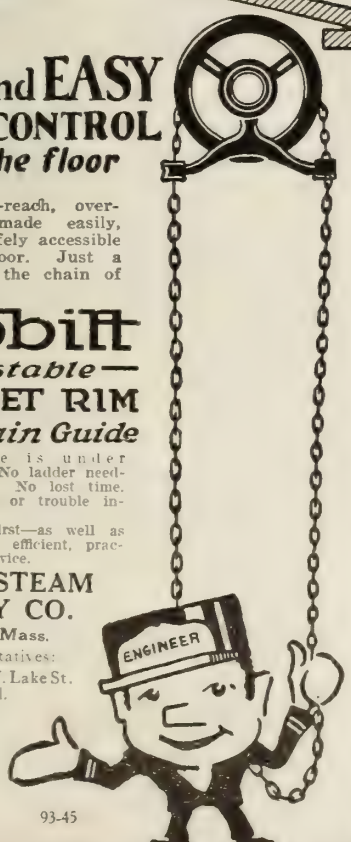
Practice safety first—as well as economy—get this efficient, practical, low-cost device.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass.

Western Representatives:
Jenkins Bros., 300 W. Lake St. Chicago, Ill.

Canadian Agents:
Engineering Specialties Co. Ltd., Toronto, Ont., Can.

93-45



When Buying Thermometers
There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss,

Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Therm meters, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal. Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago. Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

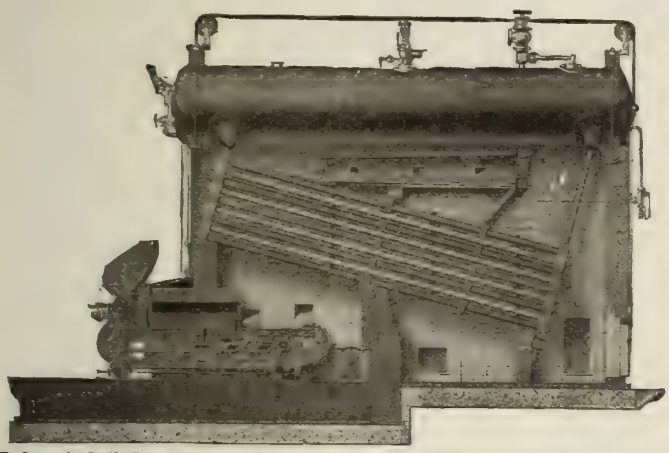
CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

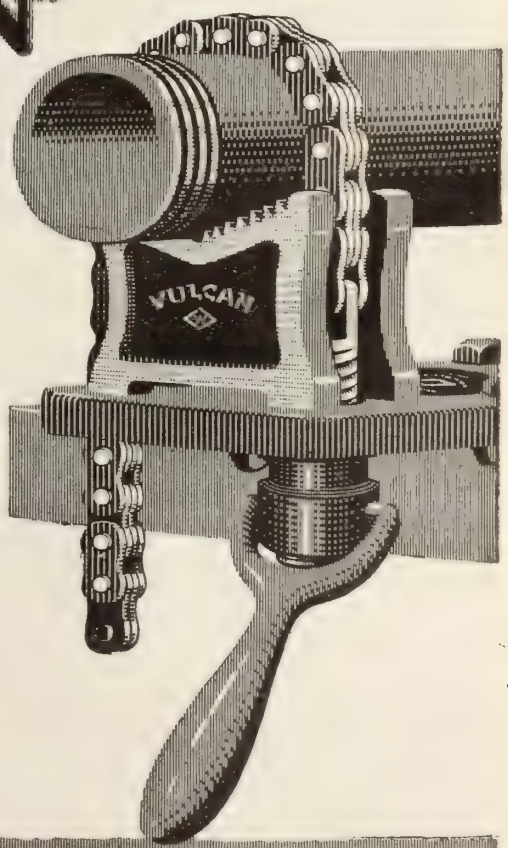
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE



A PIPE vise, like any tool intended for rough usage, should be so designed and constructed that the severe strains and stresses of hard, continuous service cannot cause breakage or failure in operation.

Williams' "Vulcan" Chain Pipe Vises have no weak parts to fail through faulty design. Though they are far lighter and cost less than the conventional cast pipe vise, they are unbreakable. These Vises are made entirely from wrought metal, tested in our Laboratories before used. Each Chain is hand made.

Nothing that engineering experience and technical skill can suggest to improve them is omitted in thier manufacture. All are backed by our unconditional guarantee.

Three sizes for ⅛ to 8" pipe. Booklet on request.

J. H. WILLIAMS & CO.
"The Drop Forging People"

78 So. Clinton St. Chicago, Ill.
78 Vulcan St. Buffalo, N.Y.
78 Richards St. Brooklyn, N.Y.

Western Canadian Agent: W. Bruce Campbell, 78 Confederation Life Bldg. Winnipeg

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto., Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London. Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

JEFFERSON

"Look for the Name on the Nut"

Test a JEFFERSON on your Toughest Job

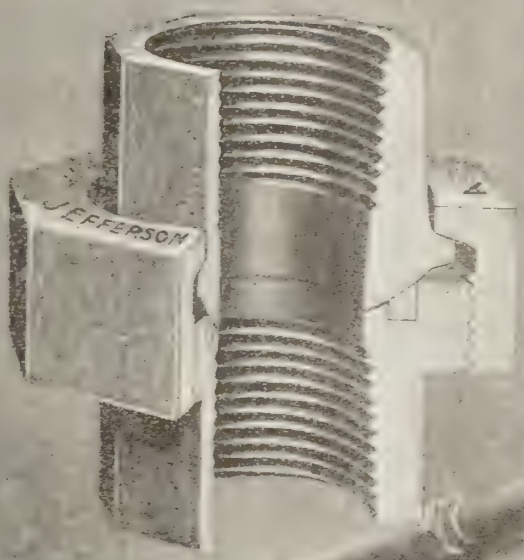
You must actually try out a JEFFERSON before you can realize perfect union service.

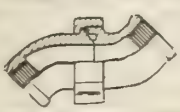
Jefferson Unions are unique in construction and are protected by basic patents covering the essential features. The Brass Seat Ring makes a tight **brass-to-iron** joint which cannot corrode and is easily disconnected. The Spherical Ground Joint takes care of alignment difficulties and makes possible a tight joint even if the line is not exactly straight.

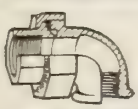
Your Jobber has Jefferson stock. Order yours to-day. You can always tell them by the name on the nut. **Write for our catalog "Unions."**

The Jefferson Union Co.

Lexington, Mass.







FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMEL-WARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

A Big Factor in Every Factory is the BELTING

EXPERT care in Manufacture is necessary to produce a rubber belt, at once durable in quality, constructed to avoid fatigue in service and cured under necessary strain to eliminate undue stretch.

"P.M.S." BELTNG

is an assurance of steady, full transmission of maximum power. If you have a belting problem, submit it to our expert; his advice is worth while.

Gutta Percha & Rubber, LIMITED

Head Offices and Factory, Toronto

Branches: Halifax, Montreal, Ottawa, Fort William, Winnipeg, Regina Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Plenty & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Duriron Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

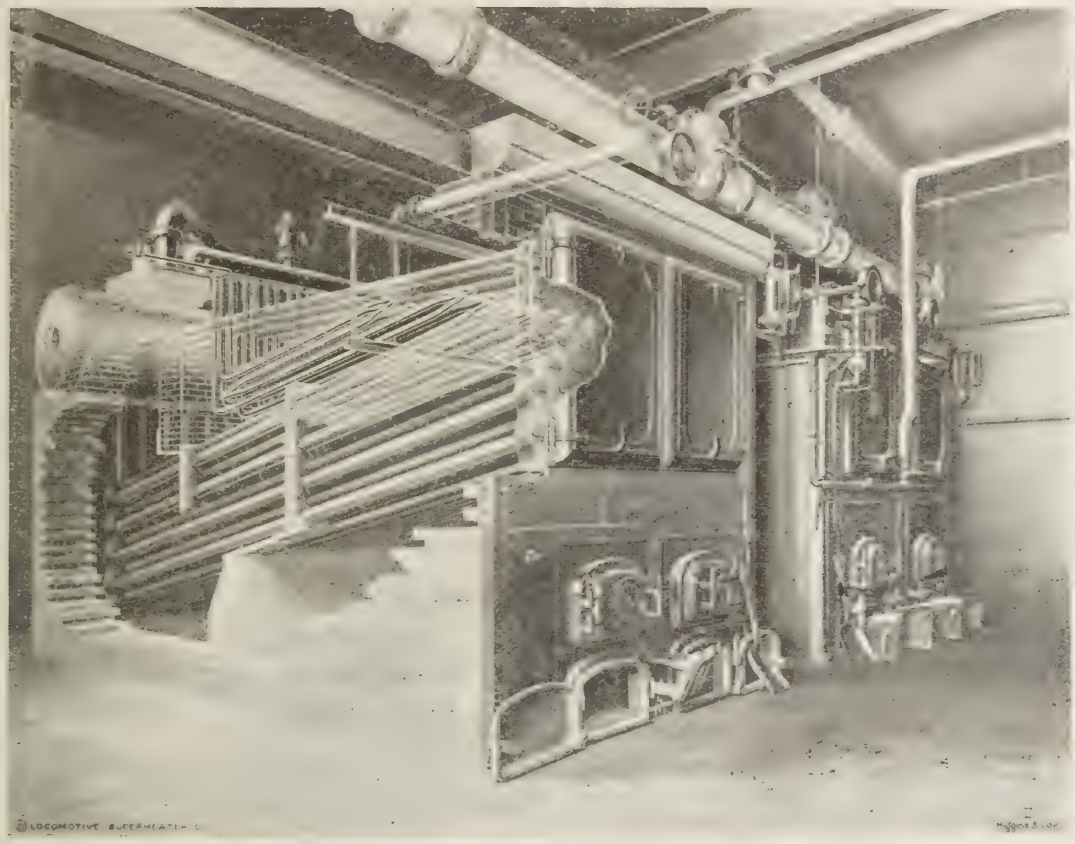
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



Cutting Costs By Saving Fuel

Elesco Superheaters will solve the problem of high fuel cost in your plant.

This saving is possible for you regardless of the product you manufacture, or the type and size steam plant you operate for power.

Fuel is too great an item in your manufacturing costs.

Made in Canada

THE ELESCO SUPERHEATER

applied to meet your operating conditions, will enable you to meet your production schedule on less fuel.

The fuel saving ranges as high as 25 per cent.

It will pay you to outline your fuel problem to our Engineers. They will gladly suggest a practical means by which you can cut the cost of operating your power plant.

Write for Bulletins.

The Superheater Company, Limited

Transportation Building, MONTREAL *Works at Sherbrooke, Que.*

Designers and Manufacturers of Superheaters and Pipe Coils for all purposes

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 223 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

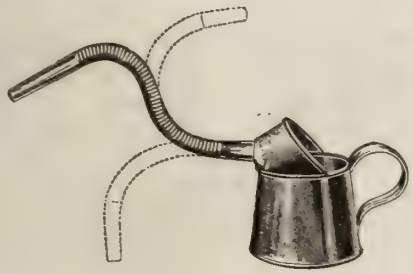
TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

Say Good-bye to Funnels Use this 'ALL-WAY' Oiler



Combination Filler and Funnel

This Filler eliminates the necessity of the use of a separate Funnel. With the Flexible Spout any part can be readil reached.

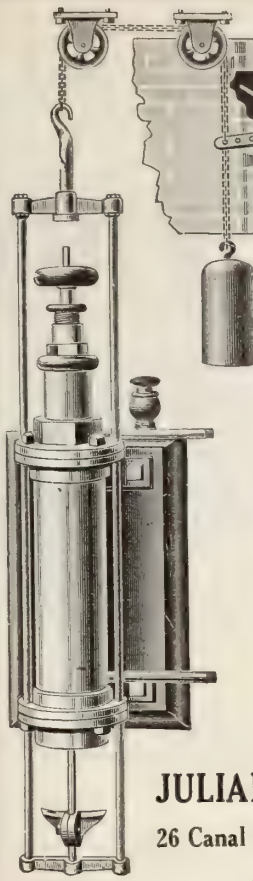
Saves much inconvenience and avoids dripping of oil.

If your dealer cannot supply you, write us.

We also manufacture the well-known "All-Way" Oil can. Saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY

196 King St. West Toronto, Ont.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1920 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

26 Canal Street - BOSTON, 14, MASS.

Agencies:
83 Barclay St., New York City
174 North Market Street, Chicago, Ill.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)

C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR

H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall. Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall. Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS

Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

FOR REFRIGERATING EQUIPMENT

USE

P⊕H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KINDS AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

PAGE-HERSEY IRON, TUBE & LEAD CO. LIMITED

Head Office:

100 Church Street, TORONTO, Ont.

INDEX TO ADVERTISERS

A

All-Way Oiler Co. 79
American Steam Gauge & Valve Mfg. Co. 64
American Steam Pump 45
Anderson Co., V. D. 48
Armstrong Cork & Insulation Co. 11

B

Babbitt Steam Specialty Co..... 69
Babcock & Wilcox 71
Badger & Sons, E. B. 69
Betson Plastic Fire Brick Co... 46
Boving Hydraulic Eng. Co. ... 57
Bowser & Co., S. F. 7
Busch-Sulzer Bros. — Diesel Engine Co. 58

C

Can. Consolidated Rubber Co... 59
Can. Fairbanks-Morse Co..... 19
Can. Farnsworth Co., The 37
Can. Johns-Manville Co. 61
Can. Link Belt Co. 49
Can. Mead-Morrison, Ltd. 54
Can. Steam Boiler Equipment.. 4
Carling Turbine Blower Co.... 57
Chaplin-Fulton Mfg. Co. 56
Cole Ltd., Geo. W. 55
Coppus Engr. & Equip. Co.... 42
Crane Ltd. 40

D

Darling Bros. 56
Dean Heater Co. 8
D'Este Co., Julian 79
De Laval Separator Co. 14
Department of Labor 57
Diamond Specialty Co. 39
Direct Separator Co. 50
Dominion Coal Co. 56
Dunham & Co., C. A. 15
Durabla Mfg. Co. 50

E

Economy Fuse Co. of Can., Ltd. 64
Electric Welding Co. 40
Empire Mfg. Co. 3
Engr. & Mach. Works of Can. 68
Escher, Wyss & Co. 58

F

Frick Co. 11

G

Garlock Packing Co. 6
Garth Co., The 57
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co... 66
Greene, Tweed & Co. 51
Green's Economizer, Ltd. 55
Gutta Percha 75

H

Hays School of Combustion... 63
Holden Co., Ltd., The..... 67
Holmes Metallic Packing Co... 56
Homestead Valve Mfg. Co..... 48
Hoyt Metal Company 36

I

Inglis Co., John..Inside back cover

J

Jamison Cold Storage Door Co.. 12
Jefferson Union Co. 73
Jeffrey Mfg. Co. 13
Jenkins Bros. 41
Jointless Fire Brick Co. 58

K

Kellogg & Co., E. H. 38
Kerr Engine Co. 43

L

La Clede Christy Clay Products Co. 44, 45
Laurie & Lamb ..... Inside front cover, 57
Leitch, The Arthur S. 62
Leonard & Sons, Ltd., E.....14, 39
Linde Can. Refrig. Co. 10
Long, J. T. 38
Lunkenheimer Co. 60

M

MacGovern & Co. 40
Magnolia Metal Co. 4
Manny Co., E. S. 40, 56
Mason Regulator & Eng. Co.... 47
Ministry of Munitions 65
Morrison Brass Mfg. Co., Jas. Outside back cover
Mueller Mfg. Co., H. 75
Murphy Iron Works 53

N

Northern Electric Co. 9
Norwalk Iron Works Co. 8

P

Page-Hersey Iron & Lead Co., Ltd. 80
Penberthy Injector Co. 5
Philip & Sons, E. J. 56
Pilley Packing & Flue Brush Mfg. Co. 57
Pratt & Cady Co., Inc. 53

R

Robb Engineering Co. 68

S

Sanford Riley Stoker Co. 53
Sexton Boiler Setting Co. 15
Scaife & Sons Co., Wm. B.... 80
Schaeffer & Budenberg Mfg. Co. 69
Starrett Co., The L. S. 48
Steel Mill Packing Co..... 69
Sturtevant Co. of Canada, Ltd., B. F. 2
Superheater Co., Ltd., The 77

T

Trimont Instrument Co. 64

U

Uehling Instrument Co..Front cover

V

Victoria Foundry Co..... 56
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd..... 50

W

Wall, W. J. 56
Waterous Engine Works Co. ... 1
Watson & McDaniel Co. 57
Williams & Co., J. H. 71
Worthington Pump & Machine Co. 52

Y

Yarnall-Waring Co. 48
York Mfg. Co. 12

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

BOILERS
TANKS AND ENGINES

Of All Kinds for Any Service
Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.
14 Strachan Ave., TORONTO

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada:
JAMES W. PYLE & CO., LIMITED
232 St. James St., MONTREAL

MORRISON

Steam Goods

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

"A tree is known by its fruit."

For half a century the quality of Morrison's products has been adding to the prestige of the Morrison name, until now the name on a steam specialty is accepted as an absolute guarantee of quality.

Specify "Morrison's" and you will receive steam goods whose every operation is a demonstration of merit.

The James Morrison Brass Mfg. Co., Limited

93-97 ADELAIDE ST. W., TORONTO

POWER HOUSE

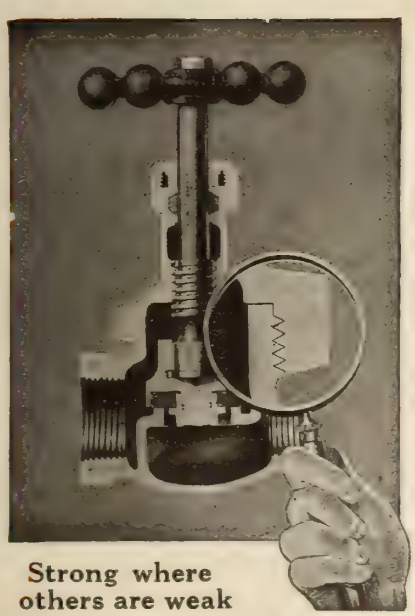
A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 16. Publication Office, Toronto—August 20, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

TRADE PENBERTHY MARK.



Strong where others are weak

The Increasing Demand for

Penberthy Valves

is sure proof that they are giving better satisfaction than any other make of valve on the market.

A Penberthy Valve
is always worth the price you pay for it.

We Make :

The Compodisk Line (with the Renewable Disc)
Gov't. approved for 175 lbs. steam pressure.

The Regrinding Line (with the Metal Disc.)
Gov't. approved for 200 lbs. steam pressure.

Brass Gate Valves (with the solid Wedge Disc.)
Gov't. approved for 150 lbs. steam pressure.

USED BY THE BEST ENGINEERS THROUGHOUT CANADA

BE SURE THIS NAME IS ON THE VALVE YOU BUY

Stocked By Leading Jobbers

Manufactured by

Penberthy Injector Company, Limited - Windsor, Ont.

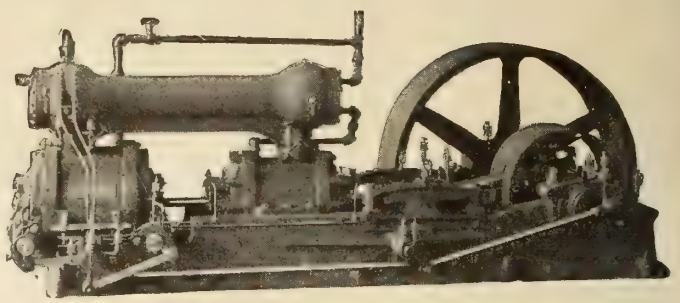
NORWALK
AIR & GAS · COMPRESSORS

Results

Every Norwalk compressor sale is based on a thorough understanding of the work to be done, and of the conditions under which it must be accomplished. Norwalk engineers do no guessing. The results they promise for any given installation are *the results they will get.*

The Norwalk Iron Works Company
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

A. S. Leitch Company, Toronto
Canadian Sales Representatives



Norwalk 100-lb. Air Compressor

If you have a special compressing problem, let our engineers co-operate with you on it. Write for the Norwalk Bulletins on air, oxygen, hydrogen, carbonic acid gas or acetylene, one or all.

ANY·CAPACITY **ANY·PRESSURE**

The Joint of Dart Union Pipe Couplings is

Bronze to Bronze

(Both Face and Seat)

This feature prevents deterioration at the vital point and is the REASON WHY

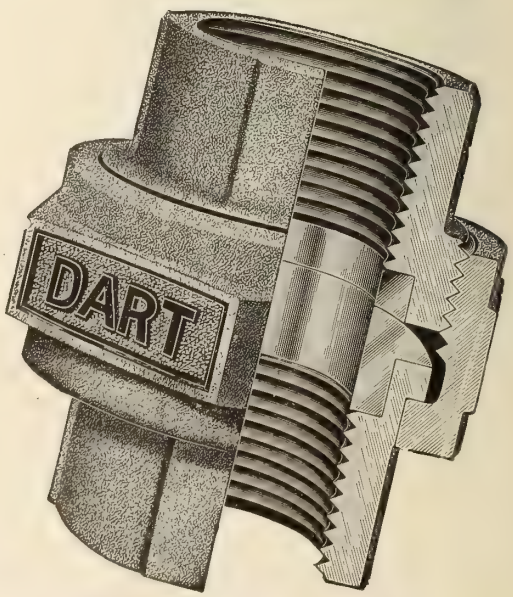
DART UNIONS STAY TIGHT

—permanently

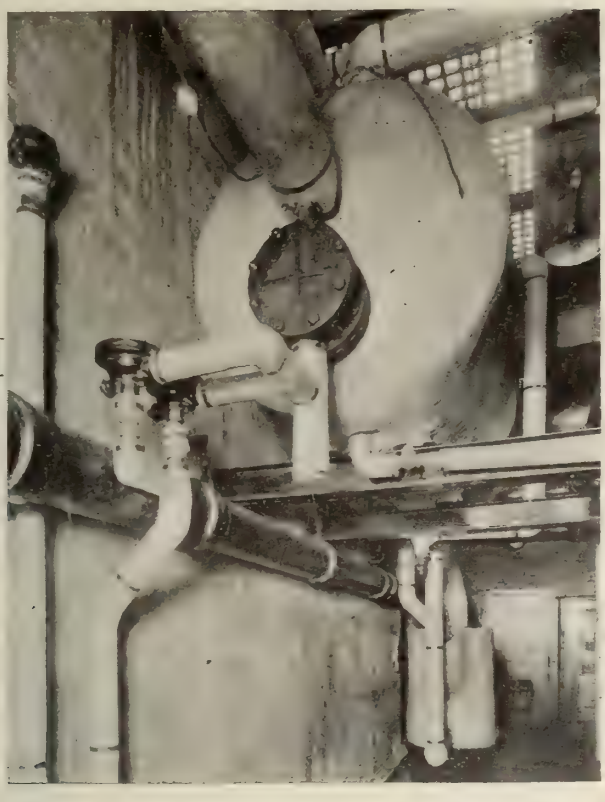
Dart Unions are really Economical and Troubleproof. Have you tried them?

Sold by all Jobbers.

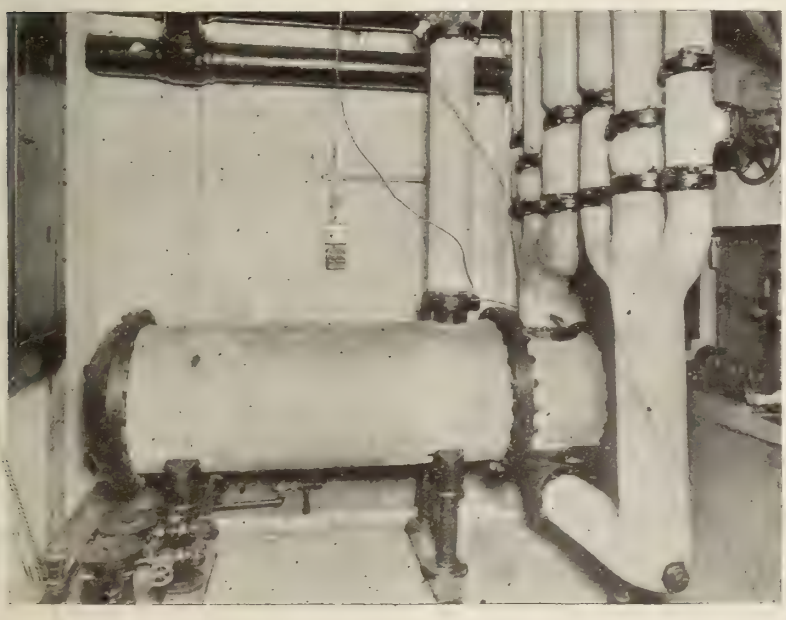
Dart Union Co., Limited, Toronto, Ont.



Sims Steam Tube *Water* Heaters



THERE are advanced features of design embodied in **Sims** heaters which distinguish them from other heaters—and **Sims** heaters are as superior in their service as they are different. **Sims** embodies straight tubes, 1½ in. O. D. Seamless Brass, rolled into a fixed head at one end, and a loose or floating head at the other. The tube structure is thus in no way attached to the heater. This construction admits of expansion and contraction of tubes without strain. Another feature is seen in the manner of grouping the tubes, which promotes the rapid circulation of water and allows for the best results in extracting the heat. **Sims** heaters have several other advantages. It is these advantages that have made **Sims** equipment preferred where large quantities of hot water, with live or exhaust steam as the heating water, are required.



The illustrations show Sims Water Heating Equipment at "Ardwold." Sir John Eaton's residence, Spadina Road, Toronto.

The upper illustration shows a 42 in. x 108 in. Sims No. 6 B.H. Clean E-Z Type Storage Heater for the Domestic Hot Water Supply. The lower illustration shows the Sims Converter, which supplies the swimming pool at "Ardwold."

For full information regarding Sims equipment write to—

THE ARTHUR S. LEITCH CO.

1001-2 KENT BUILDING, TORONTO, ONT.

POWER HOUSE, August 20, 1920. Vol. XIII., No. 16. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

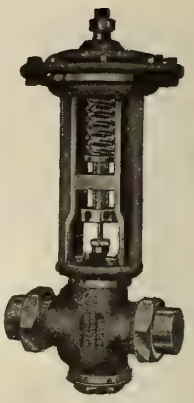
WHY "MASON"?

Mason Standard Bronze Reducing Valve

THE splendid reputation of the Mason Engineering Equipment is not the result of an accident, but the expected outcome of forty years of persistent effort backed by large capital and superior manufacturing facilities.

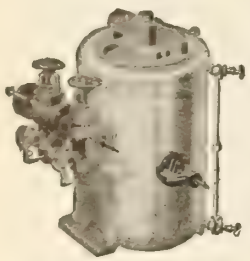
They hold the first place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend on these devices working in many critical locations and find them satisfactory. This is where Mason Service comes in. We have at your service a staff of engineers, specialists in the application of our devices. Their job is to see that you do not throw money away on unsatisfactory equipment, and to help you to choose equipment that will do the work required.

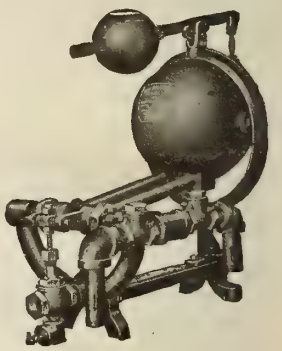


Mason No. 55 Pump Pressure Regulator

Reilly Feed Water Filter and Grease Extractor



New Bundy Return Steam Trap



We are very glad to hear from engineers who have a difficult problem in pressure regulation, engine or pump control, damper or blower regulation, or condensation drainage or returns. We have yet to hear of a problem, to which there is a possible solution, that we cannot solve.

THE MASON REGULATOR & ENGINEERING CO.,
LIMITED

MONTREAL
135-153 Dagenais St.

TORONTO
145 Wellington St. W.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Arlo Compressor Oil

The Supreme Test—Service

THERE is only one test for a lubricant and that is "service"—service rendered under service conditions. The full benefit from capital sunk in expensive machinery can only be reaped through *correct* lubrication—*the best lubricants properly applied.*

Imperial Lubricants need no introduction. They are known and used from coast to coast. They are graded for every type of machine; are Canadian made from the finest crudes and readily obtainable in all parts of the Dominion.

Choose your lubricants from the Imperial line. Take advantage of our offer of free consultation. Both aim to assist you to insure that production shall bear a true relation to the time, thought and money expended in equipment.

Correct lubrication means the selection and proper application of the right lubricant for each machine. Correct lubrication actually promotes maximum profits, increasing production per unit and decreasing depreciation charges, fuel and repair bills.

Imperial Lubrication Engineers are at your service for consultation in solving troublesome lubrication problems. Their advice is free. Write to us at 56 Church St., Toronto, or to any of our branches.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

"MEAD-MORRISON"

CANADIAN MM Co

CANADIAN MM Co

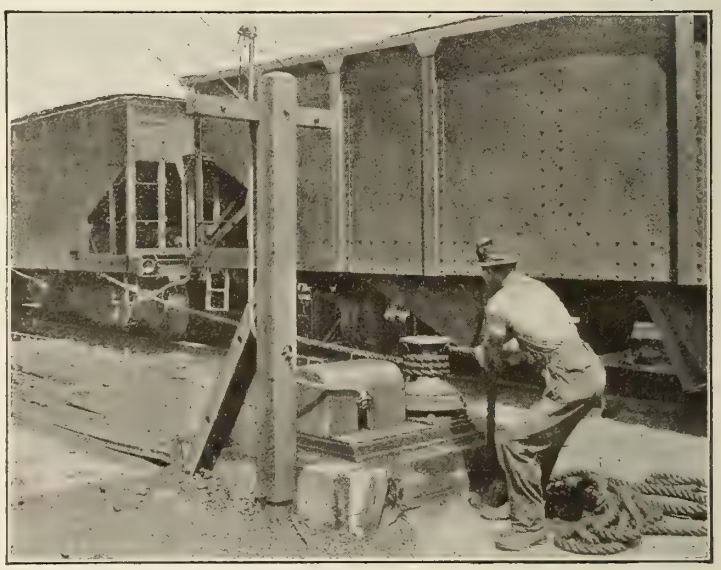
Electric Car Puller

How long does it take you to spot that car?

How do you get the empties back on the other siding?

This ***Car Puller*** requires only ***One Man.***

The capacity of the Puller is a Rope Pull of 3,500 pounds at a rope speed of 60 feet a minute.



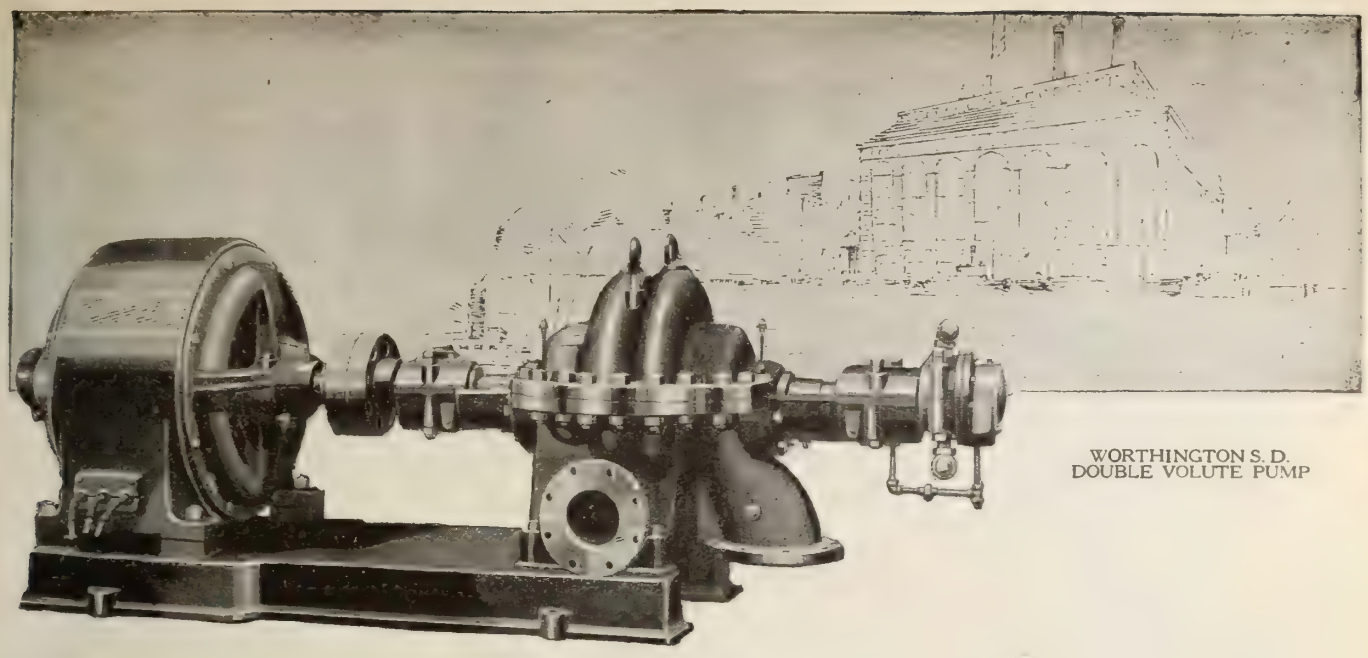
GETTING ALONG WITHOUT THE SWITCHING LOCOMOTIVE

Furnishes ***Dependable Service***
under all conditions

PUT YOUR PROBLEM UP TO US!

AGENTS: Kelly Powell, Winnipeg; Howard Turnbull, Toronto; Robert Hamilton, Vancouver.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS: WELLAND ONT.



WORTHINGTON S. D.
DOUBLE VOLUTE PUMP

"See our exhibit at the Sixth National Exposition of Chemical Industries, Grand Central Palace, New York, week of September 20th"

—another example of Worthington utility and efficiency

FOR general service in and around coal mines, there is no pump that enjoys a more favorable reputation or renders a more complete pumping service than Worthington S.D. Double Volute Pump.

For fire protection, for heads above single impeller limits, for unwatering mines—this pump can be standardized on, and because parts are interchangeable, repair bills and time losses are reduced to absolute minimum.

Simplicity of design is attained by using the double volute feature which eliminates diffusion rings, and because impellers are "back to back" there is no end thrust. This construction also results in minimum number of slippage points.

Worthington S. D. Double Volute Pump rounds out a full centrifugal pump service and typifies the wonderful 80 years old organization which sponsors it.

Other Worthington Products

Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the goodwill and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

W-279.8

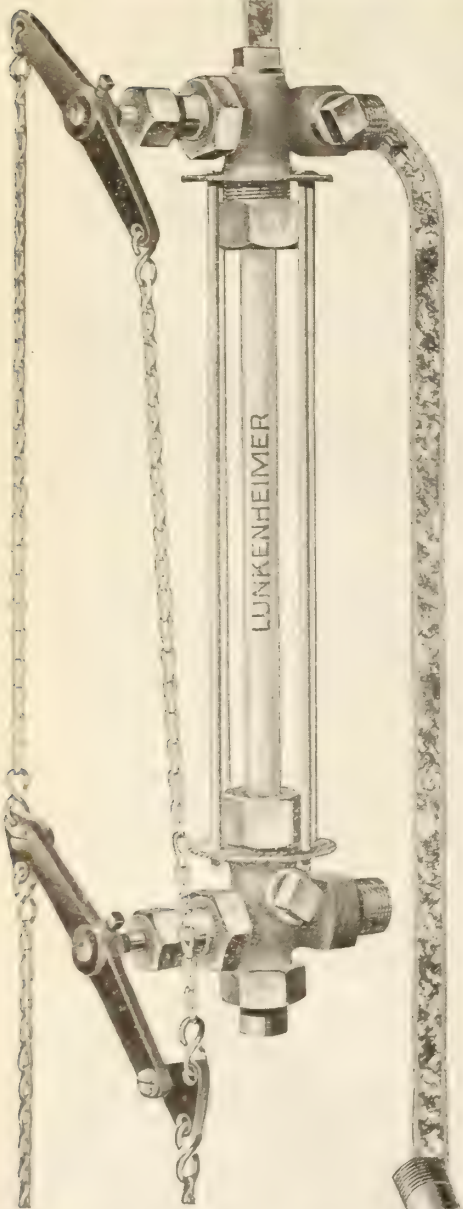
PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*

LUNKENHEIMER

WATER GAUGES, GAUGE COCKS AND FUSIBLE PLUGS



Absolute reliability in operation and maximum durability under the most severe operating conditions are the basic factors which govern the manufacture of LUNKENHEIMER WATER GAUGES, GAUGE COCKS, AND FUSIBLE PLUGS. These essential requirements, based on a thorough knowledge of operating conditions; the selection of proper metals for the specific requirements and Lunkenheimer "Quality" workmanship, have established the Lunkenheimer Line as standard for Safety and Economy.

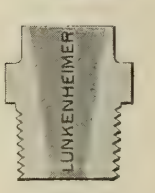
Lunkenheimer WATER GAUGES are reliably accurate. The shut-off valves provide positive control in case of glass breakage and provision is made for the easy renewal of the glass should necessity require. Made in both Automatic and Non-automatic Patterns with Hand Wheel or Cross Lever Control.

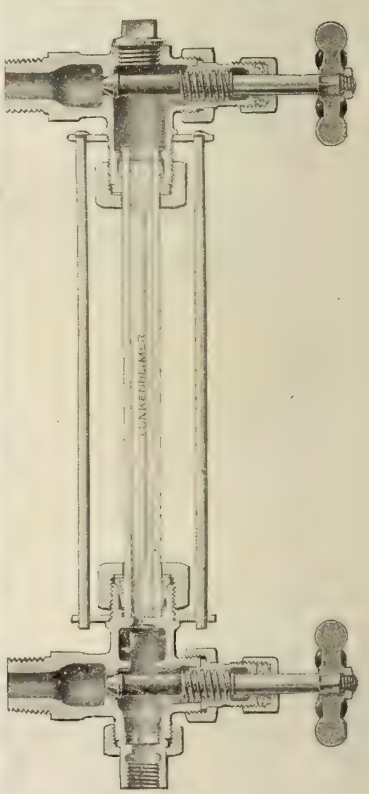
Lunkenheimer GAUGE COCKS are substantial, positive in operation, and so constructed that a worn or broken part can easily be replaced. The variety of types made covers every service requirement.

Lunkenheimer FUSIBLE PLUGS are safety devices of merit. The fusible core is pure Banca tin and the Lunkenheimer method of filling the plugs precludes the possibility of chemical change during the process. This insures dependability in service Inside and Outside types in all sizes.

For Safety, Service, and Satisfaction specify LUNKENHEIMER and insist on their installation. Write for descriptive literature.

Distributors of Lunkenheimer Products situated in every commercial center.





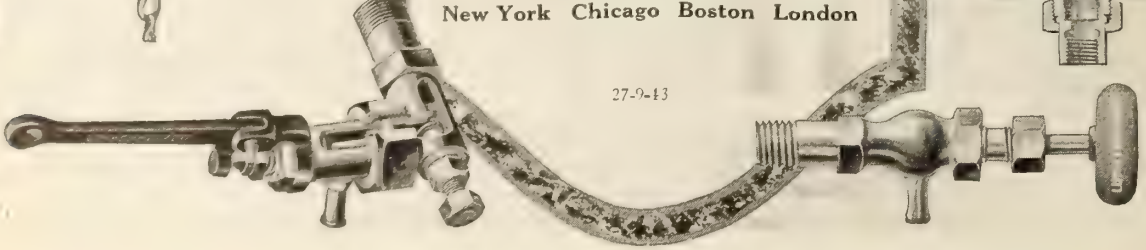
THE LUNKENHEIMER CO
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, U.S.A.

New York Chicago Boston London

27-9-43



Q

The World's Standard Sheet Packing

Rainbow Sheet Packing—the *original red sheet*—has given the mechanical world 30 years of unexcelled service under the most exacting conditions.

There are instances of gaskets cut from

Rainbow Sheet Packing

being found in excellent condition after 20 years of dependable service in high pressure steam lines. Insist on the *"Rainbow" Diamond* trade-mark to ensure this dependable service in your *steam* lines.

Our nearest branch will be glad to send you a catalogue on request, and, if you wish, one of our technical experts will gladly help overcome your packing troubles.

Genuine Rainbow Sheet Packing is made in Canada by

DOMINION RUBBER SYSTEM AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the same high standard as Dominion Friction Surface Belting.

Dominion Rubber System Service Branches

Halifax	Toronto	Fort William	Edmonton
St. John	Hamilton	Winnipeg	Calgary
Quebec	London	Brandon	Lethbridge
Montreal	Kitchener	Regina	Vancouver
Ottawa	North Bay	Saskatoon	Victoria

BELTING

Transmission: "Dominion," "Keewatin," "Para."
Conveyor: "Rockproof," "Canadian," "Hiheat."
Elevator: "Dominion," "Rockproof," "Endurance."
Agricultural: "Lumber King," "Star," "Western."
Grain Elevator: "Mercalf Standard," "St. Lawrence," "Grain King."

HOSE

Air: "Kushion Kover," "Para," "4810 Airtite."
Steam: "Indestructible," "Rockproof," "Para."
Water: "Indestructible," "Kushion Kover," "Para."
Suction: "Para," "Star," "Trade."
Garden: "Canadian," "Dominion," "Star."

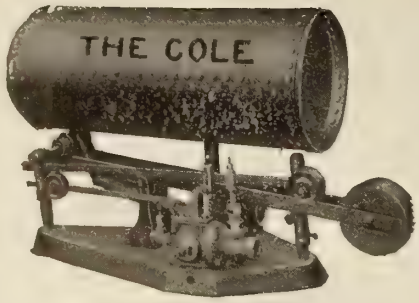
PACKINGS

Sheet: "Join-Tite," "Star," "Importers"
Rod: "Cabestos," "Valve-Bestos," "Canadian."
Valves: "Montreal," "Commercial," "Canadian."

MISCELLANEOUS

Mats, Matting and Flooring, Plumbers' Specialties, Rubber-covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rubbers, Moulded Goods.

ECONOMY AND EFFICENCY



THIS is the machine that will cure your troubles

Expert Engineers are always at your service
Let us know your troubles

GEO. W. COLE, LIMITED

Engineers and Manufacturers

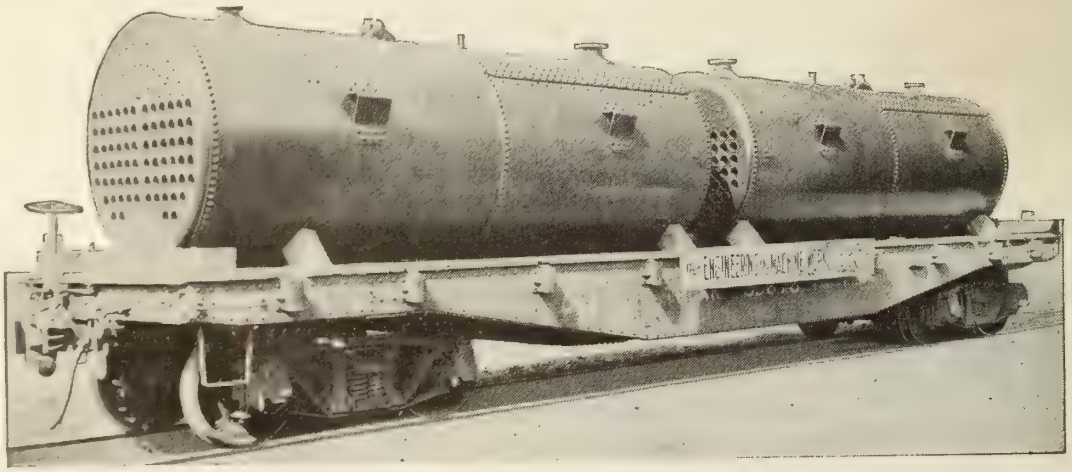
2002-4 Dundas St. W., TORONTO

Winnipeg, Man. Vancouver, B.C. New Glasgow, N.S. Montreal, Que.

IN THE STEAM PLANT.

Need a New Boiler—Now?

We offer prompt deliveries on following—sizes 125 and 150 lbs. pressure, 72″ x 18′, 72″ x 16′, 66″ x 16′, 66″ x 14′. Our facilities and experience are such that we KNOW you will be pleased with our work.



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Every Power Plant Engineer Should Have This BOOK

LINK-BELT TRAVELING WATER SCREENS

LINK-BELT Traveling Water Intake Screens are a necessity in the modern power plant. They automatically remove all floating trash and debris, and insure a steady supply of clean water to the condensers. Uninterrupted operation is assured at all times regardless of the condition of water supply.

This book gives complete information. It shows what you can accomplish by atomatically screening water before it reaches the condensers. Use the coupon.

CANADIAN LINK-BELT COMPANY, LIMITED
Wellington and Peter Streets, TORONTO

Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill.

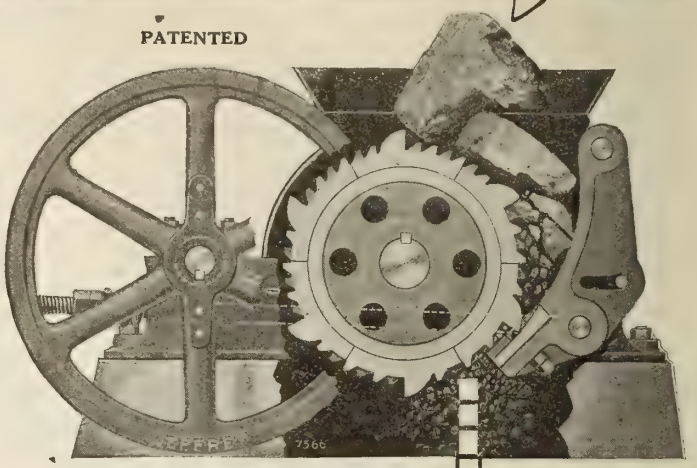
Please send me a copy of your book No. 352, "Link-Belt Traveling Water Intake Screens".

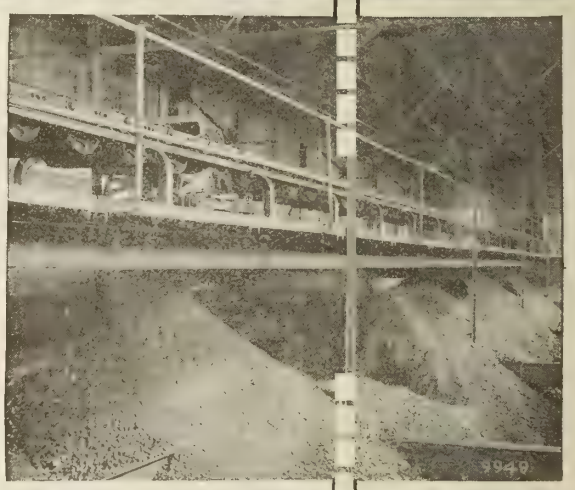
*Name*_____ *Firm*_____

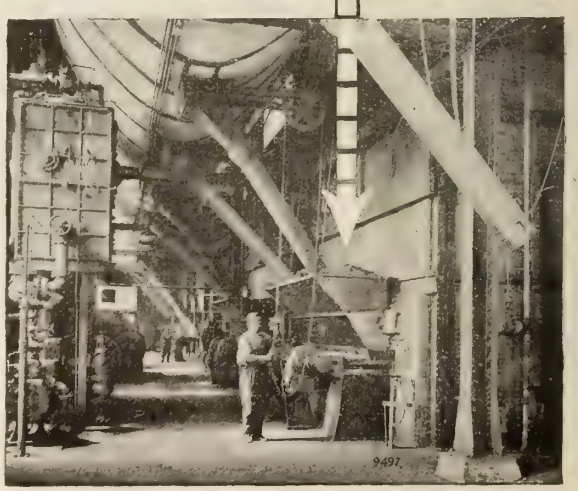
*Address*_____ *Town and State*_____

Run-of-Mine Coal Through A Jeffrey Single Roll Crusher

PATENTED







Will Insure Proper Sizes and Quality of Coal For Your Stokers

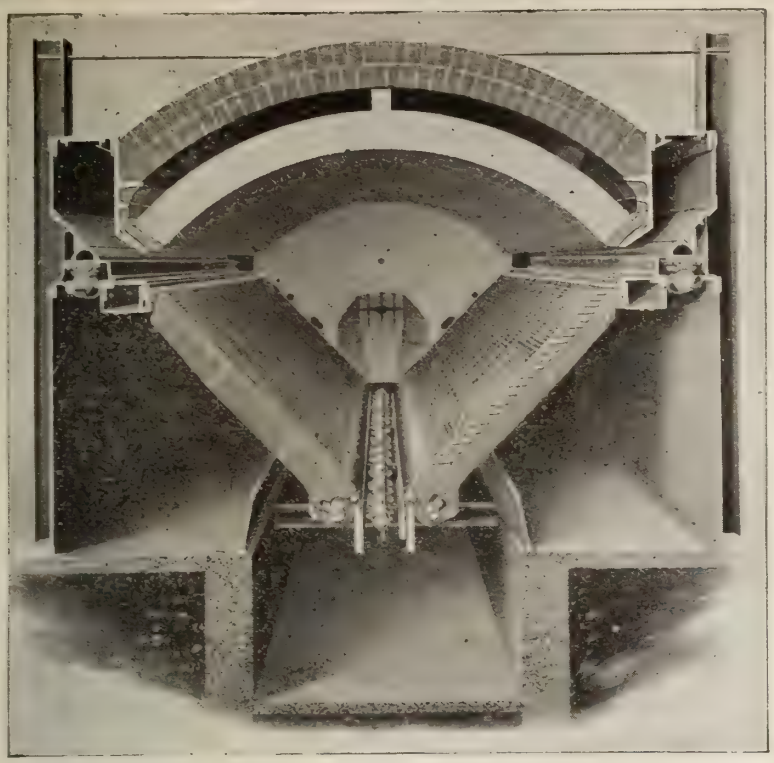
Run-of-Mine or Lump Coal give proper quality, but cannot be used in stokers without crushing. Mine screenings which are of the proper size at times cannot be secured.

The Jeffrey Single Roll Crusher installed at your plant will render it independent of the supply of screenings, and enable you to secure the maximum of stoker efficiency.

Bulletin No. 141-4 should be in the hands of every Manager, Superintendent or Engineer who is responsible for supply of properly sized coal. Send for copy.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL



Cross section showing the construction and operation of the Murphy Automatic Furnaces. As the fuel progresses downward the alternate movement of the grates ¾" above and ¾" below the surface of the stationary grates breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder.

Over 6,000 Boilers

Murphy Furnaces have been relied upon by power users in every field for 44 years to furnish continuous, efficient and economical combustion service—to burn any available fuel—and to automatically remove all ash and refuse.

To-day **over 6,000 boilers** in all sections of the country are fired by

MURPHY
AUTOMATIC
FURNACES

They are being used in practically every line of industry—from hospital to industrial and central station service.

Write for our catalog showing how **Murphy Furnaces** can be installed under any type of boiler.

For information on the Riley Underfeed Stoker for large boilers see advertisement in last issue or send for catalog HR-8.

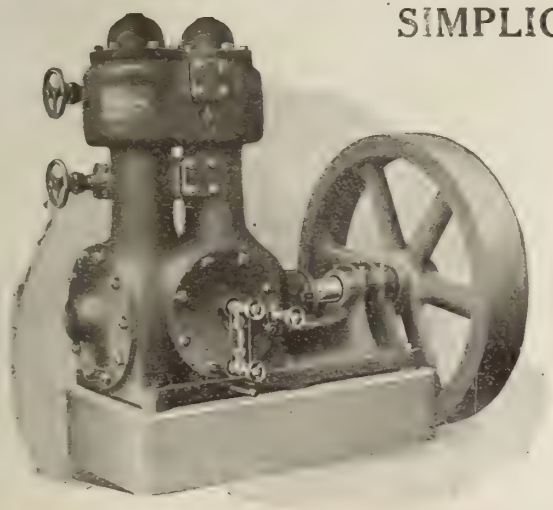
Murphy Iron Works

Detroit, Mich., U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permit them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St.
TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals
MONTREAL, 324 Craig St. West
CALGARY, 605 Second St

Gates Refractories, Ltd.

Power Plant Firebricks

Conserve Heat and Cut Coal Bills

Increased boiler capacity and higher fuel economy are two of the advantages that follow the installation of Gates Power Plant Firebricks. They conserve furnace heat and permit a more even and more efficient condition of the fire to be maintained.

Gates Firebricks are easily installed in boiler linings and are so designed that when any part becomes fused a handy man can replace it in half the time it takes to repair a standard fire brick job. There is no possibility of costly air leaks and the many joints that clinkers stick to when ordinary firebrick is used are entirely eliminated. A complete stock of various sizes always on hand. Immediate shipments.

We specialize in all kinds of power plant brickwork. Boiler setting, Furnace building, Oven work and Repair Jobs. Get in touch with us!

Head Office: 382 St. James St., Montreal

St. James Chambers, Toronto

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office

Fireman's CO_2 Guide on Boiler Front

Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet

"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 EMPIRE BLDG., NEW YORK

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Coppus in the Confectionery Industry

Wherever candy is sold Huyler's trade-mark means quality supreme. Wherever candy is made—there is an opportunity for COPPUS Turbo Blowers to save money in power plant operation.

These two 18" Blowers have been economizing time, fuel, and labor in the boiler room of the Huyler's Chocolate Company, 136 East 18th Street, New York City, since July, 1917. They burn inexpensive fuel—keep up full steam pressure—and meet peak loads without extra exertion by the engineer, **quickly, easily, cheaply.**

They can do this better than any other type of blower because of their

Standardized Construction
Rugged Reliability
Economy of Operation

What COPPUS Turbo Blowers are doing in other plants they can do in yours. If you will ask us we will be glad to send you complete information showing just how COPPUS Turbo Blowers can help you secure more power from your present equipment and greatly increase the efficiency of your power plant.

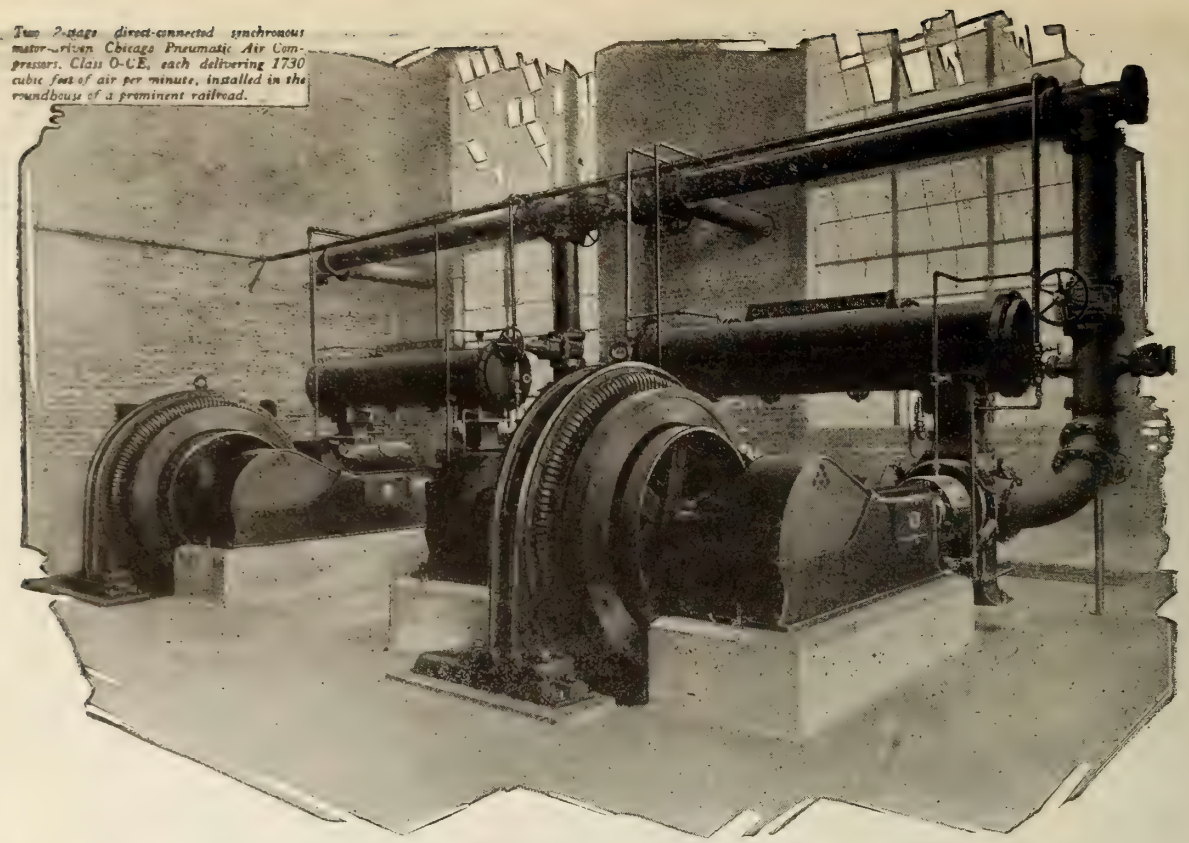
Write for Blower Catalog.

"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine
341 Park Ave., Worcester, Mass

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.

COPPUS TURBO BLOWER



Two 2-stage direct-connected synchronous motor-driven Chicago Pneumatic Air Compressors, Class O-CE, each delivering 1730 cubic feet of air per minute, installed in the roundhouse of a prominent railroad.

An unloading system that saves power

DOES your air compressor pull against a vacuum *after unloading?*

Not if it's a Chicago Pneumatic whose unloading system permits the *free passage* of air through valves automatically held open when maximum receiver pressure is reached.

This one Chicago Pneumatic feature saves marked power over compressors in which unloading by choking the inlet pipe means power lost through working against a vacuum after unloading.

Strict power economy *before* and *after* unloading, and economy of floor space, make the direct connected motor-driven compressor illustrated an ideal power unit for—

Railroad shops, shipyards, structural steel plants, cement mills, packing houses, mines, oil refineries, glass manufacturing plants, textile mills, and miscellaneous manufacturing plants.

Know *all* the advantages of Chicago Pneumatics. Have you read Bulletin 400?

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-55-H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

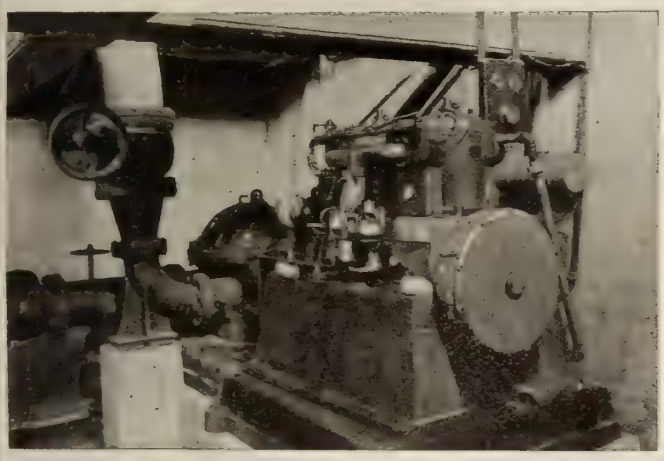
Depend upon that Name

Sterling

THE ENGINE of REFINEMENT
For the finest boats that float

With a monthly fire loss of over $25,000,000 in the U.S.A., the cost of adequate fire protection fades to insignificance.

Many manufacturing plants and municipalities are meeting the need for fire protection economically with a Sterling powered centrifugal pump.



Nominal cost. High Efficiency.

Catalogue on request.

STERLING ENGINE CO., Dept. C-4, Buffalo, N.Y.

12 to 300 H.P. at Speeds up to 1,600 R.P.M.

broken blades are not always poor blades.

Often it's a case of a good saw used in the wrong way. A hack saw may be brittle as glass or flexible as a watch spring, according to the temper of steel, but the temper is only one of the things that go to make good blades.

Starrett Hack Saws are tempered, milled and selected according to the work they are designed to do. That's why they "cut quicker and last longer."

According to the Starrett system of blade selection, there's a saw for every metal. Many saws will cut more than one metal, but no single blade will cut all metals, or even all shapes of the same metal economically.

Starrett Hack Saws plus the Starret Hack Saw Chart make it easier to cut metal economically. Ask for a copy of Chart CD—and "Hack Saws and Their Use"—both are free.

THE
L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Mfrs. of Hack Saws Unexcelled
ATHOL, MASS.

42-64

Starrett Hack Saws

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

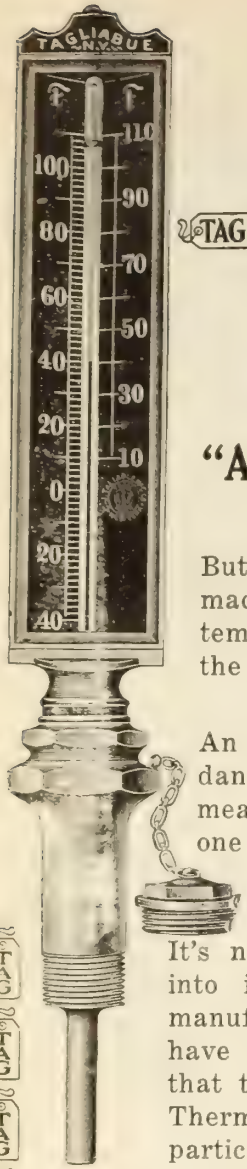
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.



TAG TAG TAG TAG TAG

Not Just

"A Thermometer"--

But TAG Thermometers made especially to register temperature conditions in the Power Plant.

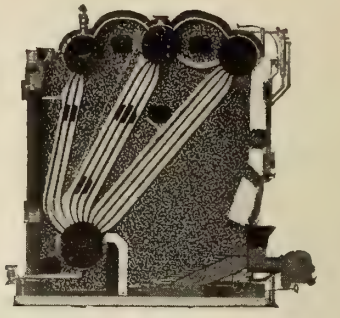
An incorrect reading is dangerous; it invariably means waste or spoilage of one kind or another.

It's not necessary to go into intricate details of manufacture here; we have a Bulletin, PP-405, that tells all about TAG Thermometers for your particular business.

They meet your requirements perfectly and are covered by an iron-clad guarantee. Not just "guaranteed," but an actual guarantee that comes with each thermometer insuring its accuracy.

Bulletin PP-405 Sent on Request

C.J. TAGLIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-68 Thirty-Third St. Brooklyn, N.Y.



Plastic Fire Brick in modern high stoker-fired furnace, including side and front walls, door arches, bridge wall and baffles

Seamless One-Piece Boiler Furnace Linings

Betson's Plastic Fire Brick is not a brick nor a cement, but a plastic compound of fire clays of highest refractory properties. It is properly proportioned to eliminate expansion and contraction and is used to build completely, one-piece furnace linings and to replace laid up fire brick, tile or moulded-brick linings.

BETSON'S TRADE MARK PLASTIC FIRE BRICK

is not high in price, it is high in efficiency. It is economical because it out-wears other linings and is so easy to install.

This plastic material is simply pounded into place with a mallet and smoothed with a trowel. No special forms, tools or training are required to execute a first-rate job.

With it tight, permanent baffles of proper size, shape and angle to form tapering passes, can be made for any type boiler, in your own boiler room, without disturbing your boiler setting.

Betson's is the pioneer and only Plastic Fire Brick. Backed by over 20 years' satisfactory service. Write for informing pamphlet.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6 Rome, N. Y.

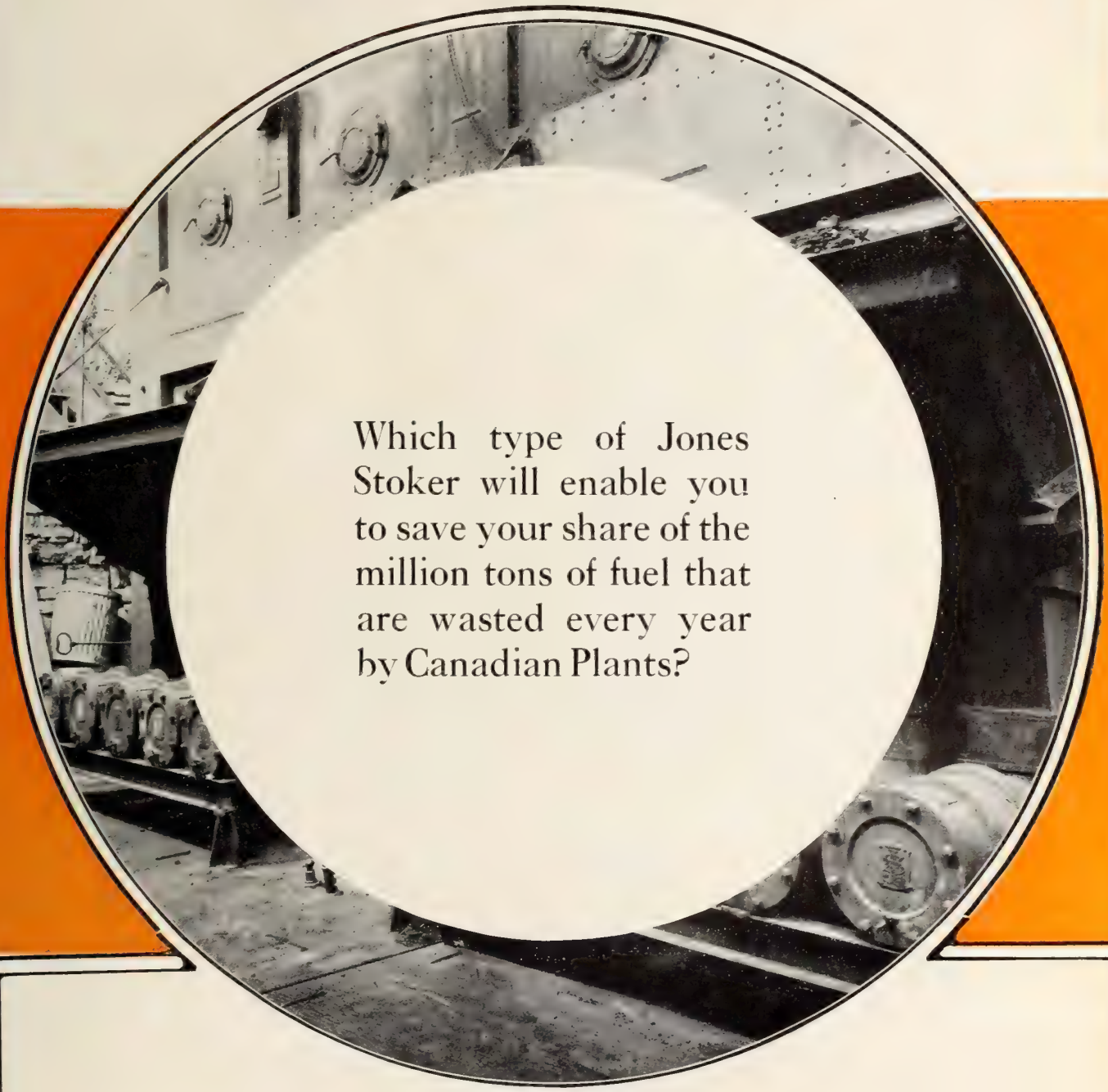
Canadian Distributors:
International Chemical Company
44-6 Lombard Street
Toronto, Ont., Canada

"If it's Plastic Fire Brick it's Betson's. If it isn't Betson's it isn't Plastic Fire Brick."

JONES

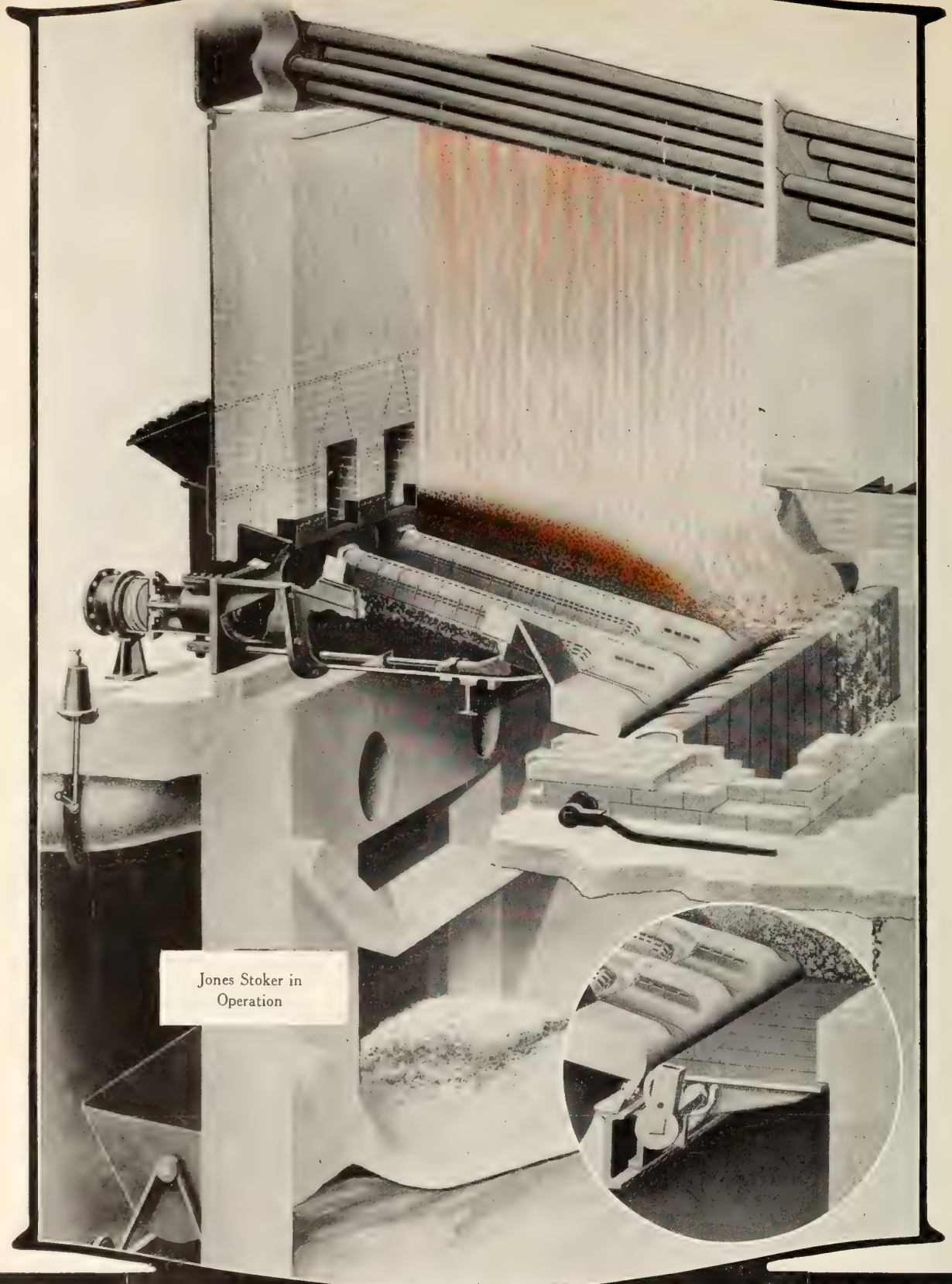
"A-C" and "Standard"

STOKERS



Which type of Jones Stoker will enable you to save your share of the million tons of fuel that are wasted every year by Canadian Plants?

Jones "A-C" and "Standard" Stokers are described in the following pages—



Jones Stoker in Operation

The JONES

Jones Stokers

for Plants of Every Type and Size

Jones "A-C"

Automatic-Cleaning, — Automatically-Controlled

JONES "A-C" Stokers are high-duty stokers. In many large plants from coast to coast they are operating continuously at heavy overloads. The automatic-cleaning ("A-C") feature saves labor. No hand cleaning is necessary. Clinkers are not formed on furnace walls. Fuel and air are automatically supplied in the right proportion for complete combustion with highest economy. Fires are automatically kept in perfect condition. Coal consumption is materially reduced.

Write for a complete "A-C" catalog

Jones "Standard"

Jones "Standard" Stokers are suitable for smaller plants. They can be installed under any boilers without disturbing boiler setting. No excavations are necessary. Like the "A-C" type, they are extremely simple in design and operation. Few moving parts—none in the fire. Foreign matter in fuel cannot cause damage. No shearing pins used. Very low maintenance cost. Smoke is prevented. Automatic fuel and air regulation insures best possible economy without expert supervision.

Write for a copy of the "Standard" catalog

UNDER-FEED STOKER

Made in Canada

The Service Behind the Stoker

THE Jones Under-Feed Stoker Company, Limited, has been reorganized, and its name changed to the Under-Feed Stoker Company of Canada, Limited. The following are the officers and directors of the Company:

President: Lloyd Harris, late Chairman of the Canadian Trade Mission, London, England; President Russell Motor Car Ltd.; President the Under-Feed Stoker Company of America.

Vice-President and General Manager: S. A. Armstrong, Vice-President and Managing Director of the Under-Feed Stoker Company of America.

Directors: T. A. Russell, President Willys-Overland Ltd.; Vice-President Russell Motor Car Ltd., and Director of the Under-Feed Stoker Company of America.

A. E. Holmested, Barrister, etc., and Director of the Under-Feed Stoker Company of America.

H. J. Fuller, President Canadian Fairbanks-Morse Company, Ltd.

David Fasken, K.C., President Excelsior Life Insurance Company.

This Directorate and reorganization makes available for all industrial Canada the engineering experience and development of mechanical stokers of the Under-Feed Stoker Company of America and the Under-Feed Stoker Company of Canada, Ltd.

This Canadian Company has carried on business in Canada for the past twenty years. Its stoker equipment is manufactured in Canada—is sold for Canadian money at par.

This is the only stoker company doing business in Canada to-day that is qualified from the standpoint of equipment to handle any type of combustion problem presented.

The Under-Feed Stoker Co.
of Canada, Ltd.

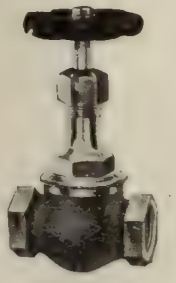
81 Victoria St. Toronto

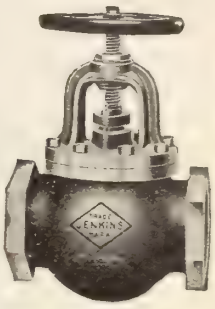
56 Years' Record of Success Throughout The World

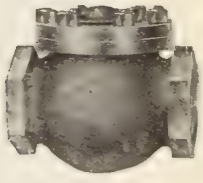
TRADE JENKINS MARK

The Jenkins Diamond Trade Mark is a Seal of Guaranteed Service

Jenkins Bros

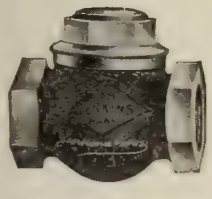






The Trade Mark That Says "This Valve is Dependable"

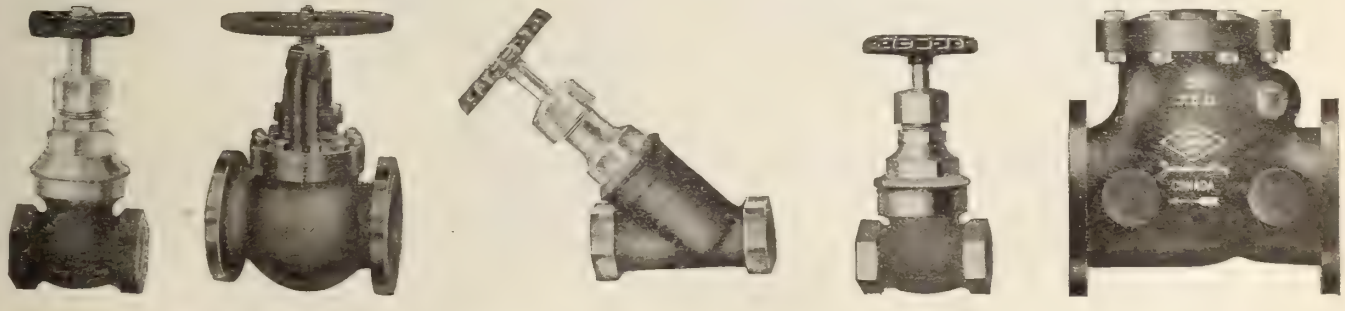
That is just what the Jenkins Diamond Trade Mark signifies—**absolute Valve Dependability.** It is cast upon the body of every genuine Jenkins Valve; put there as a protection against inferior imitations and a guarantee of lasting service under every condition of usage.



In every line of industrial endeavor—in power houses, water works, railroad shops, factories, office buildings—wherever good valve service is vital Jenkins Diamond Trade Marked Valves are giving a service in keeping with their 56 years' reputation.

Catalog No. 8, free on request, pictures and describes the complete line—A Valve for every purpose.

Obtain Jenkins Valves from dealers everywhere.



Jenkins Bros.

LIMITED

Head Office and Works: 103 St. Remi St. Montreal, can.

EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG.

Agencies in all the Principal Countries of the World

WAIT STEAM TURBINES

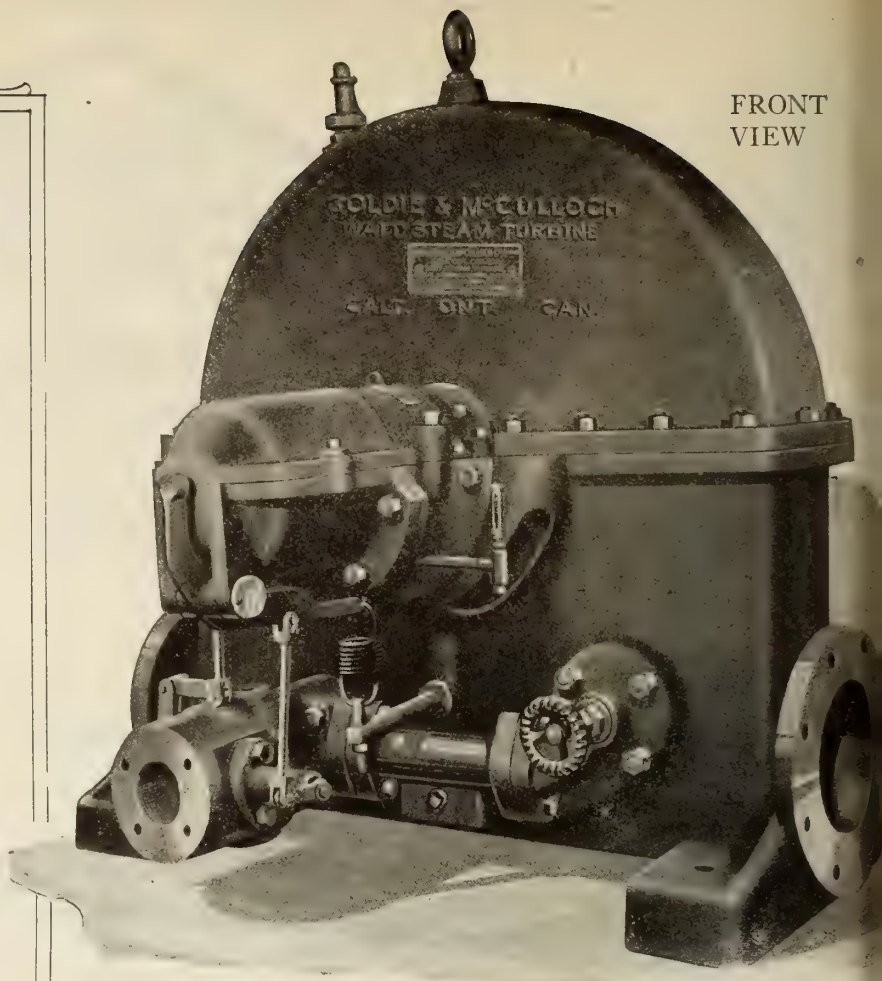
The Acme of Perfection

MANY recent improvements in detail by skilled investigators have resulted in the G. & McC. Co. "Wait" Steam Turbine reaching a high point in efficiency—it is in fact recognized by leading engineers as the acme of perfection in steam turbines. Some of its leading features include in addition to high efficiency—simplicity, ruggedness and economy of operation.

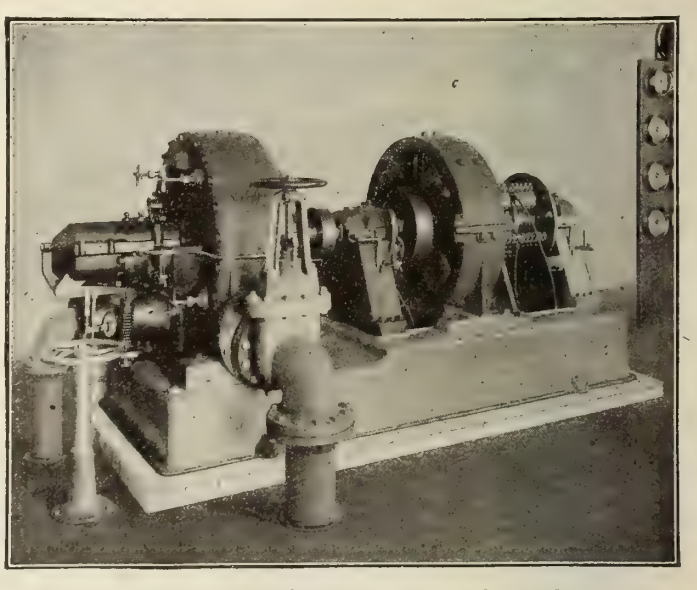
Points of this G. & McC. Co. Machine that should be remembered are:

—The Turbine is entirely automatic.
—No oil or grease cups.
—Stuffing boxes and glands, seldom require attention.
—Emergency governor and valve are entirely separate from main governor and valve.
—Interior may be easily inspected.
—Self-lubricating; dust-proof; dirt-proof.
—Speed can be changed while running.
—LOW RUNNING EXPENSE AND COST.

Dependable Power Equipment



FRONT VIEW



Goldie & McCulloch "Wait" Steam Turbine at St. Boniface Hospital, Winnipeg, Man.

The Goldie & McCulloch Co., Limited

Head Office and Works: GALT, Ontario, Canada

Toronto Office: Suite 1101-2, Bank of Hamilton Bldg.

Western Branch: 248 McDermott Ave., Winnipeg.

Quebec Agents: Ross & Greig, 400 St. James Bldg., Montreal.

British Columbia: Robt. Hamilton & Co., Vancouver, B. C.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Experiments on a Conveyor-Feed Type Stoker

As a Result of Two Years' Experimental Work, a Stoker Which Will Burn Eastern Bituminous Coal Successfully Has Been Obtained—The Author Describes Them in a Paper Before the A.S.M.E.

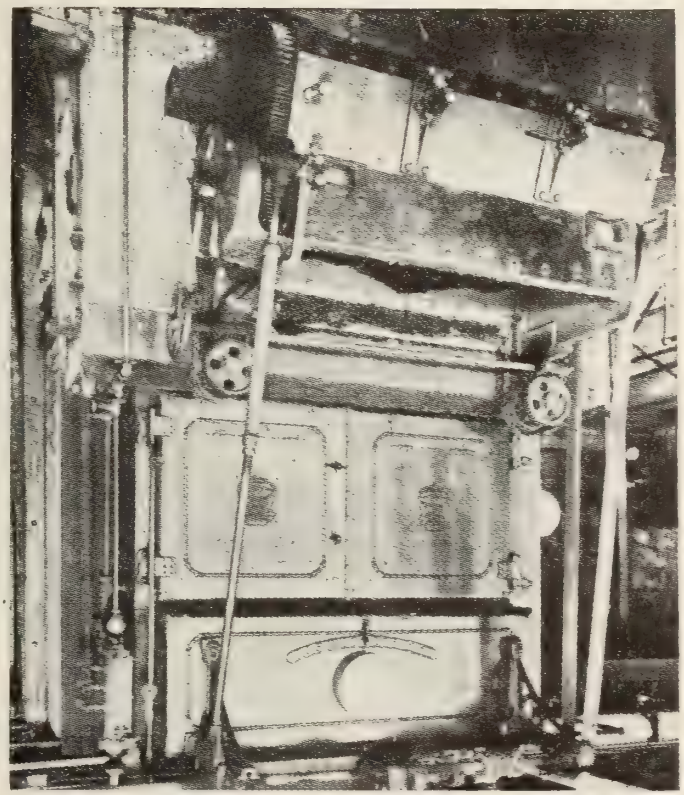
By LLOYD R. STOWE

FOR the past two years the Laclede-Christy Clay Products Company has been experimenting on a new forced-draft stoker for use with the various kinds of fuel found in this country. The boiler house of this company's Christy plant at 4600 South Kingshighway, St Louis, has been and still is being used for experimental, testing and development work. Fig. 1 shows the test boiler and stoker.

The burning of coal has always been a decidedly popular subject with engineers and naturally these two years of intensive experimentation have developed information that will be of interest to the members of this society. The stoker used employs the conveyor method of feeding, i.e., it uses progressively moving chain-grate conveying elements to feed the coal through the furnace and to discharge the refuse to the ashpit.

At the outset it is necessary that we realize the full import of the term "conveyor-feed." The conveyor-feed principle makes possible the use of grates that continually move onward in one direction. The fuel bed being supported on these moving grates is positively conveyed from the stoker hopper where fresh coal is introduced, to the discharge end where the refuse is rejected to the ashpit.

The feature of the conveyor-feed that commends its use is its handling of the fuel bed in a positive, definite fashion. By striking off the fuel evenly under a feed gate and then literally carrying it on through the furnace and over the point of ash discharge, this mechanism prevents in a large measure the evils of less positive feeding devices, namely, specifically uneven fires, balled-up spots, and immovable clinker formations. These advantages of conveyor-feeding are very attractive to the stoker designer, and as a result of this and of the fact that the underfeeds have quite thoroughly demonstrated the great advantages of mechanical draft, many builders are now experimenting on and developing various forms of forced-draft conveyor-feed stokers. In fact, work in this direction characterizes the efforts of the stoker industry at the present time, and the following particulars regarding the experimental work of the Laclede-Christy Company and the results it has attained should therefore prove of timely interest.



THE TEST BOILER AND STOKER.

It is well known that there have been many failures in attempting to burn eastern coal on chain grates. In fact, some have gone so far as to maintain that the undisturbed fuel bed of the conveyor-feed is so poorly adapted to eastern coal that it is useless to proceed further along these lines. Others have, in all sincerity, advised manufacturers to stay with the western coals, where the conveyor-feed rightfully belongs.

Now, one of the characteristics of the conveyor-feed, it will be observed, is that the fuel bed is undisturbed during the so-called coking period, or, more properly speaking, the period of destructive distillation. It is largely because of this feature that the author has elected particularly to relate what has been learned about eastern coals with conveyor-feed—coals high in heat value and low in ash and including those termed semi-bituminous and caking. And it may be as well to state at this point what may be considered as the conclusion of this paper: Namely, that the results of these experiments undertaken indicate that conveyor feeding can be used successfully with eastern bituminous fuels.

For many years it has been quite clearly established that nearly every re-

quirement of a successful stoker is lacking when burning caking fuels on chain grates with natural draft. The coal cakes almost immediately upon entering the furnace, high rates of burning cannot be secured, the combustible content of the ash is high, the admission of the air is not properly graduated to the requirements of the various stages of combustion, and maintenance of links is excessive. This is indeed a complete indictment, and with the sole exception that the automatic features are always in evidence, it may be said that the performance of chain grates on eastern bituminous coals violates every requirement of a successful stoker.

It is well known that the caking property of eastern coal is the most serious obstacle in the way of the successful use of this fuel on chain grates. In endeavoring to burn Pocahontas and similar coals it is observed that tarry oils flow through the fuel bed as a result of the application of heat at moderate temperatures. It is further observed that the coal under the arch is caked or coalesced by these tarry oils, and forms a sticky blanket that prevents the entrance of air through the coal and hence checks combustion and heat generation under the arch.

In attempting to remedy this situation the most natural thing to do is to employ mechanical means to break up the caked fuel bed, which is the course almost invariably taken by the inventor. In fact, the idea is prevalent that "A mechanical agitation of the fuel bed, for the purpose of breaking up the coke, is necessary or advisable when burning eastern coals." So many statements have appeared similar to the one just quoted that mechanical engineers have come to accept it as a basic fact. The results obtained at the experimental plant, however, have disproved this contention and in doing so have made possible the application of conveyor feeding to the burning of eastern coals.

Causes of Coke Formation in Stoker Practice and Its Prevention

All bituminous coals have a small resinous content that flows when heat is applied. In certain coals this resinous material has decided adhesive or binding properties and hence agglomerates the coal particles into a primary mass when it flows under the application of heat. This mass is the starting point of coke formation and out of it true coke may be formed by further actions that take place in the fuel bed. It must be noted here that while all bituminous coals have this resinous content its adhesive or binding property is lacking in the western, or free-burning coals.

It appears that the higher the oxygen content of the coal, the less pronounced will be the primary caking tendency. Analyses on a moisture-and-ash-free basis show that eastern coals contain less than half as much oxygen as do western coals of non-caking characteristics. Furthermore it is well known that eastern coking coals lose their caking properties by weathering, and it has been determined that weathering causes coal to absorb oxygen and to increase in weight by the weight of oxygen absorbed.

The absorption of oxygen can be accelerated and be made to take place in the boiler furnace by producing very high coal temperatures and accompanying these with a plentiful supply of air. In other words, this feature of weathering can be artificially carried on in an exceedingly short time. The oxygen absorbed apparently destroys the adhesive qualities of the resinous material referred to above and hence the primary mass from which the coke structure is later formed is not produced.

Again, when heat is applied to any bituminous coal, a chemical rearrangement or breaking down of certain of the compounds in the coal takes place. This action produces the greater part of what is termed "volatile matter," the remainder coming from the resinous content. The initial product of this chemical rearrangement is no doubt further decomposed into a fixed gas and a tarry residue. This tarry residue has not in itself the properties of a very strong binder, but it does build up and materially strengthen any primary coke structure that may already be present by leaving a film of carbon behind when the final breaking down into this carbon and fixed gas has taken place.

The foregoing theory accounts for the non-caking performance of eastern coals in the experimental work referred to in the present paper, and in its essentials seems to be the theory most commonly accepted by coal and coke analysts.

In the experiments with the new stoker the ignition temperatures are extremely high and at these temperatures considerable amounts of air are forced through the fuel bed, thus providing for the absorption of sufficient oxygen in a short time to destroy the initial caking tendency. Moreover, it is reasonable to suppose that these unusually high temperatures at the same time cause a quite different procedure during destructive distillation than that which obtains with lower temperatures. That is, these extremely high and unusual temperatures completely decompose both the resinous excretion and the remaining or major part of the volatile-forming matter before the former can set up an appreciable primary structure, and before the carbon of the latter can have time to impregnate any slight primary structure that may have formed.

The absence of coke formation changes completely the character of the fire under the arch and has almost as marked an influence on the last half of the fire because since coke is not formed in the distillation zone the cemented coke lumps cannot be present in the final stages of combustion. The individual pieces of coal retain their identity exactly the same as when Illinois coal is used, with the result that the fuel bed has the soft, incandescent and fluffy appearance which every chain-grate fireman realizes means economy and high rates of burning. The absence of coke formation in the final stages of combustion will be mentioned again.

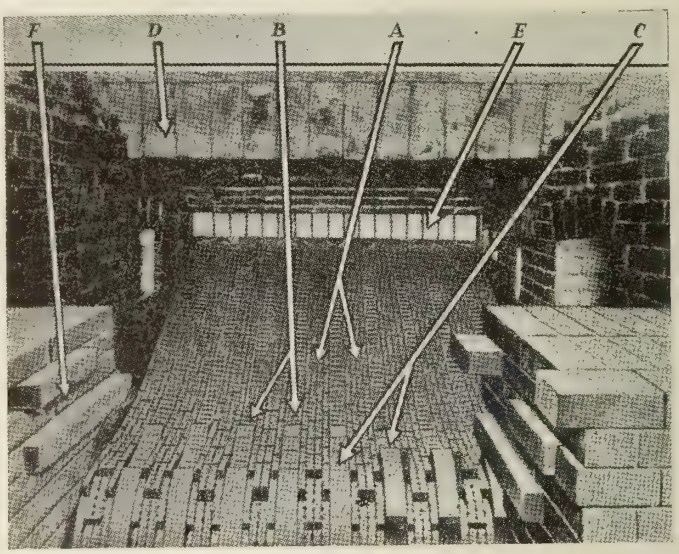


FIG. 2—VIEW OF THE GRATE SURFACE AND FURNACE TESTED.

The New Stoker

A description of the final apparatus decided on is advisable at this point for the purpose of showing how the high initial temperatures are obtained. Fig. 2 is a view of the grate surface, its general incline being 20 deg. The arrows indicated by A point to narrow chain grate or conveying elements, about 4 in. wide and placed on 7-in. centres. In the intervening 3-in. spaces are placed stationary tuyeres indicated by arrows at B. At the lower end of the grate surface the tuyeres B terminate in short pivoted bars C which are made automatically to rise above, then drop below, the surface of the conveyor chains. This action takes place slowly. D is a feed gate, adjustable to give various thicknesses of fire exactly as on a chain grate. Partly overhanging the vibrating bars C is the bridge wall E, shown cut away in the centre. An ignition arch

is shown at F. This latter provision conforms to chain-grate practice except that with the greater incline of the grate the arch is farther away from the fire. Fig. 3 shows a cross-sectioned side elevation of the stoker and boiler.

Close study of chain-grate practice has revealed much in the art of building up high ignition temperatures. A great expanse of bridge wall extending from a point horizontal with the arch to or nearly to the fuel bed is known to be of utmost value in directing heat on to the incoming fuel. This is the surface indicated by A in Fig. 3. The steep incline of the stoker in question permits this dimension A to be greatly extended over that possible with the ordinary chain grate. Moreover, it exposes the fuel bed more directly to the intense heat reflected from the bridge wall and the flame in front of it.

The form of arch was also taken from chain-grate practice and its design and placement has, of course, contributed its part toward the building up of the high fuel-bed and ignition temperatures that play so important a part in preventing the caking and ultimate coking of the fuel.

As to the admission of a generous supply of air (the second requirement for coke prevention), the greatest percentage of the total air supply is supplied under moderate pressure through that part of the fuel bed under the arch. This air supply, coupled with the very high fuel-bed temperatures obtaining, quite effectively destroys any inherent caking tendency of the fuels thus far tested, and made it possible to burn eastern coal with a considerable degree of satisfaction.

In view of the troubles known to exist with eastern fuels when using a stoker that conveys the fuel undisturbed into the furnace, the author deems it advisable to give a further description of the stoker in question in the light of what is required today in the economical burning of coal for the generation of steam, touching particularly on those features that have been conspicuously faulty in chain grates. The following outline presents the entire situation at a glance, and later in the paper each of the items therein is briefly touched upon.

It is of interest to note that the difficulties with chain grates on eastern coal have been violations of the essential requirements of the modern stoker, so it is not surprising that the opinion prevails that success cannot be obtained with eastern coals using the conveyor-feed.

An adequate treatment of the first-mentioned stoker requirement in the foregoing outline would entail a discussion of what takes place in the fuel bed and would involve a consideration of the various types and feeds of stokers, but as such a discussion is outside the purpose of this paper this requirement will be discussed only as to the essentials upon which everyone will readily agree.

Present-Day Requirements of an Automatic Stoker Compared With the Performance of Chain-grate and Conveyor-Feed Stokers, Each Using Eastern Coals.

	Requirements of the Present-Day Stoker.	Results Obtained with Eastern Coals. With Chain Grates	Results Obtained with Eastern Coals. With Conveyor-Feed Stoker Described
1	It should completely burn all combustible that arises from the grate, and perform this task under the great handicap of using no more air than is required.	Thin fires spotted with upstanding coke result in excess air and low CO_2 due to the fact that the air supply is not graduated down to a minimum at the rear of the stoker and to influence attending the coking of the fuel bed	Graduation of air supply and thickening of fire near point of ash discharge and the prevention of coke assure a consistent 10 to 12 per cent. CO_2 content with positive assurance of an intimate mixture of air with combustible gas.
2	It should bring about low combustible in the ash.	Combustible in the ash from 30 to 50 per cent.	Combustible in the ash from 16 to 24 per cent.
3	It should burn coal at high rates of burning — not only to obtain high capacities but to widen the range of economical rates of burning as well, in order that great flexibility may be assured.	Rates of burning from 25 to 35 lb. of coal per sq. ft. of grate surface per hour.	Rates of burning up to 60 lb. of coal per sq. ft. of grate surface per hour.
4	It should be as nearly wholly automatic in operation as possible.	Successful in the matter of automatic operation.	Successful in the matter of automatic operation.
5	It should not entail unreasonable expense in the upkeep of the grate surface or of the furnace brickwork.	No unusual maintenance cost for furnace brickwork, but a very high one for grate links.	Use of mechanical draft imposes a more severe condition for furnace brickwork requiring a higher grade of refractories, but maintenance of ironwork is not excessive—in fact, may be considered quite satisfactory.

Air Distribution

Rather exhaustive surveys of the gas composition in various parts of the furnace were made frequently during the development work. These surveys showed that the zone of destructive distillation yields far greater quantities of combustible particles than does that well-spent portion of the fuel bed near the bridge wall. It follows, then, that air distribution must be regulated to supply large quantities of air to the coal during the early stages of combustion and limited quantities as the fuel nears the place of ash discharge.

It will be generally admitted that in order to burn completely all the fuel with a minimum of air it is of prime importance to provide each particle of combustible with its own quota of oxygen-giving air just as it rises from the fuel bed. The tuyere construction is well suited to such a requirement and lends itself admirably to these experiments. The tuyeres are cast in interchangeable sections containing varying percentages of air openings. This feature permits any desired gradation in air spaces to be made, between the two extremes noted in the tabulation below.

It is important at this point to recognize that the wind-box pressure is uniform under the entire grate. This provides high draft intensity and high air jet velocity for all parts of the fuel bed.

Low Combustible in the Refuse

The reduction of the combustible in the refuse to a satisfactory figure was brought about by taking advantage of the four following factors that have a vital influence on the character of the refuse: (1) Strong ignition; (2) A free-burning fuel bed; (3) Thickened fuel bed near the discharge end of the stoker; (4) High draft intensity through the nearly spent fuel.

The strong ignition temperatures have been referred to previously. On the conveyor-feed type of stoker, the coal burns from the top downward during the early stages, and from the bottom upward during the remainder of its travel. The higher the ignition temperatures, the quicker this reversal is established. An early burning from the bottom upward is recognized even in chain-grate practice, as being most effective in bringing about low combustible content of the refuse.

In a caked fuel bed of eastern coal, the air breaks through only at the fissures or cracks. Naturally the burning starts only at these fissures, and as it continues, holes are formed in the fuel bed. As the holes increase in size, the rate of burning decreases, due not only to the cooling ef-

Table 1—Air-space Distribution Adopted for Conveyor-feed Stoker.

Air space in each element at feeding end		Air space in each element at discharge end	
Conveying elements	8 per cent.	Conveying elements	8 per cent.
Tuyere elements	22 per cent.	Tuyere elements	2 per cent.
8 per cent of 60 per cent.	= 4.8 per cent.	8 per cent of 60 per cent.	= 4.8 per cent.
22 per cent. of 40 per cent.	= 8.8 per cent.	2 per cent. of 40 per cent.	= 0.8 per cent.
Total air space	=13.6 per cent.	Total air space	= 5.6 per cent.

Conveyor elements, about 60 per cent. of total grate surface.
Tuyere elements, about 40 per cent. of total grate surface.

fect of large columns of cold air but also to the lessening intensity of draft occasioned by the increase in the effective air openings. This action results in a fuel bed characterized, in the final stages, by isolated lumps of coke surrounded by patches of bare grate. To prevent exceedingly low CO_2 the operator must run these bare patches out of the furnace and consequently dump the intervening or accompanying coke lumps into the ashpit.

With coking prevented and with each individual particle of coal preserving its identity, the air filters upward evenly throughout every part of the fuel bed. Freed from localized burning the fire now appears soft, intense and highly luminous.

The thickened fuel bed near the discharge end is brought about by the retarding mechanism described. (See Fig. 2.) When elevated the short pivoted bars C raise the nearly spent fuel above the chains, thus holding it back, and when depressed permit the conveyor elements to carry the ash out of the furnace. The relative duration of these two influences can be controlled by the operator and the fuel bed near the discharge end of the furnace can be held back and thickened to any desired depth.

The high draft intensity in connection with this thicker fuel bed has already been mentioned under the paragraph on air supply. Full wind-box pressure at this part of the grate forces high velocity air jets into the thickened bed and hence is particularly advantageous in burning out the remaining particles of combustible.

High Rates of Burning

From the foregoing references to mechanical draft it is quite apparent that high rates of burning are attainable with this new type of stoker. The replacement of the typical plastic fuel bed with the free-burning, intensely active bed obtained with the new equipment, materially assists in securing higher rates of coal consumption. High CO_2 results quite naturally from (a) the proper air distribution described; (b) the thicker fuel bed particularly at the discharge end; (c) the higher fuel bed temperatures that cause increased chemical activity; and (d) the impinging jet action on the fuel particles produced by small air spaces and forced draft.

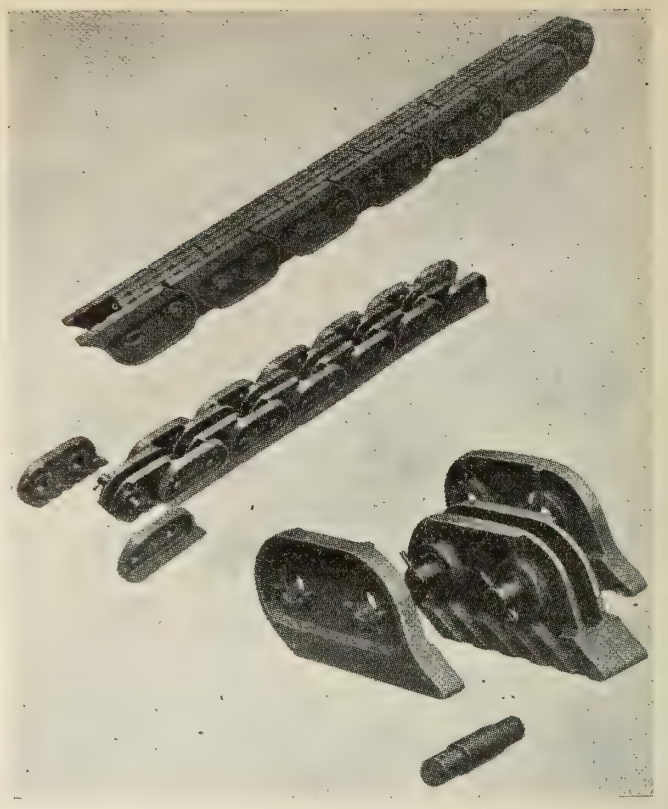


FIG. 4—DETAILS OF THE CONVEYING ELEMENTS MARKED "A" IN FIG. 2.

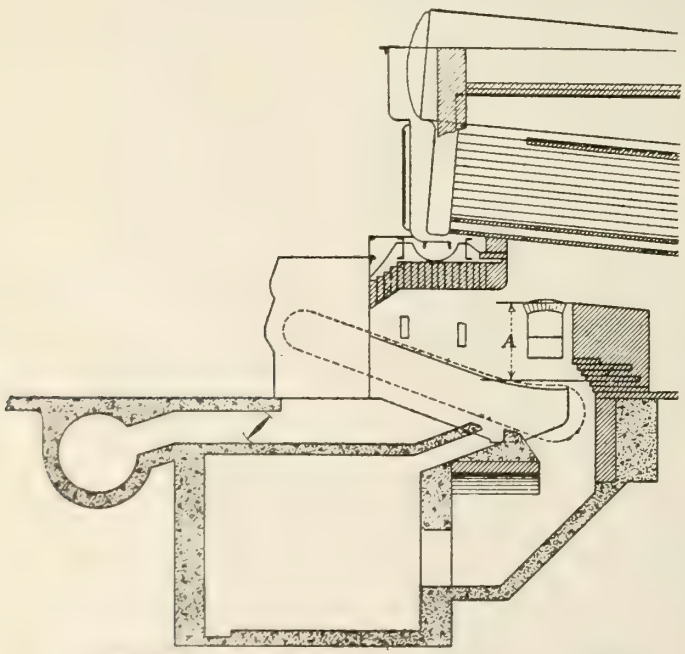


FIG. 5—SECTIONAL ELEVATION OF BOILER AND STOKER.
(Boiler has 2,500 sq. ft. heating surface and stoker 40 sq. ft., ratio 62½ to 1.)

Automatic Operation

In the matter of automatic operation it is only necessary to recall the basic principle of the conveyor-feed stoker — a positive feed fuel coal hopper to ashpit. The only action that interferes with this automatic and continuous performance and requires more than a minimum of attention from the operator is the formation of clinker on the side walls. This clinker accumulation is no more serious than with chain grates but experiments are under way to still further minimize the evil.

Eastern coals require less side-wall slicing than do those from the Middle West, probably because of the lower ash content with its higher fusing point. Also such coals have higher heat value and hence greater firing stability than Illinois coals. Because of these two advantages, the firemen of the experimental plant prefer eastern coals to those from the Central West when burned on the new stoker.

Low Maintenance

The thin uneven fuel bed at the discharge end of a chain grate combined with the low ash of eastern coals exposes the grates to the heat of the furnace. Moreover, with caking coals and chain grates, the procedure of partially closing the damper to raise the CO_2 content of the gases is too often resorted to, and such a practice invariably results in over-heated grate links.

The stoker herein described, by employing a deeper fuel bed and a thick layer of refuse near the bridge wall, effectively protects the grate from the heat of the furnace. In addition, full advantage has been taken of the cooling action of the incoming air. The small air spaces and the employment of mechanical draft produce high air velocities and this makes for cool links. An excellent idea of the very different character of the new link for eastern

coal and forced draft is obtained from Fig. 4.

High rates of burning and high furnace temperatures of course subject the furnace brickwork to very severe service. However, the wind-box pressures are low (less than 2-in. water column) and this, combined with the large number of uniformly distributed miniature air openings, causes the impinging flame or blow pipe action to disappear quite near the surface of the fuel bed, thus minimizing to some degree the brickwork deterioration.

The problem of more severe furnace conditions has thus far been met by employing refractories of a higher grade. The side walls and bridge wall have been made with standard 9-in. shapes and the writer is advised that the higher refractoriness of the brick used is in part due to its higher percentage of alumina and its low content of fluxes. Regarding the ignition arch, both the process and the mixture are new in stoker work. The material is highly refractory and porous and its performance under the harder usage bids fair to rival the ordinary arch maintenance in chain grates.

The essential points of this paper have been sufficiently marked to require no summary, but it may be said in closing that those connected with the experimental plant have derived considerable satisfaction in attaining the degree of success noted through the employment of such simple means.

COLOR SCHEMES FOR PLANT PIPING

By H. L. Wilkinson

The importance of some definite and unmistakable means of readily distinguishing between the various pipe and conduit lines and systems in the power plant has long been recognized by both designing and operating engineers. Particularly in large power plants is this question of vital importance, and it should be stated that in some of the well-ordered large power plants reasonably satisfactory systems have been installed. Also there has been some effort made to standardize this practice, a committee appointed by the American Society of Mechanical Engineers to investigate the question having reported upon the preferable distinguishing colours for the various divisions of piping systems in the usual power plant, so states the author at a recent meeting of the American Society of Heating and Ventilating Engineers.

While the importance of standardization in this detail of our power plants has been recognized, too little attention has been given to the matter of late, and the writer believes that its importance should not be overlooked. It is, therefore, suggested that the members of this society consider the following plan which is designed to apply to all piping systems.

It will be noted that the recommendation involves, in addition to piping lines, colour schemes for machinery, motors, hand-rails, dadoes, waste pails, elevator cages, etc., thus extending the usefulness of this distinguishing system to all parts of the industrial plant. It has been a revelation to the writer to find the cordial reception which this proposed colour scheme has received in many industries and concerns of national prominence, and the result is that new industries and concerns are taking it up continually. The application of this standardization might well be extended to the designating by distinguishing colours the tools used in various departments of a plant. This would bring about several benefits. In the first place, it would enable managers to hold each department of a plant responsible for its own tools. Then, because of the improved appearance of the tools, it would create more interest in their care on the part of mechanics. Last, but not least, it would surely be an insurance against tools being carried out of factories.

While the scheme designates definite colours for certain pipes, it is, of course, unnecessary to apply any one particular colour on any one pipe, the arrangement being flexible, so that an engineer may determine for himself his own design. In some cases, where there are as many as fifteen to twenty-five various pipe lines, it is necessary to use combination colours on some pipes, painting the straight pipe one colour and the joints, valves, elbows, etc., the alternating colour. Of course, some exceptions to personal selection will be found where an established custom has been in effect for some time, as in the case of sprinkler-pipes and all fire lines, where vermilion is the logical colour.

The advantage of this standardization will become readily apparent from the case of a certain plant where there was a stoppage or break in one of the pipe lines. The workmen carefully followed the line to the side wall where the trouble apparently existed, and opened up the wall for a considerable area, only to be confronted with everything but the line they sought. Of course the expense of ripping out the wall was nothing compared to the inconvenience and loss sustained, due to the suspension of operation until this repair was made. If this pipe line had been printed with a distinguishing colour and a small arrow placed on the wall where the pipe entered, indicating the direction the pipe took after enering the wall, all this difficulty would have been obviated.

NON-DESTRUCTIVE METHOD OF BELT JOINING

An unusual problem in the handling of hot cement clinkers with a temperature of 200° and over, was recently solved at the plant of the Standard Portland Cement Company, Leeds, Ala., in an interesting and cost-reducing manner. The method decided upon for moving the clinker was a rubber conveyor belt, but the clinker could not be cooled sufficiently in the process previous to conveying, to prevent scorching of the belt and its rapid destruction. The answer to this problem was found by running the belt at an incline of 12 degrees, so that the lower pulley dipped into a trough of water, thus carrying a film of cold water upon the belt, on to which the hot clinker from the loading hopper was deposited.

At this point a new problem was encountered; namely, how to join the belt so that the belt's full strength would be retained, and in a way which would withstand the extremes of temperature, the wear on the pulleys and the abrasion of the clinker. For this purpose Crescent belt fasteners were adopted, because they brought the belt ends tightly together in a snug joint, which made the belt practically endless on the pulley side, so there was no opportunity for clinker ash to get into the joint and abrade the belt ends, and also because in this method of joining, no metal came in contact with the pulleys to cause wear, and a permanent joint was thus assured. Moreover, the exceptional strength of the heads of the rivets and the formation plates prevented destruction of belt joint through abrasion by the clinker.

In six months of operation, this conveyor has carried 61,000 tons of clinker, and the Standard Portland Cement Company credits the saving of $300.00 in belt cost alone to this conveyor. The belt used was Goodyear Hy-temp, which is made particularly to withstand temperatures up to 200°, and is adapted for work on conveying jobs in mines, coking plants and cement factories where heat resistance and ability to withstand hard wear are prime requisites.

One of the most conspicuous forms of British engineering activity since the war lies in the growth of locomotive production. Every country in the world wants locomotives, and the extension of many locomotive shops in both England and Scotland, is designed to ensure that the demand will, as in the past, be met.

It is so far to the good that most of these shops were retained on locomotive work during the war. One firm alone supplied 152 locomotives to British railways, 380 to the French railways, and 300 for other overseas countries during the war. This was in addition to producing many narrow gauge locomotives, hundreds of "Tanks" and hundreds of thousands of shells, numerous aeroplanes, torpedo-tubes, gun carriages, and other "munitions." The total value of the company's output during the war was sixteen million pounds.

The Kelly Foundry and Machine Co., of Goshen, Indiana, have issued their catalogue G dealing with rocking, dumping, and stationary grates. The catalogue is well illustrated, and shows, besides the various types of movable grates, some portable kiln grates, stationary fire bars, and boiler front castings.

Common Sense in Engineering

A Lecture Delivered During the J. E. Aldred Lectures on Engineering Practice at John Hopkins University.

By WALTER M. McFARLAND

(Continued from last issue)

A very important feature in your engineering education and experience is to discover in any specific case the general principle which is involved and which may often be utilized to advantage elsewhere with considerable differences of detail from the original case. A circumstance of this kind came under my observation which illustrates the point quite well.

It was customary in the engines of the Navy up to about the beginning of the so-called "new navy" to make the eccentric straps of brass. Somewhat earlier than this, when steel castings had become available, designers for engines of the merchant service had made eccentric straps of steel castings lined with white metal, the idea being, of course, that the white metal furnished the suitable bearing surface, while the steel casting gave adequate strength. The steam launch on one of our vessels had the eccentric straps made of brass, as usual, half an inch square in cross section, and one of them broke. It was the lower half, which was a half circle with lugs to bolt to the other part. The young engineer who was charged with the repairs did not know of this practice in the merchant service, and having always seen eccentric straps made of brass, tried to make a temporary repair by taking a couple of sheets of one-quarter inch sheet brass, bending them to shape, riveting them together with a few copper rivets and bending over the ends to make lugs for attachment to the other part of the strap. Unfortunately, sheet brass is rather brittle, and, as might have been expected, this temporary strap broke off where the lug had been bent. After trying this a couple of times he was about to give up the attempt at repair and have a new strap made at a shop on shore. Another young engineer on board knew of the practice in the merchant service. It was out of question, of course, to get a steel casting, and it would have been difficult to arange for using white metal, but he remembered the principle of a proper bearing metal to go against the eccentric, backed up by a stronger one to stand the stress. Accordingly he took a piece of half-inch square bar iron, had it bent to shape and faced it with one of the strips of one-quarter-inch sheet brass, securing it to the wrought-iron backing with the copper rivets. This was properly fitted to secure a good bearing, and, of course, worked with entire satisfaction. Later on a new brass strap was secured for use, if necessary, but the repair was so satisfactory that the new strap was never used.

From the circumstances existing in educational establishments it is practically a mater of necessity that in solving problems the data should be furnished you and your work should be chiefly the handling of these data. When you get out into actual practice an exceedingly important part of your work will be the securing of these data accurately, which means that the observations must be made with care and with the aim to be thoroughly correct and reliable. It is not always possible to devise simple checks on the observations which will tell at once whether the records are reasonably accurate, but there are many cases where such checks do exist, and you should endeavor, if possible, to ascertain what such checks are. Some will come from previous observations and experience, some from study, but a great many will be a matter of common sense. A striking case which came under my observation and where common sense was the check is worth telling.

Most of the Mediterranean ports are protected by breakwaters so that the water inside is smooth, and as a result when coal is brought off to vessels it is in rectangular piles on flat scows. Unfortunately, coal dealers in the Mediterranean have a rather bad reputation for trickery. Consequently, in naval vessels when coal is taken on board great care is used in measuring the coal piles so as to be sure of the amount received. I was attached to a vessel which called in the harbor of Algiers. A couple of our midshipmen were detailer to measure the coal piles which were, roughly, 40 feet long, 20 feet wide, and between 5 and 6 feet high. At the end of the first day they handed in figures to show the amount received, which came to 375 tons. The executive oicer of the vessel had been attached to her for some two years, and so was familiar with the rate at which coal could be taken in. He said at once that some serious mistake had been made for the reason that never before had more than 300 tons been received in one day, even when the conditions were better for rapidity than existed at Algiers.

The midshipmen were told to go over their work again to see if there was any mistake, and they examined their computations but could find no error. I was the possessor of a slide rule, and was, therefore, supposed to be something of an expert on figures, and was called in to see if I could find what was wrong. I had had nothing to do with the coaling, but was on board during the day, and happened on several occasions to notice the young men while they were making their measurements. I checked up some of their arithmetical work and found it was correct, so it seemed that the trouble must be in the measurements themselves. I remembered that when I saw them making the measurements the particular piles on which they were working did not come above their heads, while I noticed a great many heights recorded as being over six feet. The solution of the difficulty then occurred to me at once. They had used one of the tape measures from the engine room. If you do not know it now you will learn by experience that the ordinary linen tape measures are fitted with a brass ring in the end for convenience and to prevent the tape from slipping into the case. These rings are invariably torn off after a relatively short service, and the common practice is then to tie a knot in the end of the tape and to make all measurements from the 1 foot mark. I asked the midshipmen if they had used the linen tape, and found they had. It appeared on further investigation that the man who held the knot recorded the figures, which were caled off by the man at the other end. The recorder assumed that the other man had deducted one foot before calling off the measurement, while the man at the other end called off what he saw, assuming that the recorder would deduct one foot. There would have been no easy way to check this on the measurements of 20 feet and 40 feet, but obviously it was absurd to put down heights of 6 feet 3 inches and 6 feet 6 inches when, as a matter of fact, they were looking over the piles. Remembering that when I saw them the piles were below the tops of their heads, I asked them if there were any piles which they could not look over. On reflection they said that there were none. I asked then where they got their heights of over 6 feet, and at once the error developed that every measurement they had made was one foot too great. When the correction was made the amount of coal received was only 275 tons instead of 375.

As you hear the story you may think that these young men were unusually stupid. As a matter of fact, this is not true at all, and both have since made enviable records in the navy. They simply failed to use common sense in applying the obvious check as to height when they could look over the piles of coal, which should have at once have called their attention to the carelessness with which they were making the measurements.

While speaking of this subject of checks on observations you will in time

acquire a great many of these from practice and experience, and it is well to do so as soon as possible. For example, with good average coal of, say, 14,500 B.t.u.'s pepr pound, if all the heat went into the formation of steam (that is 100 per cent. efficiency) you would have evaporation from and at 212° F. of about 15 pounds. Likewise, with good quality fuel oil of, say, 19,500 B.t.u.'s the corresponding evaporation would be about 20 pounds. These are figures easy to remember, and when you remember in addition that the best average results in good boilers are about 75 per cent. efficiency with coal and from 80 to 82 per cent. efficiency with oil, you will be in a position to discourage fairy tales about remarkable performances in the way of boiler efficiency. It is the custom now in all carefully-conducted boiler tests to tabulate what is known as a "heat balance," showing the way in which the heat in the fuel is distributed. Two elements of loss which are present in every fuel are the heat carried away in the dry chimney gases and the loss due to moisture formed by the burning of hydrogen. The sum of these two losses at moderate rates of combustion is, roughly, about 15 per cent. in the case of coal, and about 14 per cent. with oil fuel. You will see at once that if all the other losses are eliminated the possible efficiencies would be only roughly some 85 per cent. Consequently, if figures are shown you indicating an evaporation of 13 or 14 pounds of water per pound of coal, or 18 or 19 pounds of water per pound of oil, you will know at once that these results are impossible. Either there has been excessive priming of the boiler or there has been an error in the observation of the amounts of fuel and water.

Some years ago a friend of mine who is a very able engineer was discussing the matter of what is known as "surface combustion," where the gassified fuel passes through a porous earthen plate and burns on the surface. He asked if I had gone into the matter carefully, and I told him that while I had read something about it, I did not know very much. He then went on to say that it was a matter of the very greatest importance because the efficiency with this method of combustion was claimed to be five or six times as great as by any other method. I reminded him at once that this was absurd because a good average performance with oil fuel gave 80 per cent. efficiency, and five times this would have been 400 per cent., which was, of course, ridiculous. He then concluded that the ratio of five or six times referred to the efficiency of an open grate or some other similar very inefficient method of burning coal.

While as engineers we always want our work to be accurate, common sense teaches us that there is a time for everything, and there are often occasions where you want to reach a decision quickly and where approximate data will be just as useful as those which are absolutely accurate. You will find as you go along that there are a number of "thumb rules" or "round figures" which are very convenient to carry in your memory for just such occasions. For example, a square foot of sheet steel one inch thick weighs approximately forty pounds, which gives you a "round figure" easy to remember and easy to divide for sizes which you are likely to need. The error is only about 2 per cent. Again, one foot in length of a tube four inches in diameter gives one square foot of surface, and two feet long of two inches diameter, and four feet long of one inch diameter. Here the error is a little greater, being about 4 per cent.

There is another convenient figure to remember at the present time—when the question often comes up as to whether it will pay to change a coal-burning installation to one using oil. If you will take the relative thermal values of oil and coal and allow for the higher efficiency when using oil than coal, which is, roughly, about 10 per cent. of the efficiency with coal, you will find that the cost for the same thermal value of fuel may be expressed as follows:

When the price of oil in cents per gallon is half the price of coal in dollars per ton (of 2,240 pounds) the cost for the fuel only is the same. In other words, two-cent oil costs the same as $4 coal. There are economies in using oil due to a smaller boiler-room staff, the absence of ashes and other things, which must be considered, but this "thumb rule" will often enable you to say whether the step is worth considering at all. For example, if oil is selling at five cents a gallon while coal can be obtained for $5 a ton, it is perfectly evident that the difference in the cost of the fuels is so great as to make it unwise to change. If, however, oil, say, is four cents a gallon and coal $7 a ton, the difference is then so small that it is possible the other savings would justify shifting over to oil, so that it is advisable to make a detailed investigation.

From one point of view the talk that I have given you may be regarded as rather disconnected, because so many subjects have been considered, and yet the same theme runs through them all —the application of common sense in the solution of engineering problems. Perhaps the very diversity of the subjects may impress you all the more with the great importance of common sense.

My aim has been to encourage you to develop and trust your own common sense by showing how it applies everywhere and is of the greatest service. Indeed, without it great mental ability is often helpless or goes wrong. One of the most brilliant engineers whom I know, who has designed some of our most important electrical machinery, and who is an accomplished scientist, once said "nine-tenths of good engineering is common sense." And, in closing, let me say again that common sense is not a special gift and does not replace careful study, but it does mean the application to the problem at hand of your best experience and judgment without prepossession or prejudice.

COPPER-ALUMINUM-IRON BRONZE AS AN ACID-RESISTING ALLOY

By O. L. Kowalke

Copper-aluminum-iron bronze is known to possess many valuable qualities. In tensile strength it ranks with mild steel. It can be forged while hot, and also rolled into sheets; it can be machined to a nice finish, and sound castings can be made of it, free from shrinkage-holes and blowholes. These among other qualities render the alloy suitable for bearings and gear. But very little has hitherto been known concerning its acid-resisting properties. With a view to acquire knowledge in that direction, a systematic series of tests have been made at the University of Wisconsin laboratories. The results of these tests, which were made with various acids and alkalies, are set out for detailed comparison in three tables. Only two of the bronzes experimented with are reported on; they are distinguished as A and B. Their average compositions and properties were:

	Bronze A	Bronze B
Copper	87.0 %	85.6 %
Aluminium	9.8 %	10.81%
Iron alloy	3.11%	3.57%
Ultimate unit stress	74,800 lb. sq in.	66,600 lb. sq. in.
Reduction in area	19.0 %	13.0 %
Elongation in 2 in.	21.0 %	11.5 %
Specific gravity	7.71%	7.58%

The specimens for the corrosion tests were approximately 1 in. by 0.07 in., and were finished smooth, with square edges. Most of the tests were made at room-temperatures of 72 deg. F. and 85 deg. F., but a few were made at 194 deg. F.

Bronze A was found to be resistant to several acids, particularly to sulphuric, lactic, phosphoric, tartaric, and acetic acids. Nitric acid attacked the metal readily, the concentrated acid acting violently. Hydrochloric acid and ammonia solution both attacked the metal too readily for commercial purposes. Caustic soda had but little effect. In the case of bronze B, a strikingly higher resistance to sulphuric acid is shown. Also ammonia did not corrode it so readily as bronze A. Nitric acid attacked bronze B also too readily; and hydrochloric acid attacked it more readily than bronze A. It is interesting to note that the corrosion, in 35 per cent. sulphuric acid, of a forged specimen of bronze A is only about half that of the rolled-sheet and cast forms.

The Illinois Stoker Company, of Alton, Ill., have issued a catalogue "L," describing their natural and forced draught type of mechanical stokers. These are of the chain-grate type, those for natural draught being type A, and the force draught, type G. A preface is included, showing the advantages of mechanical over hand firing, and following this is a well-illustrated section descriptive of the two types. At the back of the book is a description of the Illinois arch, and a chapter on boiler and furnace efficiency, including several diagrams.

Some Useful Information on Gauge Glasses

The Various Troubles to Which They Are Subject Are Discussed Also Means of Preventing Some of Them—The Right and Wrong Way of Fitting a Glass is Explained

By H. E. WAVERLEY

THE glass water gauge, which is such a familiar object and may be seen on almost every boiler front, may be considered a time and labor-saving device, and to a certain extent a safety appliance also. The glass gauge, like other safety appliances, must be kept clean and in good condition at all times in order to ensure reliable indications of the water level in the boiler. It is a simple device to keep in order, and not a difficult one to repair when it gets out of order. Where raw feed-water is employed, as is generally the case where boilers are not used for power purposes in non-condensing plants, the gauge glass should be kept clean by blowing out at regular intervals. The interval between cleaning-out times depends upon the quantity and the quality of the water used. Muddy water deposits a sediment, principally mud, while clear water deposits carbonate and sulphate of lime and magnesia which form scale.

When closing the valve after blowing out the column and glass, a certain quantity of water carrying deposits is retained in the column and glass, and in a few minutes these settle along the bottom of the lower column pipe and in the bottom connection leading to the glass. If the blow-off valve be now opened a very little and for about 5 seconds these accumulations may be removed before they have had an opportunity of becoming attached to the surfaces, and without renewing the entire contents of the column and glass. By a careful manipulation of the blow-off valve under the water column, and of the drip-cock under the glass, these parts may not only be cleaned of sediment but they can to a considerable extent be kept free of such troublesome accumulations. Where the feed-water is very bad and the amount of sediment is found to be large, it always pays to be very careful when blowing out the column and glass, and to remove as much of the deposits as possible, not because of the trouble that would otherwise be experienced in removing hard scale, but to ensure accurate indications of the water level at all times and upon which the safety of the plant very largely depends. The glass water gauge in many plants is relied upon almost entirely from one week's end to the other, the gauge cocks being used in emergencies only. It is nothing more or less than criminal negligence to place so much confidence in a glass water gauge unless great care is taken to ensure its proper condition at all times, and that can only be done by frequent and thorough cleaning.

In certain works on steam engines and boilers directions are given for the proper care of the water column and gauge glass. The directions are generally to the effect that the glass should be blown out from four to six times each day, and that the gauge cocks should be tried at least once every half-hour. These directions are decidedly on the safe side in one respect, and that is that a gauge-cock cannot possibly clog or become scaled over during a single half-hour, and with the worst possible feed-water and condition of boiler. On the other hand, experience with different firemen and water tenders seems to indicate that the directions if followed to the letter eventually lead to dangerous conditions.

It must be understood that there are exceptionally careful men to be found in boiler-rooms, and there are water columns fitted with exceptionally good gauge-cocks and water gauge connections. The directions referred to are all that can be desired when these exceptional conditions exist, but under ordinary conditions the very frequent use of these important devices produces needless wear and a large amount of avoidable labor and annoyance. Gauge-cocks cannot be expected to remain steam and water-tight for many weeks when used twice an hour day after day, and when they begin to leak at very short intervals and spatter mud and water over a nicely kept boiler front the temptation to plug them, or to repair them and then neglect to use them often enough to ensure safety, is indeed very great, and too often proves irresistible. The moderate use of gauge-cocks is all that is necessary to ensure safety, and it further ensures the continued use of the gauge-cocks without leakage or other inconvenience.

Gauge glasses as a general thing break oftener when frequently blown out. There is a practical limit to the frequency with which the glasses should be blown out the same as with the opening of gauge cocks, and the limit depends upon the frequency with which the boiler is cleaned, the kind of water used, and the kind of glass gauge fittings employed. With fittings having liberally proportioned openings leading to the glass, say, not less than ¼ inch in diameter, and when the boiler is cleaned every two weeks or after 135 hours' run, four times a day is often enough to blow out the glass, and three times a day is often enough for the water column. A day is assumed to be the length of time necessary to prepare for a day's run of ten hours, and to prepare the machinery for the night after shutting down.

Glasses last anywhere from two minutes to two years on power boilers, and frequently as long as three years on boilers used for low pressure heating. Probably three or four months would be a fair average for power boilers carrying pressure of 100 pound and upward. Glasses used on power boilers are generally blown out much oftener than the glasses on heating boilers, especially in non-condensing plants. The effect upon the glass of frequent blowing, and consequently of frequent heating and cooling, is similar to what is known as the fatigue of metals. After expanding and contracting rapidly a certain number of times the glass will fail. If such a glass lasts 24 hours it will generally last a month or more. When the packing, which is soft and pliable at first, becomes dried out and hard as it will in the course of a month or two, the glass is more apt to break because it is not as free to expand as it was when the packing was first put in, and this, together with the alternate heating and cooling and the gradual wearing away due to blowing out the glass, tends to greatly shorten the life of gauge glasses when used on boilers supplying high-pressure steam.

When condensed steam is fed into the boiler, or gravitates into it from the heating system, very little deposit and accumulation of scale occurs, and the water is generally clear and of course does not tend to obstruct small passages quickly, so that the gauge cocks are seldom used, and the gauge glass is blown out at rather long intervals. Glasses last much longer under the latter conditions.

The gauge cocks should be used to check the indications of the glass each time the latter is blown out. It is important to have the fittings exactly in line with each other, and to have them large enough so as not to cause the glass to bind or to be cramped in the least. When the fittings are not in line the glass is apt to be cramped either when putting it into the sockets in the fittings or when tightening the packing nuts. When tightening the nuts around a glass when in the position indicated in Fig. 1, the tendency is to straighten the glass—that is, to bring the glass into a position parallel to the socket at the end being tightened, and this tends to bend the glass, as shown in Fig. 2. It is, of course, impossible to bend the glass consequently the glass either snaps when the nut is turned or when the glass expands when it becomes heated. Failure to notice these little points is responsible in many cases for continued annoyance from breaking gauge glasses.

Sometimes it is necessary to ream out the fitting, say 1-32-in. or 1-16-in. larger so as to give the glass sufficient free-

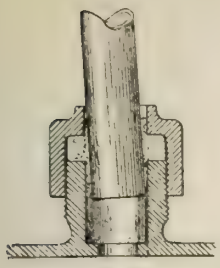


FIG. 1.

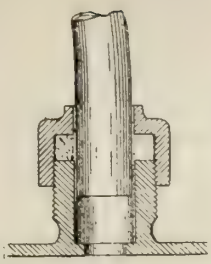


FIG. 2.

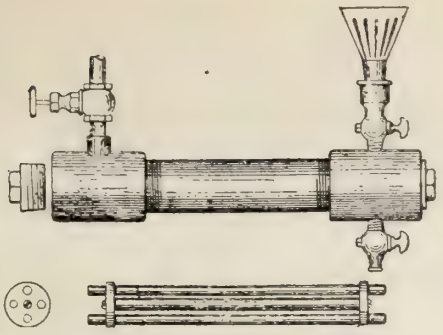


FIG. 3.

dom. Wrenches should almost never be used for tightening the packing nuts around the gauge glass. When a glass is packed with the proper kind of packing and the nuts have been screwed up just tight enough to prevent leakage when both the glass and the packing have been warmed, the glass may readily be turned around in the fittings with merely the thumb and forefinger.

After putting in a new glass turn on a very little steam, leaving the drip at the bottom of the glass open so that the steam will gradually fill the glass and escape through the drip cock. The glass is thus warmed thoroughly before the water is let into it and before it is subjected to pressure. When the glass has become thoroughly hot, open the steam valve wider, then open the water valve a like amount, and continuing to open both valves alike until fully open, then slowly close the drip at the bottom. This method not only allows the fittings to be thoroughly blown out, but enables the operator to increase the pressure on a new glass and new packing more gradually. The drip-cock should now be opened and closed suddenly. If the fittings are filled with sediment to such an extent that sudden opening and closing of the drip-cock is necessary to clear it, it is evident that the drip is not opened often enough, or that the boiler is extremely foul.

When the drip has been closed for some time the water in the glass will become comparatively cool which is due to the absence of circulation, while the upper part of the glass will become comparatively hot. As this change of temperature in the low end of the glass takes place very slowly, no trouble is experienced, but when the drip is opened suddenly and the steam is thus brought in contact with the cooler end of the glass the latter very frequently breaks, and when that is the cause of breakage the glass will nearly always fail at some point below the middle, and generally about one-third the length of the glass from the bottom.

It frequently happens that an entire package of gauge glasses will prove to be too hard and brittle, and that the entire number will break within a few minutes after putting them in. It is due to experiences of this kind that many engineers have been led to anneal all the glasses before using them. This is generally accomplished by means of a water and steam bath, the water and the glasses being heated by steam. Engineers generally rig up some apparatus with what old material they have on hand that will accomplish the purpose. A simple device that has given satisfaction for this purpose is illustrated in Fig. 3.

It consists of a short piece of 2-in. or 2½-in. pipe about 4-in. longer than the glasses. On one end is screwed a coupling with the outer end plugged, and a drip-cock screwed into the upper and lower sides. On the other end is a reducing tee, which is plugged at the outer end, and a ½-in. or ¾-in. pipe screwed into the smaller opening at the side. A valve is placed in the smaller pipe close to the tee. The vertical pipe is connected to the boiler or to one of the steam pipes. A rack made of wood is provided having suitable holes in both heads for the gauge glasses; the rack serving to keep the glasses away from the pipes.

The plug is removed, as shown, and the rack containing the glasses slipped into the pipe. The plug is then screwed in and the pipe filled with water of the same temperature as the air in the room. Both cocks being closed, the valve is opened and the condensed steam in the vertical pipe, which is practically cold, is admitted into the remaining space in the 2-in. pipe and connections. The lower drip-cock is then opened a very little thus permitting the water and condensed steam to gradually work out, which admits steam and heats the pipe and the glasses very gradually. When steam issues from the lower cock the valve is opened wide, the cock serving to keep the pipe drained. The glasses are then kept under boiler pressure, and consequently at boiler temperature for from three to four hours. At the end of that time the lower cock is closed, when the pipe at once begins to fill with hot water, the water cooling down very gradually owing to lack of circulation as the vertical pipe becomes filled. When the pipe has cooled to its original temperature the valve is closed and the two cocks opened thus draining the pipe. The plug is then removed and the glasses taken out, dried, and put away again in the box.

Glasses treated in this way have given the best of satisfaction on high-pressure boilers where the change of temperature when blowing out is very great, and where glasses are subjected to draughts of cold air, and also for portable and hoisting engine boilers, which are subjected to rather severe usage, as far as changes of temperature are concerned. Any other device which will permit the glasses to be heated very gradually and again cooled very gradually will serve the purpose fully as well as the one just described.

The bursting of gauge glasses is attended with not a little personal danger and discomfort, and it is important that all reasonable precautions against such breakage be taken by the person in charge. When a gauge glass breaks when under pressure always close the lower valve first. It is cheaper in the long run to cut glasses with a gauge-glass cutter than to attempt to cut or break them off with a broken file, or by similar means, because a slight nick in the glass at the wrong place may mean the early destruction of the glass when subjected to pressure and varying temperature.

There are other practical means for preventing the breakage of gauge glasses. Some engineers fit a thin brass or copper thimble into the upper end of the tube, as shown in Fig. 4, which prevents scale and water from coming in contact with the glass when blowing out the latter, and hence it reduces the eroded and pitted appearance commonly seen at the upper end of unprotected glasses. Tubes made of aluminum may be obtained of dealers in engineers' supplies which accomplish the same result.

These tubes and thimbles, it will be seen, protect the inner surfaces of the glass only, and as the glass is liable to be crowded to one side or the other in the packing nut as well as in the fitting itself, it is a good plan to also protect the glass on the outside. A simple means of protecting the glass on the outside is also obtained from dealers in gauge glasses.

It consists of a rubber sleeve adapted to slide over the end of the glass, as shown in Fig. 5. The glass cannot come in contact with the socket in the fitting, neither can the packing nut touch the glass when the packing is screwed up. The combination of the thimble and the latter device prevents the rapid wear of the glass at the top, and also retains the glass clear of all metallic contacts which has been found to be very desirable where glasses are subjected to high pressure and temperature and sudden changes in the latter.

When the rubber protector is employed separate packing rings are not needed, because the packing forms a part of the sleeve as shown. Annealed gauge glasses protected inside and out by this or similar means will last as long under any circumstances as it is possible to make them by any means thus far made known.

Many engineers suffer unceasing annoyance due to breaking gauge glasses because they do not pack them with the proper material. Candle wicking and asbestos wicking should be used only in case of emergency. The latter materials are too porous and require too much

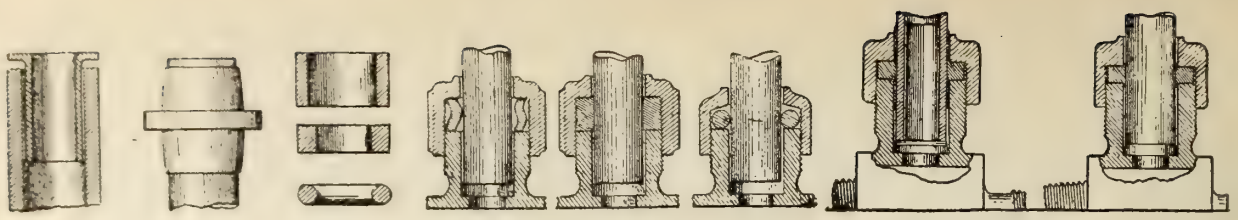


FIG. 4. FIG. 5. FIG. 6. FIG. 7. FIG. 8 FIG. 9. FIG. 10. FIG. 11.

pressure in order to make a tight joint to be suitable for packing a glass tube of any kind. The wicking soon becomes charred and hard and begins to leak, and it is evident that after it becomes hard it is useless to attempt to tighten the packing nuts. A second tightening merely serves to compress the glass so tightly as to prevent the necessary expansion, and the almost invariable result is breakage.

When a gauge glass is packed with wicking, either candle wicking or asbestos, and begins to leak at the end of, say, a month, the best thing to do is to repack the glass. Tightening the nuts on hard, dry packing, especially on an object so delicate as a gauge glass, avails nothing in the long run; but, on the other hand, it does add immensely to the number of glasses broken in a given time. Soft-rubber rings of the proper size are by far the best, and consequently these rings furnish the cheapest means of packing gauge glasses. The first cost of rubber is merely a trifle greater than that of wicking, while the life of the packing is more than doubled, and the number of glasses broken is greatly reduced.

Rubber rings are made in three forms or shapes when referring to cross-section —viz., the thimble, the square ring, and the round ring. These are shown in Fig. 6. Which of these three shapes will be found the more serviceable will depend upon how they fit the packing nut. Gauge-glass fittings are made of a variety of designs, some having a wide but shallow space to receive the packing, while others have a narrow and deep chamber between the sides of the nut and the glass. It is evident that the same form of packing cannot well be used equally well with all forms of packing nut. That is getting details down rather fine, but it is well worth considering when we remember that the durability of the glass and the safety of one's eyes depend largely upon the manner in which this work is done.

The packing ring should be of such size and shape that one ring only at each end of the glass will be required. A good job of packing gauge glasses can seldom be done when two or more rings are employed. When a rubber thimble is used on a packing nut adapted to the square ring, the result is about as shown in Fig. 7. This may be exaggerated a little, but it serves to illustrate the principle. The rubber thimble is particularly well adapted to the style of nut illustrated in Fig. 8, because the space between the nut and the glass is of the same shape, and is nearly the same size as the ring. The ring in this case is merely compressed lengthwise, and this becomes wider without any tendency to buckle or double up.

If fittings are used having a wider space for the packing, either the square or round rings give better satisfaction. The round ring is particularly well adapted to fittings having bevelled edges and nuts as shown in Fig. 9. The inclined surfaces are supposed to assist in crowding the packing against the glass, and perhaps they do, but as a general thing the bevel or angle is so slight that it is doubtful whether it is of much assistance in making a tight joint. When the edges of the fitting and nut are square, the square packing ring is best adapted, as shown in Fig. 10.

When two rings are employed the resut is very apt to be similar to that shown in Fig. 7, on account of the yielding nature of the rings, and this is especially so when both rings do not fit the nut perfectly, one ring tending to crowd the other away from or against the glass, thus rendering one of the rings practically useless, and the other one less efficient. A glass packed with a protector ring, and also protected on the inside is shown in Fig. 11. It will be seen that this is an ideal arrangement when the water is muddy and the glass and water column have to be blown out frequently.

There may be found on the market at a reasonable price rubber packings adapted to every construction for gauge glass fitting regularly made; also highly annealed glasses under various trade names, and after considering the subject as thoroughly as its importance demands it will readily be seen that in order to secure a tight joint with the least possible pressure, thus avoiding any tendency to break or to cramp the glass due to the packing, it is necessary to obtain a form of packing that will fit snugly in the space in the nut.

To get the best result from gauge glasses in any service first procure a good glass, then get suitable packing and keep it in a cool, dry place so that it will not harden. See that the fittings are in line, then pack the glass and screw up the nut with the fingers only. If the glasses break frequently, try some means for protecting them inside and out, and also anneal the glasses, which may be accomplished in the manner previously explained. A little more careful attention to the seemingly insignificant detail in a steam plant will be the means of saving a great deal of needless annoyance and not a little danger of personal injury.—"Southern Engineer."

A REMARKABLE RUBBER DISCOVERY

A discovery of the highest importance has been made by a lecturer in chemistry at the Manchester (England) School of Technology. When rubber and sulphur are mixed together at a high temperature the rubber becomes hard and tough—"vulcanized" is the technical term for the change. While rubber can stand the necessary heat, other raw material with which it might be usefully mixed would be destroyed. The new invention is a cold process, in which two gases are used to produce the free sulphur required in vulcanising. When crude rubber, either in the solid or the liquid form, is treated with the two gases it becomes efficiently vulcanized, and when it is mixed with any waste material such as sawdust, leather scraps, or paper, a similar change takes place without the properties of the waste material being affected. This discovery is to be applied immediately to the manufacture of linoleum, the heavier classes of wallpaper, and artificial leather for upholstery. It is also applicable to the manufacture of one-piece boots (of rubber and leather scrap) and of felt (combining rubber and "shoddy").

ANOTHER FIRM TO BUILD DIESELS

The Worthington Pump and Machinery Corporation have issued a bulletin announcing their entry into the marine Diesel engine construction field. The bulletin reviews the marine situation and the case for the Diesel internal combustion engine, and quotes instances of actual working to demonstrate the reliability of this prime mover. The announcement of the building of a 2,400 I.H.P. six cylinder marine Diesel by the company follows. This engine was built at the company's Snow Works, Buffalo, and the cylinders are 29 inches bore by 46 inches stroke, and the crank shaft makes 120 revolutions per minute, the engine being of the 4 cycle type. The engine is built to the Worthington Company's own designs, but the leading features of successful foreign builders have been incorporated. The company have made plans to enable them to produce these engines in large numbers as the demand increases.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

MAGNETISM and electricity are so intimately related that one can hardly be studied without the other. In the earlier days of electrical science this relation was not so apparent and it has only been during the past century that the true relationship has been worked out. From the study of these things indeed the whole electrical industry of to-day is largely based.

In the last lesson it was seen that the lines of magnetic force around the poles of permanent magnets could be visualized by means of iron filings. If we now take a piece of cardboard and passing a heavy wire through it cause a current to flow through the wire; by sprinkling the cardboard with iron filings we shall see the filings arrange themselves in concentric circles around the wire, much as is shown in Fig. 22.

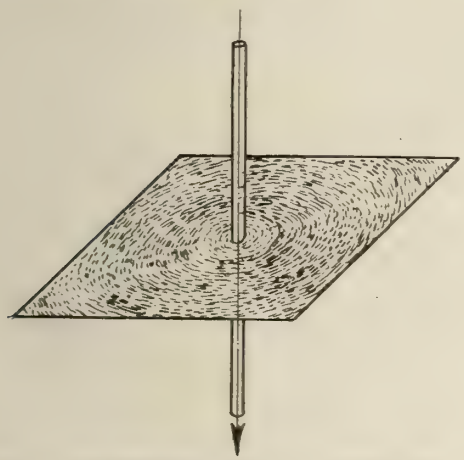


FIG. 22—MAGNETIC FIELD OF FORCE SURROUNDING A WIRE CARRYING CURRENT AS SHOWN BY IRON FILINGS.

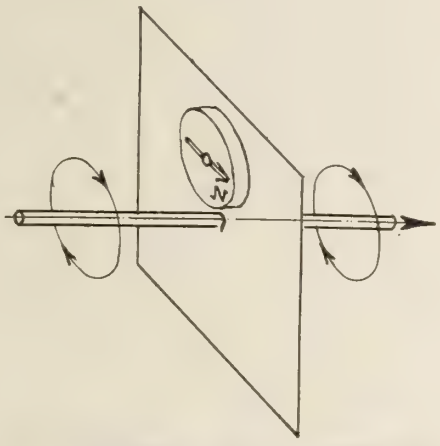


FIG. 23—MAGNETIC FIELD OF FORCE SURROUNDING A WIRE AND DIRECTION OF FLOW.

This will give rise to the suspicion in our minds that the electric current exerts some kind of force upon the field of space around the wire through which it is passing and from the behavior of the filings we will naturally conclude that some form of magnetic force is present. This is the case, although a difference exists between the magnetic fields of magnets and wires. In a permanent bar magnet the lines of force emerge at one end and enter at the other, while in a wire carrying current the lines of force surround the wire.

If instead of filings we use a compass as in Fig. 23 and move it around the wire on its cardboard support we will find that the needle changes its position and any point on it will trace a circle around the wire, the needle always pointing in a direction tangent to a circle drawn through its centre. Examination will show that the magnetic force gets bigger as the current increases, disappears when the current stops and reverses if the current is reversed.

Direction of the Magnetic Flux Due to Current

From the behavior of the needle when the current is reversed, it may be suspected that the direction of the current has quite an effect on the direction of the magnetic lines of force surrounding the wire. In Fig. 23 if the wire is carrying current in the direction indicated by the arrow at its lower end, then the needle will come to rest with the north pole pointing out at the observer. If the current is now reversed and made to flow up through the wire instead of down, the compass needle will immediately swing around and point with its north pole away from the observer. In the first case the lines of force are said to travel around the wire in the direction shown by the arrows on the two circles.

The direction which the lines of force will take may be easily remembered by thinking of a right hand nut and screw. If the nut is turned over to the right on the screw it will travel away from the observer. The direction of rotation of the nut corresponds to the direction of the magnetic lines of flux, while the travel of the nut along the screw indicates the direction of current flow.

The relations between current flow and magnetic flux are also easily remembered by another simple little rule shown in Fig. 24.

The right hand is supposed to grasp the wire with the thumb extended along it in the direction in which the current is flowing. The fingers of the hand will then wrap around the wire in the direction in which the magnetic flux is travelling.

The Solenoid

If we take a coil of wire and thread it through a piece of cardboard as shown in Fig. 25, then pass a current through it and sprinkle iron filings on the cardboard, a figure will be obtained much as is shown. The filings will arrange themselves in an orderly pattern. Some of them will group themselves in little circles around each individual wire, but the majority of them will group themselves in lines passing around all of the wires in through along the axis of the coil and around to the outside. It will be seen that the figure has some resemblance to that made by a permanent bar magnet and we have actually produced a magnet though perhaps weaker and of no consequence. If the current is interrupted the filings will lose their orderly arrangement and will show no indication of lines of force.

Magnetic poles are formed in the same way as with the permanent magnet, at the ends of the coils. The reason for this may be better understood from Fig. 26. Here a small coil is shown in section with the top part cut away. The current is travelling in the direction indicated by the arrows and the magnetic lines of force around each wire, indicated by the circles have the directions shown. In the top half of the diagram the flux will travel clockwise since the current is flowing away from the observer, while in the bottom half they will be seen to travel in the opposite or counter-clockwise direction since the current is flowing towards the observer. By applying the right hand rule given above this will be seen to be so. Instead of the magnetic flux, due to each wire passing around the individual wire, the greater portion of it will flow around all the wires and we will thus have a strong stream of magnetic flux passing through the coil emerging at one end and entering again at the other.

If a bar of iron is placed in the centre of the coil of wires shown in Fig. 25 the magnetic effect will be found to be very much increased. As stated in the last issue of Power House, some materials have the property of offering much less resistance to the flow of magnetic flux than others. Iron in some of its forms is one of the best conductors for magnetism and its insertion into the magnetic circuit lowers the magnetic resistance appreciably. Thus supposing we have the same coil and the same flow of current through it the force causing the flow of magnetic flux will be the same, but since the magnetic resistance,

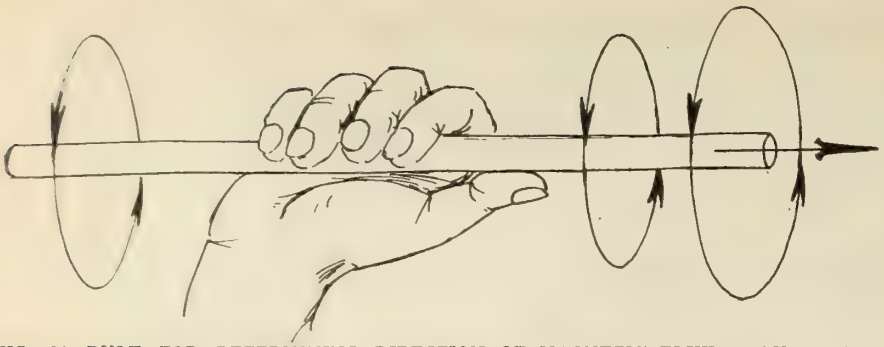


FIG. 24—RULE FOR DETERMINING DIRECTION OF MAGNETIC FLUX AROUND WIRE CARRYING CURRENT.

if it may be called such, will be much less, a greater effect will be produced.

There is a limit to the amount of magnetic flux which can be forced through iron or rather it becomes more and more difficult to increase the strength of any electro-magnet after a certain point is reached. In many problems it is important to be able to express the amount of flux as a numerical quantity and a unit has been chosen for this purpose called the Maxwell. This name that when magnetized to a high flux density the permeability or capacity for further magnetization greatly decreases. Under such conditions the magnetic material is said to be approaching saturation and with very high flux density is said to be saturated. Saturation is rather an indefinite term. With good wrought iron or steel it would be reached at something like 20,000 or more lines per sq. centimeter, while in cast iron it would be in the neighborhood of 8,000.

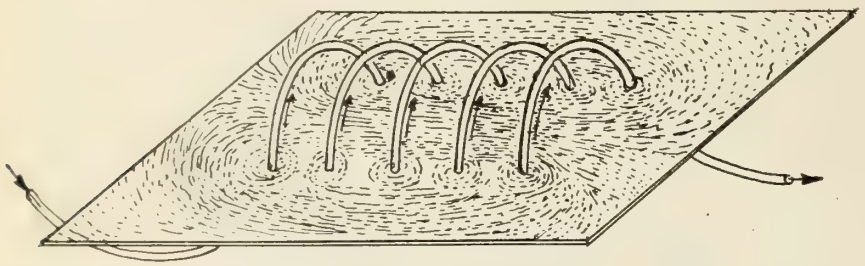


FIG. 25—THE MAGNETIC FIELD OF FORCE SURROUNDING A SOLENOID AS SHOWN BY IRON FILINGS.

is somewhat out of use at present and instead of saying so many Maxwells, it is more usual to say so many lines of force. The flux density or the strength of the magnetic field is measured in lines of force per square centimeter or per sq. inch. This unit finds considerable use in the design of electrical apparatus. Iron and all other substances which are magnetic have the peculiarity

In Fig. 24 a method of determining the direction of flow of magnetic flux around a wire carrying current was shown. Fig. 27 shows a corresponding method of determining the polarity of solenoids or electro-magnets. In this case the coil of wire is grasped by the *right* hand with the fingers pointing in the direction of current flow. The thumb extended along the coil will point in the direction of the magnetic flux and since the flux flows out of the north pole the thumb will also point towards the north pole of the magnet or solenoid.

In the next issue of Power House the elementary theory of dynamo-electric theory will be discussed.

Uehling Instrument Co., 71 Broadway, New York, has just issued Bulletin No. 111 describing style U Uehling CO_2 equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Neglect of this factor is costing power plant owners heavily. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous (not intermittent) record, showing all changes in boiler adjustments that are conducive to either waste or economy.

The Uehling Instrument Co., 71 Broadway, New York, manufacturers of fuel economy equipment, announces that it is now being represented in the New England states by the Smith Engineering & Supply Company, 89 State street, Boston, Mass., manufacturers' agents and engineers, specializing in power plant equipment. Mr. S. W. Smith, president of the latter company, was until very recently associated with the Uehling Instrument Company with headquarters in their New York office.

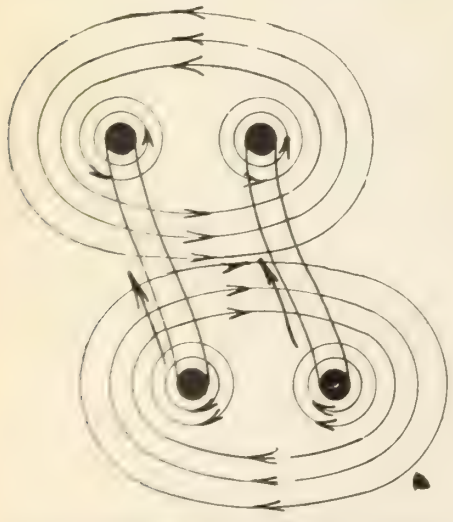


FIG. 26—ELEMENTARY SOLENOID SHOWING LINES OF FORCE

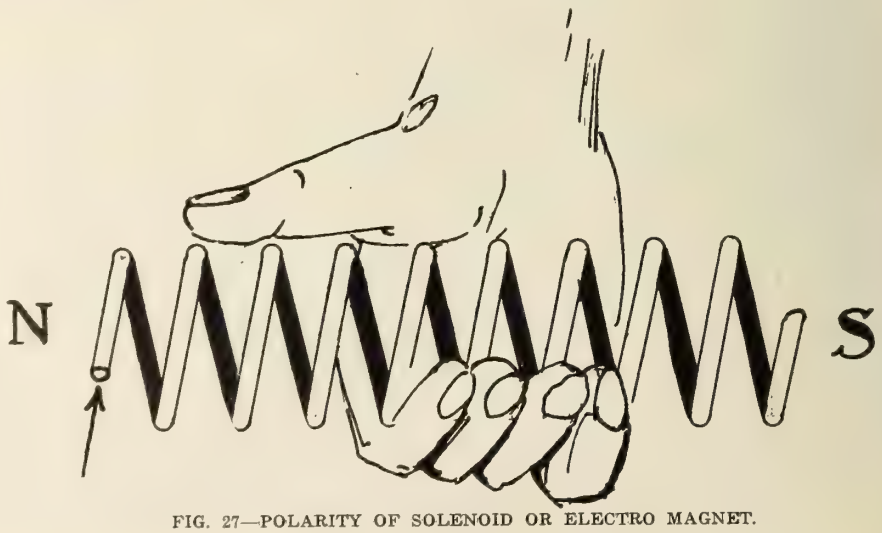


FIG. 27—POLARITY OF SOLENOID OR ELECTRO MAGNET.

Starting Properties of D. C. and A. C. Motors

The Various Characteristics of Different Types of Motors Discussed in Relation to Their Starting Properties—Paper Read Before the London Branch of the Association of Mining, Electrical Engineers

By O. L. RECORD

ONE has often to decide what type of motor is best suited for a particular purpose, and consequently a few notes on motor characteristics, with special reference to their starting properties, may be useful.

Direct-Current Machines

(a) Series-wound.—In this type of machine, as the field is excited by the main current, an increase of load increases the strength of the field, and so slows the machine down, and vice versa.

As the torque is proportional to the product of the armature current and field strength, the torque of a series motor would always vary directly as the square of the current were it not that the magnetic circuit becomes saturated above a certain point. In such a theoretical case, doubling the current would give four times the torque, and, at the same time, the speed would be halved, so that the motor would deliver double the power at half the speed. In practice one would obtain considerably more than double the torque and rather more than half the speed.

The curves in Fig. 1 give the relation between current, torque, speed, and power on a typical motor of this kind. It will be seen that the motor automatically adjusts itself to the load, taking a heavy load at a low speed and a light load at a high speed. At starting the torque will be proportional to the current taken, the motor giving full-load torque with full-load current, the latter being limited to the value required by a series starting resistance.

(b) Shunt-wound.—In this type of motor, as the field is excited by a circuit separate from that of the armature, the speed is independent of the armature current except for a slight drop on heavy loads, due to armature resistance voltage drop, and it depends merely on the field current, which again is proportional to the supply voltage. By varying the excitation the speed can be altered quite independently of the load. For a constant field the torque is proportional to the armature current.

Fig. 2 gives curves of torque, speed, and power for this class of motor, and it will be useful to compare this with Fig. 1. In this class also the starting torque will be proportional to the current taken, the motor giving full-load torque with full-load current, and the latter being limited to any desired value by means of a series starting resistance.

(c) Compound-wound.—The effect of the compounding is to give increased starting torque for the same starting current, but at a somewhat lower speed, depending on the proportion of series turns, and also to increase the momentary overload capacity of the machine. On the other hand, the difference in speed between no-load and full-load will be increased.

If even greater constancy of speed is required than that given by a shunt machine, this may be obtained by having a few turns of series winding arranged in opposition to the shunt winding, so that as the load is increased the field is weakened and the speed kept up. This arrangement, however, makes the starting up more difficult, and also decreases the overload capacity of the machine.

Figs. 3 and 4 give the torque, speed, and B.H.P. curves for a compound-wound motor, with cumulative compounding and differential compounding respectively.

Alternating-Current Machines

(a) Polyphase, Asynchronous, or Induction Motors.—In motors of this class the speed is constant except for a slight drop due to slip, amounting to not more than 5 per cent. at full load, and depends solely on the frequency of the supply and the number of poles for which the motor is wound.

The torque varies as the current taken from the line, and both are proportional to the square of the applied voltage. It is important to bear this in mind, for if the voltage only drops as much as 10 per cent., the torque will drop as much as 19 per cent., perhaps sufficient in the case of a heavy load to throw the machine out of step and bring it to a standstill.

Curves of torque, speed, and B.H.P. for a typical motor of this class are given in Fig. 5.

In order to deal with its starting characteristics, it will be necessary to subdivide this class of motor as follows:

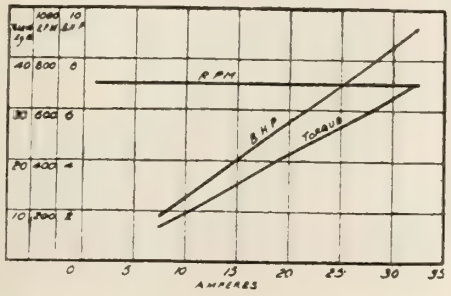
1. Squirrel-cage Type.—These motors may be started in the following ways: First, small motors may be switched direct on to the mains, and will then give a starting torque of about double full-load torque with about six times the normal full-load current. This method of starting is naturally not advisable except in the case of very small machines starting light.

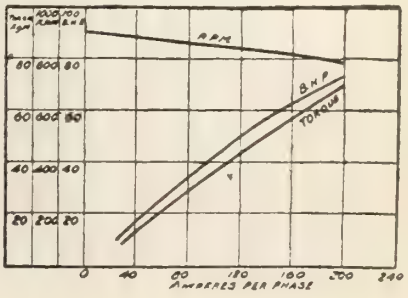
Secondly, by means of stator rheostatic starters. The effect of inserting resistance in the stator is to reduce the voltage across the stator windings, and limit the starting current; but this, unfortunately, results in reducing the torque to a much greater extent—namely, as the square of the voltage, as explained above. If sufficient resistance is inserted to limit the current to even as high a value as two and a half times full-load current, yet the motor will develop a starting torque of only 10 to 25 per cent. of full-load torque; a loose pulley or clutch is therefore necessary for starting in such cases.

Thirdly, by means of star-delta switching in the case of three-phase and series-parallel switching in the case of two-phase motors: If a three-phase motor is started in this way the voltage across each phase winding at starting is reduced to about 0.6 time the running voltage. Consequently the starting current taken will be about 0.36 of the direct-connected starting current, or about two and a half times the normal full-load current. At the same time, the starting torque will be reduced to about 0.36 of full-load torque.

Fourthly, by means of an auto-transformer starter or compensator. The effect of using this type of starter is exactly similar to that obtaining with star-delta starting. Thus the direct-connected starting current and the starting torque are reduced approximately as the square of the reduction in the starting voltage. The voltage tappings very usually employed are 0.5, 0.6, and 0.75 of the line voltage, corresponding to motor starting currents of 1.5, 2.5, and 3.5 times full-load current, and starting torques of about 0.25, 0.36, and 0.56 of full-load torque. The corresponding line currents will be approximately ¾, 1½, and 2½ times full-load current.

2. Slip-ring Type.—Wound-rotor machines are started by inserting resistance in the rotor circuit to limit the starting current to any desired value. When started in this way full-load torque will be obtained with one to one and a quarter time normal full-load current. The relation between torque and current for





other values of the latter is roughly as follows:

50% of full-load current gives 25 % of torque.
55% of ful-load current gives 33 1-3% of torque.
65% of full-load current gives 50 % of torque.
70% of full-load current gives 66 2-3% of torque.
80% of full-load current gives 75 % of torque.

It will therefore be seen that, if a starting torque of 25 per cent. or more of full-load torque with not more than full-load current is required, a slip-ring machine is essential.

3. Self-starting Type.—There is another class of polyphase induction motor having all the advantages of a squirrel-cage machine, but which will start up satisfactorily with a high starting torque without the use of any auxiliary starting apparatus. In motors of this type the rotor winding is composed of two or more sections, which are normally connected so as to give a high resistance at starting, the connection being automatically changed to give a low resistance when the motor has reached 70 to 80 per cent. of its normal speed, by means of a switch operated by a centrifugal governor.

In one motor of this class, one-third of the supply and the number of poles for which the machine is wound, whilst the torque is approximately taken, that is to the load. The characterization curve is similar to those of polyphase machines. Owing to the fact that the field produced by a single-phase current is oscillating and not revolving, as in the case of two or three-phase, a single-phase motor has no inherent starting torque, the latter only being produced when the rotor revolves; consequently an auxiliary or starting phase with a phase-splitting device (consisting usually of a non-inductive resistance in the main winding and a choking coil in the auxiliary winding) has to be provided. Even then the starting torque is but feeble, and a loose pulley must always be employed.

These machines are built of the squirrel-cage and slip-ring types. A squirrel-cage machine will not give more than 10 to 15 per cent. of full-load current. The starting qualities of the slip-ring type are rather better, but even in this case a starting torque of not more than 20 per cent. of full-load torque will be

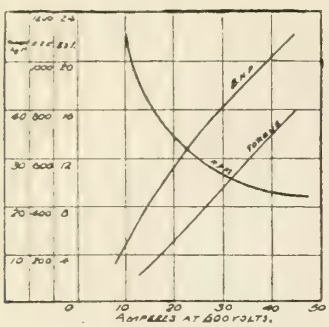


FIG. 1.

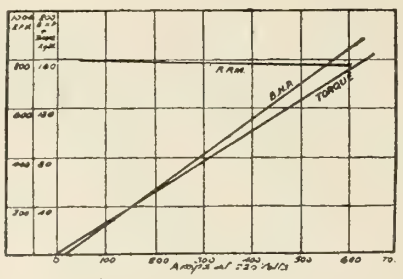


FIG. 2.

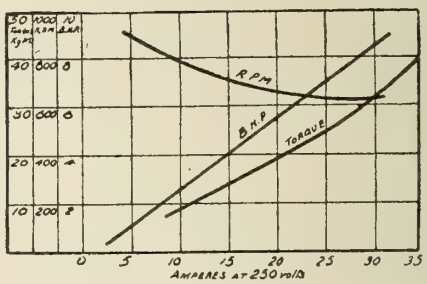


FIG. 3.

only of the rotor copper is in circuit at starting, the remaining two-thirds being open-circuited and connected to a short-circuiting device, which operates when a predetermined speed has been reached.

In another motor of this class the rotor winding is in two or three sections, which are connected in series for starting and in parallel by means of the governor switch when up to 70 to 80 per cent. of the normal speed.

Motors of this class are normally designed to give at starting about 2½ times full-load torque with two to three times full-load current, depending on the size, make, etc. Compare this with the starting torque of about 70 per cent. of full-load torque for three times full-load line current of a squirrel cage motor auto-transformer starter.

If desired, the starting current taken by these motors can be reduced by means of any of the starters employed with squirrel-cage motors, but, of course, with a corresponding reduction in starting torque.

As these motors run as ordinary induction motors, the running characteristics are exactly similar to the latter class of machine.

(b) Single-phase Motors.—1 Induction Type.—As in the case of polyphase induction motors, the speed of these machines depends merely on the frequency obtained with 100 to 125 per cent. of full-load current.

2. Repulsion Induction Type.—These machines are really repulsion motors as far as construction is concerned, and start as such, but are fitted with a centrifugal governor which short-circuits the commutator and lifts the brushes when the motor has got up to speed, so that it continues to run as an ordinary single-phase induction motor. The running characteristics are therefore exactly similar to the latter type, but as against the very feeble starting torque of the split-phase motor they have a starting torque of about 2½ times full-load torque with about 2½ times normal full-load current.

If it is necessary to limit the initial current taken from the mains to a lower value, a plain series starting resistance, such as is used with a direct-current motor, is employed. This tends to raise the power factor so that full load current at starting will give about 1 to 1½ times full-load torque.

ELECTRICALLY DRIVEN PUMPS.

At a meeting of the Institution of Water Engineers, held at Birmingham, Mr. C. F. Bekenn, A.M.Inst.C.E., contributed a paper on "The Application of Turbine-pumps to Water Supply." In the course of the paper the author remarked that while turbine-pumps could be driven by any type of prime mover, he placed the electric motor in the first place as regarded efficiency and convenience. The installation costs, including foundations, were low, and the space occupied was small. The pump and motor required very little attention, as the bearings were automatically lubricated with oil-rings. Low installation costs permitted the sets to be conveniently distributed. They were easily started up, and could also be operated from a distance or automatically stopped and started, either by varying levels in the reservoir or by varying pressures between pre-determined limits. The alternating-current motor was preferable to the direct-current machine owing to the absence of a commutator, and most of the installations at work were driven by A.C. motors. If a heavy current rush on starting was permissible, it was advisable to install squirrel-cage motors, as the turbine-pump, owing to its low-starting torque, could easily be started up by this type of motor. One point that had to be noted was that the slip between synchronous and asynchronous speeds could not be exactly determined, and might vary as much as 2 to 4%. The B.H.P. required to drive the turbine-pump varied as the cube of the speed, so that should the slip be less by, say, 2% than the makers' original estimate, the B.H.P. would be considerably increased, with a proportionate increase of water. For squirrel-cage motors, auto-transformer starters of the oil-immersed type should be installed, with no-volt and overload release on the three circuits, these operating in the stator circuit. The starter consisted of a transformer with tappings on the windings, of varying percentages of the line voltage. The tappings should be selected as best suitable for the starting torque, and as that was not more than 50% of full load torque, a low percentage, say, 25 or 30%, was sufficient. The automatic features were arranged in the "running" position only, because in the "starting" position they would at once break the circuit owing to the rush of current, which was generally two or three times the ordinary running current. This type of starter required only three terminals on the motor and six on the starter—namely, three for the motor and three for the line. In cases where low starting currents were necessary, slip-ring

motors should be installed, as those would start up with 50 per cent. of full load torque using normal running current. With reference to motor terminals, trifurcating boxes were recommended as providing an extremely neat finish and effectively enclosing all the live parts. In large pumping-stations, where the current had to be carried some distance and the motor-power was at least 150B.H.P., the motors could be wound for 6,000 volts, and so dispense with transformers. For motors of less than 150B.H.P. a lower voltage was necessary on account of the difficulties of insulation in the coil windings.

Proceeding to discuss the relative costs of steam and electric pumps, the author gave several examples as showing that economy was on the side of the latter. Thus, the City of Hereford had three electrically driven pumps working off a three-phase, 50-cycle circuit, two sets delivering 60,000 gals. per hour, and the other set delivering 20,000 gals. per hour, against a total lift of 120 ft. in each case. The costs, as recently determined, showed that with electricity at 0.75d. per unit, the cost of electric pumping was 0.5d., as compared with 0.426d. per 100,000 gals., the cost of steam pumping. Those figures included men's wages, lubricating oil, waste, etc. The Newbury District Water Company, early in the year 1912, made careful tests of its compound condensing steam pumps, and of its electric pumps. The latter were driven by direct-current motors, one set having a capacity of 30,000 gals. per hour against 185 ft. lift, one set 20,000 gals. per hour against 150 ft. lift, and a further set 3,000 gals. per hour against 164 ft. The 1912 costs worked out at 1.18d. per 100,000 ft.-gals. for steam, as against 0.957d. for electrically driven pumps, but for 1920 the figures are 2.61d. and 1.576d. respectively. The Chester Waterworks Co. had installed a Diesel engine and dynamo supplying power to drive turbine pumps built by Sulzer and the Rees Roturbo Company, at two separate stations connected by cable. The costs, including all transmission losses and "shut-downs" due to interruption in working consequent on erection of additional plant, came to 0.657d. per 1,000 gals. 100 ft.

Advantages of Flat Furnace Arches

THE recent development of flat arches to a point of distinctive serviceability for boiler furnace construction lies in many cases in simplified design and besides offers greater convenience in the matter of routine repairs. Frequently the design of furnaces calls for reflecting surfaces at various angles and in some special cases some advantages are to be gained in using curved surfaces. The use of sprung arches limits the latitude of construction in these respects and thus many possibilities for furnace improvement go begging.

Also in natural draft furnaces wherein the construction is more or less standard, the support of the necessary curtain wall requires the construction of a separate sprung arch for this purpose although this arch has no function in the combustion of the fuel itself. In designs calling for step-up arches the construction is further complicated. On the other hand flat suspended arches have answered to a considerable extent the criticisms of the usual construction in two respects in particular; viz.: (1) the design eliminates a quite usual source of air leakage into the furnace through the clearance space between arches, and (2) the gaining of increased available headroom which, in the case of forced blast stokers is particularly desirable. In other minor respects flat arches have overcome the effect of sag in sprung arches, in which case no real effective seal can be made either bethe "keying up" with the curtain wall arch, or between the curtain wall and roof, as is the case on B. & W. or similar type boilers.

In the matter of routine repairs of sprung arches, the rebuilding of a bock ring at the fire end requires that the new brick be bonded with the old, and this is rather a difficult matter to do without subsequent cracking. Besides the "keying up" with the curtain wall support arch in place is by no means an easy matter. Here again the flat suspended arch offers convenience of repairs with an increased amount of salvage of the used materials.

As to the proper position, length and pitch of fire arches, it can be stated that there is no exact or precise method of determination, thus giving rise to much diversity of opinion as to these matters among engineers. The only reliable guide is trial and experiments; there are, however, many fundamental principles from a combustion standpoint which determine these factors with some practical degree of accuracy, but too frequently the overall design of boiler and furnace is such that the best proportioning is interfered with, particularly in the matter of the position of the grate with respect to the boiler. In standard construction the art has developed certain relations, which, from the results of actual test and practice appear to offer the most economical results. It is proposed to consider a few of these in this instance.

The function of an ignition arch is to produce as intense a heat reflection at the point of ignition as is possible. The temperatures obtained at this point are, of course, largely dependent upon the sizing and general character of the coal, but most of all to the air supply over this area. In the case of natural draft the temperature possibilities are limited mostly on account of the latter reason, while in forced draft stokers the problem of ignition is simple and controllable. On natural draft a number of trials have shown that the most effective distance between the ignition arch and the fuel bed is from 6 in. to 7 in. and that there is no particular advantage in extending the length of this surface beyond 12 inches insofar as benefiting combustion is concerned. There are, however, many instances where mechanical difficulties have necessitated a departure from this practice. Under forced draft conditions the larger volume of gases requires a greater space between the fuel bed and ignition arch, it being approximately proportional to the amount of increased fuel burned per square foot, per hour. The figures given above apply to a coal rate of 40 lbs. free burning coal per square foot per hour and an 8 in. fuel bed.

The height of the main or fire arch should be such that the intensity of the heat reflection is sufficient to insure continuous combustion the full length of the grate, and in addition provide sufficient volume for the intimate mixture and easy flow of gases of combustion. It is thus evident that the height above the fuel bed is a function of the coal rate per square foot per hour. Under normal natural draft coal rate of 40 lbs. the most effective point is shown by experiment to be between 13 and 20 inches at the front end. However, an arch constructed in accordance with this minimum require that the pitch be such that the increasing sectional area be proportional to the increasing flue gas volume. This steep pitch does not permit of an intimate mixture of gases, particularly over the area of destructive distillation, and unburned hydro-carbons and smoke are the result. These objectionable conditions are removed by raising the front end to the maximum height and using only a slight pitch of about 1 in. per foot. Under forced blast conditions additional furnace volume is required not only on account of the increased coal rate of 60 lbs., excellent conditions were obtained with the main arch 4 ft. above the grate.

Theoretically, the arch projection which gives 100 per cent. over the grate should be correct, but a practical design on this basis is obviously impossible. Good practice calls for a 65 per cent. projection, which gives the maximum length possible, while at the same time providing sufficient exit area from the furnace. Except for this limiting factor and easy flow of air through the fuel bed at the ignition arch, the longer the arch the lower the carbon content of the ash. The disposition to smoke is also accordingly reduced. In the case of forced blast stokers where ample furnace volume is provided, arches of this length are not required as far as combustion of fuel on the grate is concerned.

In general, it can be said that in furnace design the type of boiler and its position with respect to the grate in many cases required deviation from the

(Continued on page 385)

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

IN our last article we arrived at the leading dimensions of a boiler to give 100 h.p. at the standard rating of 34½ lb. water from and at 212 deg. per horse power. These we found to be 72 in. in diameter by 18 ft. long. As the pressure determined on was to be 125 lbs. per square inch we must decide on the thickness of shell and type of riveted joints on the longitudinal seam to carry this pressure, with due allowance for the factor of safety. This factor of safety must be determined by the rules given in the Ontario Government Act, and will vary according to the conditions under which the boiler is built. Following are the rules as given in the handbook issued by the Government.

Factors of Safety

Boilers well designed, well constructed, and made of good material, should be allowed a higher working pressure than boilers inferior in any of the above respects, and unless this is done the superior boiler is placed at a disadvantage and the use of good workmanship and material will be discouraged. To provide for the above, the following rules regarding factors of safety for cylindrical boilers and cylindrical parts of boilers have been adopted.

When cylindrical shells of boilers are made of the best material either in iron or steel with all holes drilled in place from the solid plate, the plates afterwards taken apart and the burrs removed, and all longitudinal seams fitted with double butt straps, each at least ⅝ the thickness of the plates they cover, the seams being double riveted with rivets having an allowance of not more than 75 per cent. over the single shear, and having the circumferential seams constructed so that the per cent. is at least one half that of the longitudinal seam and provided that the boiler has been inspected by inspectors authorized by the act during the whole period of construction in accordance with these regulations, then 4.5 may be used as a factor of safety, but when the above conditions have not been complied with the additions to the following scale must be added to the factor of safety according to the circumstances of each case.

To be added to the factor of 4.5.

A .10 Holes in longitudinal seams, fair and good, but drilled from solid out of place after bending edges of plates.

B .20 Holes in longitudinal seam, fair and good, drilled from solid out of place before bending edges of plate.

C .20 Holes in longitudinal seams, fair and good, punched after bending edges of plates and reamed after assembling.

D .30 Holes in longitudinal seams, fair and good, punched before bending edges of plates and reamed after assembling.

E .07 Holes in circumferential seams, fair and good, drilled from solid out of place after rolling plates.

F .10. Holes in circumferential seams, fair and good, drilled from solid out of place before rolling plates.

G .10 Holes in circumferential seams, fair and good, punched after rolling plates and reamed after assembling.

H .15 Holes in circumferential seams, fair and good, punched before rolling plates and reamed after assembling.

I .70 Longitudinal seams, if double butt straps are not fitted and the said seams are lapped and double riveted.

J .50 Longitudinal seams, if double butt straps are not fitted and the said seams are lap and treble riveted.

K .60 Longitudinal seams, if only single butt straps are fitted and the said seams are double riveted.

L 1.00 Longitudinal seams, when any description of joint is only single riveted or when double straps are used and only one row of rivets in double shear.

M .50 Holes or rivets in longitudinal seams if not fair and not good.

N .20 Holes or rivets in circumferential seams not fair or not good.

O .40 Holes in any seams not properly spaced in crossing.

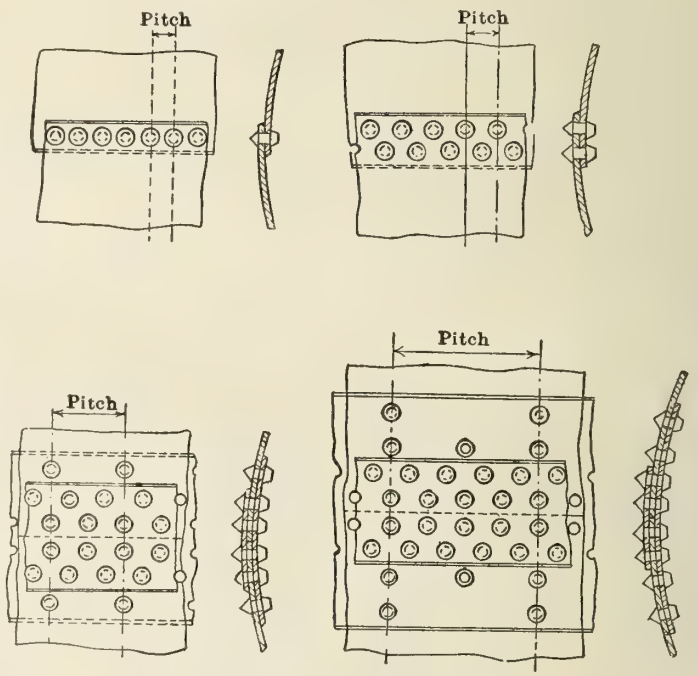
P .40 When material is doubtful and not properly certified in accordance with regulations.

Q .50 If joints are not close fitting the plate being open when boiler is finished or workmanship unsatisfactory.

R .50 If boiler has not been inspected by inspectors authorized by the act during the whole period of construction in accordance with these regulations.

The inspector is allowed some latitude according to his judgment of the circumstances in appying these regulations.

In designing a boiler, the highest factor of safety will be aimed at. This means that the best possible type of joint must be used on the longitudinal seam and that workmanship and material must be good. Before going any further we will therefore discuss the different types of joints.



TYPES OF RIVETED JOINTS

Kinds of Joints

The efficiency of a riveted joint is expressed always as a percentage of the strength of a solid plate. When holes are drilled or punched out of a plate to allow of riveting, the plate is weakened by the amount of metal cut out. If we have a plate of one square inch section, and remove .25 square inches in drilling, the section remaining is only .75, and the resistance of the plate to stress will be only 75 per cent. of its original resistance. This would represent what is known as per cent. of plate strength to solid plate. This is only one factor. The second factor is the proportion that the strength of

the rivets bears to the strength of the solid plate. This will depend on the diameter and number of rivets in the unit section of plate considered, and is also expressed as a percentage. We shall consider the means of arriving at these efficiencies shortly.

There are several styles of riveted joints, and two distinct classes. The lap type of joint is so called because it is made by lapping the edges of the plate over each other and riveting them together. The second type is known as a butt joint and is made by bringing together the edges of the plates to be joined and placing a broad plate over them, riveting all three plates together. In many cases two cover plates are used. These two types of joints are subject to various modifications. Thus a lap joint may be single, double, or treble riveted and the rivets may be placed in regular rows or in staggered rows, known as chain or zig-zag riveting. The butt strap joint may be made with one or two straps, with equal or unequal straps, with double, treble or quadruple riveting. The type of joint selected will depend upon the pressure to be carried, cost of manufacture and rules of the province in which the boiler is to work. The cut here shown illustrates the type of joints mentioned above.

To Find Efficiency of Joint

The efficiency of a riveted joint varies with the diameter of rivets, pitch of rivets, number of rivets in a pitch, and the thickness of the plate. In considering riveted joint efficiency, the unit of plate area considered is always contained within a pitch or between the centre lines of two adjacent rivets. Where there is more than one row of rivets the pitch of the rivets in the outer row is taken. We will explain each type as we come to them. The most simple is of course the single riveted lap joint. Suppose we have a plate of 5-16 inch in thickness, and with ⅝ rivets pitch 2 inches. We have to consider the strength of the joint as compared to the solid plate. We will consider the plate to be of 60,000 lbs. tensile strength. We shall therefore have a section, before any drilling is done, of 2 x 5-16 = ⅝ square inches. This section will have a resistance of 60,000 x ⅝ = 37,500 lbs. Now, after drilling, the amount of metal removed will be in diameter just equal to the diameter of one rivet because in the section we are considering there will be just half a hole on each side. A glance at the sketch which shows the pitch of line passing through the centre of rivets will make this clear. Therefore the amount of metal removed will be equal to the diameter of one rivet multiplied by the thickness of the plate, or

$\frac{5}{8} \times \frac{5}{16} = \frac{25}{128}$. This amount subtracted from the original area will give the section remaining, and if this remainder be divided by the original section we will have a fraction, representing the proportion of original section remaining. To express this as a percentage we multiply by 100. Now to follow out the procedure step by step.

Let

P = pitch.
d = diameter of rivet.
t = thickness of plate.

We have a plate section of pitch P, and thickness t, the area being Pt. The rivet area will be equal to dt, so that when the holes are drilled we shall have

$$Pt - dt = P - d$$

the t on each side cancelling out.

The proportion of plate section remaining is $\frac{P-d}{P}$ and the percentage of plate to solid plate is $\frac{P-d}{P} \times 100$. Substituting figures, we get

$$Pt = 2 \times \frac{5}{16}$$

$$dt = \frac{5}{8} \times \frac{5}{16}$$

$$Pt - dt = 2 \times \frac{5}{16} - \frac{5}{8} \times \frac{5}{16}$$

$$P - d = 2 - \frac{5}{8}$$

$$\frac{P-d}{P} = \frac{2 - \frac{5}{8}}{2}$$

$$\frac{P-d}{P} \times 100 = \frac{2 - \frac{5}{8}}{2} \times 100$$

$$= \frac{2 - .625}{2} \times 100$$

$$= \frac{1.375}{2} \times 100$$

$$= 68.75$$

So that the proportion of plate strength to solid plate is 68.75 per cent.

This formula is always used, and may be set down

$\frac{P-D}{P} \times 100 =$ per cent. of plate strength to solid plate.

In the Ontario regulations the plate efficiency is symbolized by the letters Kt, so the formula is

$$\frac{P-D}{P} \times 100 \text{ Kt}$$

The next point to consider is the efficiency of the rivets in the joint. This is the proportion that the area of the rivet in the pitch limit bears to the unit section of plate. As rivets are not as strong in resisting shearing stresses as they are in resisting tensile stresses, an allowance must be made for this difference. The Ontario regulations use the constant C, and this is expressed

$$C = \frac{\text{Shearing strength of rivets}}{\text{Tensile strength of plate}}$$

C may be taken as

.85 for iron rivets in iron plates
.70 for steel rivets in steel plates.
.65 for iron rivets in steel plates.

In the joint we are considering there is but one rivet in the pitch, and as there are but two plates which the rivets pass through they are in single shear. We will then have an area of d × d × .7854, divided by the area of the unit section, which is P × t. This is expressed in the formula:

$\frac{a \times n}{P \times t} \times C \times 100 =$ per cent. of rivets' strength to solid plate.

So we have

$$\frac{5 \times 5 \times .7854 \times 1 \times 16 \times C}{8 \times 8 \times 2 \times 5} \times 100 = \text{Ks}$$

This worked out becomes, if we take C as .85

$$\frac{5 \times .7854 \times 85}{8} = 41.72 \text{ per cent.}$$

If we neglected the constant C we would get about 49 per cent. This lowest percentage is the one used in calculating the working pressure of the boiler. In our next article we will consider the strength of riveted joints of more complicated design.

ADVANTAGES OF FLAT ARCHES

(Continued from page 283)

principles of good practice. With boilers of the B. & W. type or Heine type where sufficient headroom obtains, the opportunities for flexible design are not interfered with, but in the case of Stirling, Conolly and similar types, practical conditions have to be overcome, and in many cases at the expense of efficiency. It is obviously quite difficult to formulate a code of furnace practice to cover all special conditions, but on the other hand those principles established by usage and corroborated by experiment should offer the furnace designer considerable insurance against failure.

Many engineers are at the present time prone to accept the fantastic and gamble with untried principles. Again there are others who opine that the mere changing of a detail is a cure for all ills. The best guide after all that can be said, is trial and experiment.

A. S. M. E. MEETING

The 1920 annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th Street, New York City, from December 7 to December 10.

Sessions will be held on the subjects of appraisal and valuation, and the application of engineering to woodworking.

The newly founded profession sections on management, power, fuels, machine shop, railroads and textiles will also conduct sessions to consider the vital problems in their field. In addition a number of valuable papers will be presented at general sessions.

A memorial session for Dr. Brashear is planned, as a fitting tribute to his life and work.

The Open Type Locomotive Feed Water Heater

The Theory and Practice of Feed Water Heating by This Type of Heater is Discussed by the Author in a Paper Read Before the A.S.M.E.

By THOMAS C. McBRIDE

THE use of feedwater heaters on locomotives dates back to the beginning of the locomotive itself. There are records of the application of an "open" or "injection" type heater to a locomotive in England in 1827, and an English patent of 1828 describes a tubular heater for the same purpose. Ross Winans of Baltimore applied tubular heaters to two types of Baltimore & Ohio railroad locomotives in 1836. It is worthy of note that the desirability of the feedwater heater for the locomotive was recognized at these early dates, although it must be appreciated that the advantages possible at that time were proportionately greater than at the present time because of the low-steam pressure then in use.

There is much of interest in the history of locomotive feedwater heating in a paper, Feedwater Heaters and Their Development by J. Snowden Bell which was presented at the fiftieth annual meeting of the American Railway Master Mechanics Association, in June, 1918. Every conceivable type of heater and all possible sources of heat, even the hot ashes, seem to have been proposed or tried, and in view of the amount of study that has been given to the subject it seems rather remarkable that locomotive feedwater heating is not now in more general use. Possibly the reason lies in the fact that it is only in comparatively recent years that the essentials of heater performance and pump operation have been understood. Furthermore the small size of the locomotives formerly in general use limited the saving per locomotive, and the general adoption of the injector, because of its simplicity and convenience, rendered feedwater heating impossible, for injectors heat the water which they use to such an extent by live steam that there is little or no opportunity for further heating.

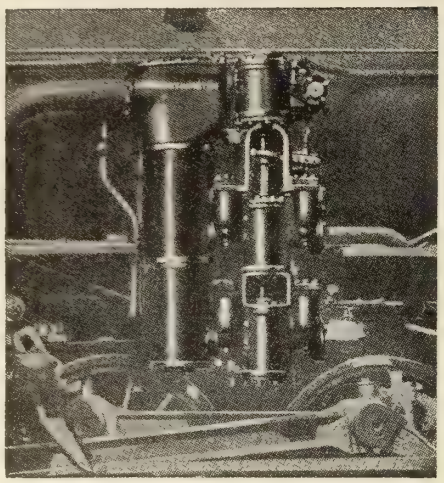


FIG. 1—PUMP AND HEATER APPLIED TO MIKADO LOCOMOTIVE.

There are two possible sources in a locomotive from which otherwise waste heat may be obtained to heat the feedwater: (a) the waste gases in the smokebox or stack, (b) the exhaust steam. Stationary practice with economizers indicates the waste-gas heaters cannot be supplied with cold water because the accumulation of condensation and soot on them seriously interferes with their efficiency. It is, therefore, necessary to turn to the exhaust steam for the source of heat and to develop this type of heater first, leaving the waste-gas heater for later development as may be found either necessary or advisable.

The exhaust steam heater may be either of the open or injection type in which the exhaust steam comes into direct contact with the cold feedwater so that the water condensed from this exhaust steam is added to and mixed with this feedwater; or, of the closed or surface type in which the heat from the condensation of the exhaust steam passes to the feedwater through thin sheets of metal, generally in the form of thin brass tubes. Practically all of the development work to date that has been at all successful has considered only the surface type. There are a great many heaters of this type in service in Europe, but there are objections to it for locomotive use. It is a complex and delicate structure; it also wastes the water condensed from the exhaust steam with its heat or raises complications as to saving it, and it requires enough exhaust steam to heat all of the feedwater. On the other hand, the open or injection type of heater necessarily recovers both the water condensed from the exhaust steam and its heat so that both are returned direct to the boiler with the water taken from the tender. Less water is therefore taken from the tender and less exhaust steam is required for the heating.

Description of a New Type of Heater

With these thoughts in mind, the author has devised a system of locomotive feedwater heating which makes use of a heater of the open type which is manufactured and marketed by the Worthington Pump and Machinery Corporation. The system follows marine practice in heaters of this type, and the pump and heater have been combined into a single unit which can be conveniently attached to the side of the locomotive

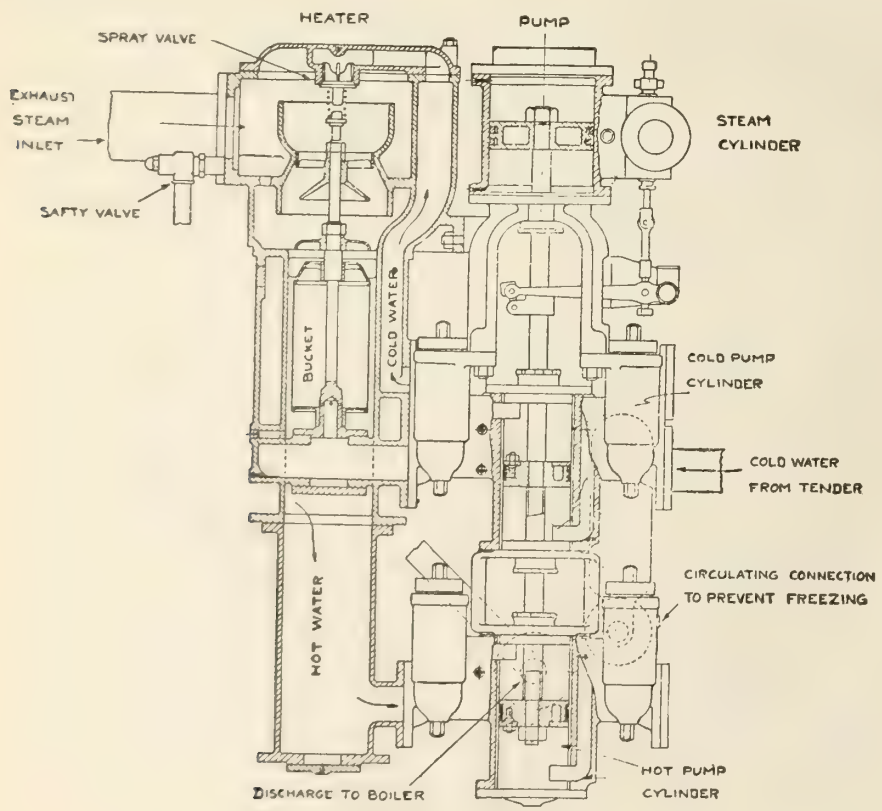


FIG. 2—SECTION OF THE HEATER.

boiler as is the practice with air-brake compressors. Fig. 1 shows a unit with a capacity of 60,000 lb. of feedwater per hour in service on a Mikado locomotive. Fig. 2 is a sectional view of the heater and pump. In these illustrations the heater is shown at the left, the feed pump at the right.

The heater is a simple cast-iron box, the upper part of which is supplied with exhaust steam taken from the locomotive through holes cut in the back of the cylinder saddle and a pipe which has in it a stop check valve and an oil separator, the latter having a small hole in it so that there is a continuous drip for the oil.

The pump is of the vertical type attached to the side of the heater by the various pipe connections. The steam cylinder of the pump is at the top, and it has two water cylinders clearly shown in the illustrations, both operated from the same piston rod. The water cylinder in the middle of the pump takes cold water from the tender and delivers it through a port in the side of the heater to a spray valve in the extreme top of the heater where it is sprayed into the exhaust steam that fills the top of the heater. This condenses as much of the exhaust steam as the water needs to heat it, and the mixture, dropping to the bottom of the heater is taken by the other pump cylinder and delivered to the boiler through the usual check valve. The pump cylinder which takes the cold water from the tender and delivers it to the heater is really a measuring device which feeds into the heat approximately the same amount of water that the lower pump cylinder takes out of the heater, but the varying amounts of exhaust steam condensed in heating the feedwater cause a tendency for a slight excess of water to accumulate so that in time the heater would become flooded. This is prevented by returning this excess water under the control of a bucket in the heater to the pump cylinder in the middle of the pump through one of its pump-suction valves serving this water alone.

The pump is driven by saturated steam taken from the locomotive boiler through a 1-in. steam pipe and controlled by a throttle valve in the cab within convenient reach of the engineer. The exhaust steam from the pump is led into the back of the stop check valve where it mixes with the exhaust steam from the locomotive, and passes with it through the oil separator to the heater. These pipe connections as well as the cold-water pipe from the tender passing back of the air-brake compressor and the feed line from the lower pump cylinder to the boiler are shown in Fig. 1.

The adoption of the open heater for the locomotive may seem a radical step, but from this description it will be evident that no new elements are used. The heater itself is of a general type that has been in use in marine service for at least twenty years. The open heater with the oil separator to remove the oil from the exhaust steam before it enters the heater because of its merits has been almost universally adopted for stationary plants. One of these heater and pump units was thoroughy tested out on the locomotive test plant of the Pennsylvania Railroad at Altoona, Pa., in 1917, and has been in operation on road service since October 1918. Three more units have been in operation for approximately a year on pooled locomotives and have given no trouble other than the usual pump maintenance. Nothing has developed indicating that the open heater as a type is not well adapted to the locomotive and the coal and water savings have been so marked as to be evident to the crew.

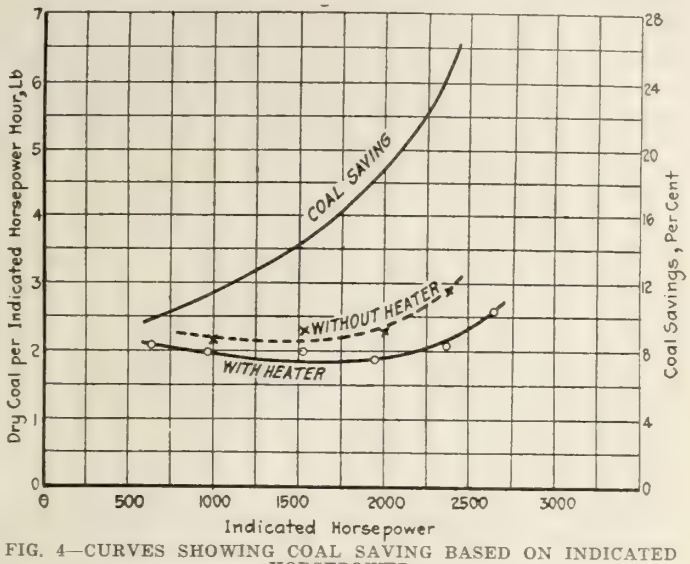


FIG. 4—CURVES SHOWING COAL SAVING BASED ON INDICATED HORSEPOWER.

The pump is much easier to operate than an injector as it requires only a slight turn of the 1-in. throttle valve to either start it or to make it run faster or slower as the boiler may need more or less water. It does not require priming and can be operated continuously at low capacities where the injector must be stopped and started periodically.

The feed pump should not be used, as is often done with the injector, to fill the boiler on the down grade and then be shut off as long as possible on the up grade; first, because there is not as much inducement or necessity for operating it in this way, and secondly, because the prime purpose of the heater is to recover heat and it can only do so when the locomotive is pulling and exhaust steam is available for the heating. If the injector is operated continuously and maintains a constant water level in the boiler each pound of steam generated will require 1276 B. t.u. from the fire with 200 lb. steam pressure, 150 deg. superheat, and 40 deg. water in the tender. If the injector is shut off each pound of steam will require somewhat more than 925 B.t.u.

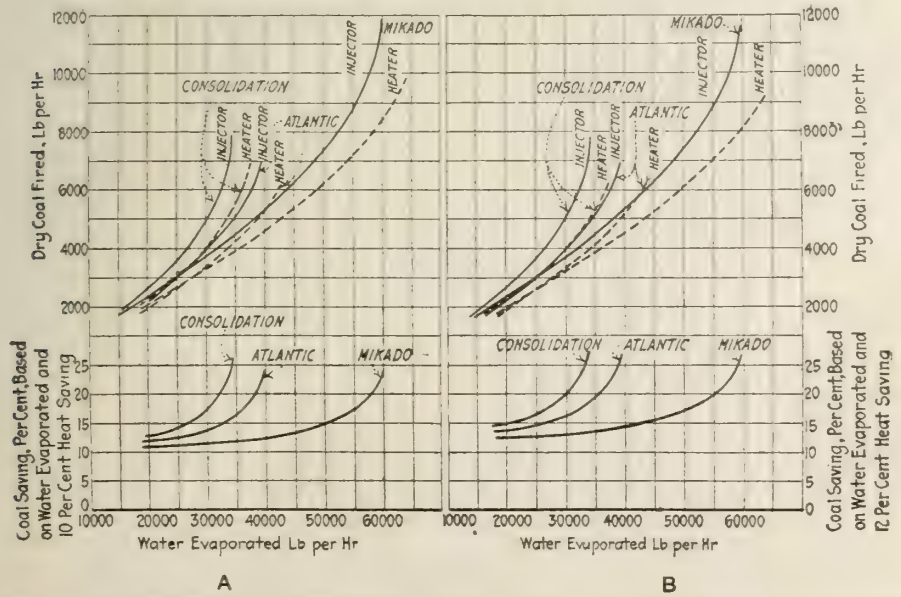

Dry Coal Fired, Lb per Hr
Coal Saving, Per Cent Based on Water Evaporated and 10 Per Cent Heat Saving
Coal Saving, Per Cent Based on Water Evaporated and 15 Per Cent Heat Saving
Water Evaporated Lb per Hr
CONSOLIDATION
ATLANTIC
MIKADO
INJECTOR
HEATER
A
B

FIG. 3—CURVES SHOWIUG THEORETICAL COAL SAVING BASED ON WATER EVAPORATED.

so that the amount of steam from the same fire will be increased less than 38 per cent. It will later be shown that under the same conditions the feedwater heater would increase the amount of steam about 13.6 per cent. The feedwater heater will, therefore, materially increase the amount of steam on the up grade, although not to the extent possible in the case of the injector and should be depended upon to feed the boiler entirely on the up grade with the consequent greater amount of heat recovered from the exhaust and more nearly constant water level in the boiler.

Advantages of Locomotive Feedwater Heating

It is not possible to make an exact general statement of the advantages to be obtained from locomotive feedwater heating, because much depends on the particular locomotive to which the heater is to be attached, the capacity at which it is worked, the temperature of the water in the tender, and the basis on which the advantages obtained are stated.

We are able to base our notions as to the advantages of feedwater heating on the results obtained in stationary practice where the coal saving is very properly considered as equivalent to the reduction in the amount of heat necessary to evaporate the water because of the higher temperature at which the water is delivered to the boiler. In the case of the locomotive, however, with its very complicated relations of the different operations that are going on, and the very wide range of capacity through which the boiler is operated, there is generally a much greater coal saving than in stationary practice. Three factors enter into the final result. These are as follows:

1. The reduction in the amount of heat required to evaporate the water in the boiler, which might be called the *heat saving due to the feedwater heater.*

2. The reduction in the amount of heat required results in a greater reduction in the amount of coal required because of the better efficiency of the boiler at the lower rate of combustion. These two factors give the *coal saving based on water evaporated.*

3. The exhaust steam taken by the heater from the exhaust ports of the locomotive reduces slightly the back pressure in the locomotive and should show some advantage. All three factors combined will give *the coal saving based on indicated horsepower.*

An analysis of these three factors will show the coal and water saving referred to the steam that is used in the locomotive cylinders, and therefore, the minimum saving since it does not include the saving in generating the steam used by the auxiliaries. It is necessary to make this analysis partly theoretical assuming certain constant operating conditions in order that a fair comparison may be made of the effect of the heater on different locomotives and at different locomotive capacities. It can only apply to the coal burned while running since the heater can have no influence while standing or at terminals. The percentage of coal saving due to the heater, and to a lesser extent the percentage of water saving when based on ton miles, the month, or the year will be less than the percentage while running by an amount determined by the use made of the locomotives.

Heat Saving Due to Feedwater Heater

The first factor, the heat saving, is determined by the amount the feedwater is heated by exhaust steam taken from the locomotive. This factor will evidently be greatest when the tender-water temperature is low and when the exhaust steam pressure in the heater is highest, as this pressure determines the temperature to which the feedwater can be heated. This pressure will be highest when the locomotive is working hard, and when the exhaust steam for the heater is taken from that part of the steam valve chests or cylinder saddles where its pressure is greatest.

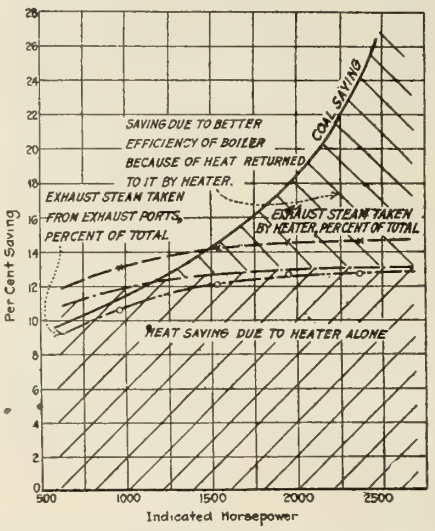


FIG. 5—ANALYSIS OF COAL SAVING BASED ON I.H.P. WITH EXHAUST STEAM LIFT AVAILABLE FOR DRAFT.

The exhaust steam from the feed pump need not be be wasted, since it can be and is used in the feedwater heater, but this use prevents the recovery of the same amount of exhaust steam and heat from the exhaust of the locomotive. The amount of steam used by the feed pump is, therefore, a direct charge against the saving due to feedwater heating as compared to injector operation when considered in the light of recovery of waste heat from the locomotive exhaust, or when estimated by the temperature rise of the feedwater in the heater.

Test plant results and actual daily operation on the road with superheated steam locomotives show that the feedwater heater described can be depended on to effect a reduction of at least 10 per cent. in the summer time and 12 per cent. in the winter time in the amount of heat required to evaporate the water and superheat the steam. This heat saving will not be constant at these figures but will vary with the capacity at which the locomotive is worked because the steam pressure in the heater determines the temperature to which the feedwater can be heated. These figures can, however, be conservatively accepted as representing average working conditions at which the greater part of the coal is burned.

The tabulation given in Table 1 is based on heating the feedwater to 215 deg. This is quite conservative as it has been found easily possible to obtain this temperature with this heater even with tender-water temperatures of 40 deg. and on locomotives worked at less than two-thirds of their maximum capacity. The tabulation shows that greater heat saving is possible with saturated than with superheated steam locomotives; therefore the percentage of coal saving will be greater with saturated than with superheated steam locomotives. Table 2 gives the exhaust steam required for the heating. The percentage of water saved is shown by table 3.

The allowances which have been made for the steam used by the feed pump are based on carefully conducted tests of the feed pump and heater which show that this feed pump when running with saturated and fairly wet steam required for its operation 2 per cent. or less of the weight of steam generated by the boiler. The pump, therefore, uses 2 per cent. or less of the heat required from the fire by the saturated steam locomotive, but in the case of superheated steam locomotive the feed pump will re-

Table 1—Heat Saving Due to Feedwater Heater.

Assumed steam pressure in branch pipe, lb. per sq. in.	200	200	200	200
Assumed superheat, deg. fahr.	None	None	150	150
Assumed temperature water in tender, deg. fahr.	40	70	40	70
Heat content per pound of steam, B.t.u.	1199.1	1199.1	1284.6	1284.6
Heat content per pound of water, B.t.u.:—				
at 40 deg.	8.0	...	8.0	...
at 70 deg.	...	38.0	...	38.0
Heat required to generate one pound of steam, B.t.u.	1191.1	1161.1	1276.6	1246.6
Heat saving in B.t.u. when water is heated from:—				
40 to 215 deg.	175.0	...	175.0	...
70 to 215 deg.	...	145.0	...	145.0
Heat saving, per cent.	14.7	12.5	13.7	11.6
Total heat required by locomotive with feed pump as compared to injector operation, per cent.	102	102	101.75	101.75
Heat saving in locomotive with heater as compared to injector operation, per cent.	15.0	12.75	13.94	11.80
Heat required, per cent.	87.0	89.25	87.81	89.95
Heat saving as compared to injector operation	13.0	10.75	12.2	10.05

quire but about 1.75 per cent. of the heat from the fire of the locomotive because of the greater heat required to generate the superheated steam. The tabulation is based on steam leaving the branch pipe at 200 lb. pressure with 150 deg. superheat in the superheated steam locomotive and gives value of the heat saving, water saving, and percentage of exhaust steam required by the heater for tender-water temperatures of 40 and 70 deg. respectively. The term "heat content" is used to express the amount of heat in the water or steam above that in water at 32 deg. fahr. temperature.

From the tabulation it will also be noted that in the case of the feedwater heater for the locomotive, because of its comparison to injector operation, it is not possible to apply the usual short rule customary in stationary practice stating that a certain number of degrees of heating of the feedwater results in 1 per cent. heat saving, but rather that it is more exact to state, assuming the conditions of the table, that in the saturated steam locomotive, after the first 23.8 or 23.2 deg. heating, each 11.9 or 11.6 deg. of heating represents 1 per cent. heat saving, and that in the superheated steam locomotive after the first 22.3 or 21.8 deg. of heating each 12.8 or 12.5 deg. of heating represents 1 per cent. heat saving, the first figures in each case applying with 40 deg. and the second figures with 70 deg. water temperature.

European practice, as far as the author is informed, involves the use of tubular heaters differing only in details of their construction and discharging to the track the water condensed from the exhaust steam in the heater, thus losing both this water and its heat, necessarily with some additional steam that must be blown through the heater to prevent it becoming air-bound. These locomotives require 2 per cent. more water than when operated with the injector because of the steam used by the feed pump and discharge to the track from 15 to 18 per cent. of this with from 2.6 to 1.8 per cent. of the heat of the saturated and 2.4 to 1.6 per cent. of the heat of the superheated steam locomotive in the water alone for 40 and 70 deg. water respectively. There are a few surface heaters in operation on locomotives in this country in which this water is saved by pumping it back to the tender through filters to remove the oil, but in doing so approximately 80 per cent. of its heat is lost by radiation from the tender. This loss of heat from the locomotive with the surface heater does not count directly against the coal saving since it is supplied by the exhaust steam, but it does count indirectly since it decreases the amount of exhaust steam left available for the draft. The open heater is more economical in the use of exhaust steam and leaves more available for the draft with the possibility of lower back pressure and saving because of this.

The locomotive with the open heater or the surface heater saving the water condensed from the exhaust steam requires the extra 2 per cent. steam to operate the feed pump, but from 15 to 18 per cent. of this 102 per cent. is recovered, so that the net water saving is from 13.3 to 16.4 per cent. respectively for the assumed summer and winter conditions as compared to injector operation.

Coal Saving Based on Water Evaporated

To combine these results with the second factor in order to obtain the coal saving based on water evaporated it is necessary to consider particular locomotives since the second factor involves the change in the efficiency of the boiler with varying boiler capacity. For this purpose the curves of Fig. 3 have been prepared. The curves on the left marked A are on the basis of 10 per cent. heat saving; those on the right marked B on the basis of 12 per cent. heat saving. The upper solid curves marked "Injector" are test plant results of a Consolidation, Atlantic, and Mikado type locomotive respectively, and show the total amount of water evaporated per hour against dry coal fired. The dotted curves marked "Heater" for each of these three locomotives show the amount of water that would have been evaporated by the same amount of coal with a feedwater heater reducing by 10 per cent. respectively the amount of heat required to evaporate the water and superheat the steam. The vertical distances between the solid and dotted curves represent the amount of coal saved and these quantities are shown in the lower set of curves. This lower set of curves, therefore, shows the coal saving based on water evaporated due to the feedwater heater that follows a reduction of 10 per cent. and 12 per cent. respectively in the amount of heat necessary to evaporate the water and superheat the steam. These curves show that the feedwater heater attached to a locomotive will effect a coal saving beginning at low capacities practically identical with the heat saving, or the coal saving which we have been accustomed to in stationary practice, but which increases at first gradually and then more rapidly as the capacity of the locomotive is increased, reaching values twice or more than twice these figures as the maximum capacity of the locomotive is approached.

It would be difficult to credit this result were it not warranted theoretically by the second factor mentioned above, and had it not been confirmed in test plant results with a wide margin to spare. A study of the upper curves in connection with the lower curves of both figures will show that the very great coal saving possible is accompanied by an increase in steaming capacity due to the feedwater heater and that it should be possible to work the locomotive with the heater at greater steaming capacities than are possible with the injector but how much greater would depend largely on the particular locomotive.

Referring to the lower set of curves of Fig. 3 and assuming that the Consolidation locomotive would be operated normally at a steaming rate of say 25,000 lb. per hr., it is noted that the 10 and 12 per cent. heat savings assumed as summer and winter conditions would result in 14 and 16.6 per cent. coal savings respectively. Assuming that the Atlantic type locomotive would also normally be operated at a steaming rate of 25,000 lb. per hr., the coal saving would be 12.8 and 14.5 per cent. respectively. Assuming that the Mikado locomotive is hand fired and operated at a steaming rate of 37,500 lb. per hr., the coal saving would be 12 and 14.2 per cent. respectively.

On the other hand, it is altogether possible that advantage should be taken of the feedwater heater either in increased speed or increased hauling capacity and the same amount of coal burned with it as would have been burned if the locomotive had operated with the injector. In this case, the summertime 10 per cent. heat saving would result in a

$$\frac{100}{100 - 10}$$

per cent. steaming capacity or 11.1 per cent. increase; and the 12 per cent. heat saving would result in a

$$\frac{100}{100 - 12}$$

per cent. steaming capacity or an increase of 13.6 per cent. But as compared to injection operation at this increased steaming capacity the coal saving in the Consolidation locomotive would be 15.5 and 19 per cent., in the Atlantic locomotive 13.3 and 15.5 per cent., and in the Mikado locomotive 13 and 15.3 per cent. respectively.

The feedwater heater does not appear to as great advantage in the Mikado locomotive as in the other type locomotives because it is not as fully loaded.

Table 2—Exhaust Steam Required For Heating

Assumed tender water temperature, deg. fahr.	40	70
B.t.u. required to heat one pound of feedwater to 215 deg.:		
from 40 deg.	175	....
from 70 deg.	....	145
Heat content of exhaust steam assumed at 7 lb. pressure. B.t.u. per lb.	1157	1157
Heat content of water at 215 deg. B.t.u. per lb.	183	183
Heat given up by exhaust steam in condensing from 7 lb. pressure to water at 215 deg. B.t.u. per lb.	974	974
Exhaust steam required to heat one pound of cold feedwater, per cent.	18	15
Exhaust steam to heater from feed pump, per cent.	2	2
Exhaust steam from exhaust ports of locomotive required by surface heater, per cent.	16	13
by open heater, per cent.	13.8	11.5

If the Mikado locomotive was operated at a steaming rate of say 50,000 lb. per hr., the assumed 10 and 12 per cent. saving would have resulted in a 15 and 17.3 per cent. coal-saving respectively, and if advantage had been taken of the feedwater heater for the increased capacity burning the same amount of coal as with the injector the coal saving would have been 18 and 21.2 per cent. respectively.

Coal Saving Based on Indicated horsepower

Any modification which the third factor makes in the combination of the first two factors as shown in Fig 3, leading up to the coal saving per indicated horsepower, must be but slight and depend on the particular locomotive. Saturated steam locomotives should show a further gain of a few per cent. from reduced back pressure. Test plant records show some reduction in this back pressure in superheated steam locomotives accompanied by a reduction in superheat and indicate that, at least until further tests are made, this factor should not be considered for superheated steam locomotives.

The curves of Fig. 4 are test plant results of a Mikado locomotive, comparing its operation with the injector and with the feedwater heater described in this paper. Table 4 shows the heat recovered by the feedwater heater and Table 5 the coal saving and increase in efficiency. They show a coal saving curve of the same general character, but slightly higher than the curve for the Mikado locomotive of Fig. 3, based on water evaporated, although the tests were made under practically identical operating conditions as to temperatures and pressures.

The coal-saving curve of Fig. 4 has been reproduced in Fig. 5, and a curve added showing the reduction in the amount of heat required to evaporate the water and superheat the steam, because of the heater. The cross-hatched area above this curve shows the additional saving presumably all due to the better efficiency of the boiler with the reduced amount of heat required from the fire because of the heat recovered by the heater.

Exhaust Steam Available for the Draft

The question has been raised as to whether the exhaust steam taken from the locomotive by the feedwater heater would cause trouble with the draft. This question could be analyzed from the partly theoretical curves of Fig 3, but as actual operating conditions are of more interest, curves have been added to Fig. 5 showing the total exhaust steam taken by the heater and the exhaust steam taken from the exhaust ports of the locomotive. The distance between these two curves represents the exhaust steam furnished by the feed pump to the heater. It is noted that the curve of exhaust steam taken from the exhaust port is below the curve of coal saving. The feedwater heater, therefore, reduced the amount of coal burned at a greater rate than it reduced the amount of exhaust steam, so that there was surplus of exhaust steam left available for the draft and no necessity for reducing the size of the blast nozzle and consequent possibility of reduced back pressure in the locomotive cylinders because of this heater. For instance, at 2,000 i.h.p., the reduction in the amount of coal burned was 18 per cent., and in the amount of exhaust steam, 12½ per cent. As compared to injector operation, 82 parts of coal had to be burned and 87½ parts of exhaust steam were left available for the draft to burn it.

Table 3—Water Saving Due to Feedwater Heater

Steam for locomotive cylinders, per cent.	100	100
Steam required for feed pump, per cent.	2	2
Water required by locomotive with surface heater discharging water condensed from exhaust steam to track, as compared to injector operation, per cent.	102	102
Exhaust steam condensed in heating feed water, per cent.:		
0.18×102	18.4	...
0.15×102	...	15.3
Water required by locomotive with open heater or surface heater saving condensation from exhaust steam compared to injector operation, per cent.	83.6	86.7
Water saving, per cent.	16.4	13.3

Table 4—Heat Recovered by the Feedwater Heater.

Test No.	1	2	3	4
Steam to engine, lb. per min.	314.5	492.8	599.1	757.3
Steam to feed pump, lb. per min.	7.4	10.5	12.5	14.6
Steam to safety valve, lb. per min.	0.8	0.7	2.1	5.5
Exhaust steam condensed, lb. per min.	42.3	71.4	90.0	113.7
Heat in steam, B.t.u. per min. to engines	402,749	639,063	780,867	996,531
to feed pump	8,876	12,594	14,994	17,393
to safety valve	960	840	2,519	6,597
Total heat in steam	412,585	652,497	798,380	1,020,521
Heat recovered from exhaust, B.t.u. per min.	50,725	85,694	108,063	136,736
Per cent. of total heat	12.3	13.1	13.5	13.4

Table 5—Coal Saving and Increase in Effciency With Feedwater Heater

Test No.	1 and 5	2 and 6	3 and 7	4 and 8
Speed in m.p.h.	14.6	14.6	22.0	22.0
Indicated horsepower:				
Without heater	990	1549	2001	2388
With heater	965	1534	1949	2373
Coal per indicated horsepower hour, lb.:				
Without heater	2.2	2.3	2.3	2.9
With heater	2.0	2.0	1.9	2.2
Coal saving by feed heating, per cent.	9.1	13.1	17.4	24.7
Drawbar horsepower:				
Without heater	824	1289	1690	2019
With heater	783	1293	1679	2055
Thermal efficiency of locomotive, per cent.:				
Without heater	7.0	6.7	6.7	5.4
With heater	7.6	8.0	8.6	7.8
Increase in efficiency with heater, per cent.	8.5	19.4	28.3	44.4

Conclusions

The feedwater heater on the locomotive may be used to reduce the coal and water consumption working the locomotive at the same capacity as with the injector or to increase the capacity of the locomotive, or partly for both, as occasion demands. It will save coal and water all the time, and permit of increased capacity when needed.

The feedwater heater might be considered as alternate to large size of locomotive boiler and grate as a means to coal economy, if for any reason both are not considered advisable or possible for still further economy. This feature is well illustrated in Fig. 3, where it is noted that the Consolidation locomotive with an open heater gives more steam per pound of coal burned than the Mikado locomtive without a heater up to 2800 lb. of dry coal fired per hr., with the 10 per cent. heat saving, and up to 3000 lb. per hr. with the 12 per cent. heat saving. Test plant records show the Consolidation with heater burns less coal per indicated horsepower than the Mikado without heater up to a still greater rate of coal fired. The smaller amount of coal burned by the Consolidation locomotive at terminals and its lower first cost and maintenance cost favor it still further in the comparison.

Viewed from the standpoint of coal and water saving, the adoption of the heater becomes a question of interest on first cost, depreciation and maintenance cost against these savings. Viewed from the standpoint of increased capacity, the question becomes one as to whether the feedwater heater does not offer increased capacity at the lowest first cost, especially if, as in the case of the comparison of the Consolidation locomotive with and the Mikado locomotive without a heater, the adoption of the heater permits of the use of a simpler and less costly type of locomotive.

The feedwater heater offers a solution of the pressing problem of these times, when so many fairly old and small locomotives have outgrown their usefulness because they are not large enough for present-day demands. The feedwater heater will not only increase the capacity of these locomotiyes, or what might be called their economical operating capacity, at a comparatively low cost and with little change in them, but it will also show a larger percentage of coal saving because of their full loading than would be obtained with present-day larger locomotives.

The feedwater heater offers the peculiar advantage of being of most assistance to the locomotive just at the time when the locomotive needs assistance. It offers its greatest saving in fuel or increase in capacity in the winter time, and these advantages are not ef-

fected by reduced steam pressure or superheat, but continue in spite of them and at a proportionately greater rate.

The study of the subject of the feedwater heater for the locomotive that has been reviewed in this paper has resulted in the adoption of the open-feedwater heater as a type. It has been developed into a unit with the pump, so that it can be attached to the locomotive at minimum expense. These units have been thoroughly tested both on the test plant and on the road, and every confidence is felt in their ability to meet the severe requirements of locomotive service, and to effect the maximum possible saving of fuel and water with a minimum amount of attention from the crew.

STANDARDIZATION OF STRUCTURAL SHAPES

On the entrance of the United States into the war with the Central Powers there came a demand for immediate increase in ship construction which, in turn, meant increased production by the steel mills. To increase production to the minimum and to simplify order practice, a conference of steel makers was held in Washington on July 2, 1917, at which was adopted American standard practice for structural steel for ships.

The result of this action proved distinctly beneficial both to the mills and the shipyards, but was not followed immediately by a standardization of and a reduction in the number of structural shapes used at the yards, and in consequence the Emergency Fleet Corporation undertook an investigation to ascertain definitely the number of structural shapes used in shipbuilding and the possibility of their standardization and reduction in number. As an outcome of these investigations carried on by Mr. Fred T. Llewellyn in the Division of Steel Ship Construction under Daniel H. Cox, Manager, it became possible to determine what were the sections in most general use and at the same time were brought out clearly the divergencies in the sections rolled by different mills

At a conference of steel makers held in Philadelphia on November, 19, 1918, inasmuch as the British standard sections of ship channels and shipbuilding bulb angles appeared to be better adapted to economical manufacture than the American standard sections and inasmuch further as the new rolls which had been turned in recent years to produce sections conformed in general to British standards, it was decided that therefore American standard sections should be discontinued and that rolls not then to British standards be redressed at as early a date as possible to roll such sections as closely as possible to British standards and this particularly in view of the further fact that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever utilized in shipyards, either at home or overseas.

The British standard sections thus adopted as American standards were those adopted by the British Engineering Standards Association as published in 1903, and it was not known that this Association had undertaken a revision of the British standard sections in 1913, work on which, however, had been suspended by reason of the war activities. When, however, through the trade press, information as to what had been done in the United States came to the attention of the British Engineering Standards Association, that Association advised American steel makers as to the situation and later through their secretary, Mr. LeMaistre, expressed their desire to have the American structural trade co-operate with the British Engineering Standards Association in the formulation of common Anglo-American standards for structural shapes.

At the instance of the Association of American Steel Manufacturers, a Sectional Committee on Steel Shapes was organized under the auspices of the American Engineering Standards Committee. This Sectional Committee is composed as follows:

American Bureau of Shipping—Captain C. A. McAllister; David Arnott; John Martin.

American Society of Civil Engineers—J. H. Edwards; J. B. French; H. G. Balcolm.

Association of American Steel Manufacturers—R. B. Woodworth, (Chairman); G. H. Blakely; Geo. E. Thackeray.

Railway Car Manufacturers' Association—A. E. Ostrander.

Society of Naval Architects and Marine Engineers—Fred T. Llewellyn; E. H. Rigg; J. W. Stewart.

United States Navy — Commander C. M. Simmers; Lieut. Com. H. D. Rouzer.

The Sectional Committee gave very careful consideration to the entire routine of structural practice in the United States not only as it affects the profiles of structural shapes themselves, but also as regards methods of order practice, calculation and publication of weights, areas and properties, etc., with the idea to insure as far as possible a complete accord between makers and users wherever the sections rolled in English - speaking lands were used. At its meeting held on April 27, 1920, it formulated its recommendations for submission to its sponsor organizations, to the American Engineering Standards Committee and to the British Engineering Standards Association as a basis for common Anglo-American standards, and its conclusions are now to go before these organizations for further discussion and endorsement. The essential features of these recommendations are:—

1. The adoption of the decimal system for the expression of dimensions, thicknesses and other elements of order practice.

2. The adoption as an Anglo-American standard of the standard order practice adopted by the Association of American Steel Manufacturers on February 20, 1920, under which structural shapes are to be ordered by weights per foot and not by thickness.

3. The adoption as an Anglo-American standard of American standard practice as it relates to ranges of thicknesses, methods of computation and methods of publication.

4. The adoption of definite ranges in thicknesses of angles and other structural shapes, under which are established two zones of variations between minimum and maximum thicknesses. Under .60-in. thick variations are fixed at four one-hundredths inch (0.04-in.) and above .60-in. thick at eight one hundredths inch (0.08-in.)

5. Included in the list of angles is an equal angle (9x9) and four unequal angles (8x4, 9x4, 9x6 and 10x4) which are not now rolled in United States, but are subject to the considerations which weigh with manufacturers when new rolls are contemplated.

6. The adoption of a new line of bulb angle sections as proposed by the British Engineering Standards Association that are recommended on account of their greater efficiency as compared with present British and American standards.

7. The adoption of a single line of channel sections with a 5 deg. flange taper to displace the present two American lines, the structural line with its flange taper 9 deg. 27′ 42″ and the shipbuilding line with its flange taper of 2 deg. This line of channel sections is not quite in accord with that proposed by the British Engineering Standards Association, but is believed to be more suitable to the requirements of the American trade and better proportioned.

8. The adoption of a new line of beam sections to take the place of the present American standards adopted in 1896. These sections have wider flanges than present American standards and do not agree very closely with the British proposals, but are believed by the Sectional Committee to be more nearly in accord with the recent developments in the fabrication of buildings and bridges.

A recent communication to the French Academy of Sciences, states that coal has been discovered in the region of Port Gueydon, French North Africa. This coal appears to belong to very extensive beds lying in the region mentioned. Analysis taken have revealed the following composition:—"Moisture, 1.05 to 1.15 per cent.; ash, 37.15 to 53.65 per cent.; volatile matter, 8.05 to 12.27 per cent.; fixed carbon and sulphur, 37.25 to 49.45 per cent; the calorific value varies from 3960 to 5390 calories.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, AUGUST 20, 1920 No. 16

PRINCIPAL CONTENTS

Experiments on a Conveyor-Feed Type Stoker	369
Common Sense in Engineering	374
Some Useful Information on Gauge Glasses	376
Theory and Practice of Electricity	379
Starting Properties of D.C. and A.C. Motors	381
Advantages of Flat Arches	383
A Course of Instruction	384
The Open Type Locomotive Feed Water Heater	386
Editorial	392
Progress in New Equipment	393

The Council of Action

THE creating of what is known as a Council of Action by the leading trades unions in Great Britain, with the avowed object of dictating to the Government its policy on certain questions of national importance, creates, as Mr. Lloyd George plainly states, "the most formidable challenge ever given to democracy." There can be no doubt that the people of Great Britain generally are war weary, and not labor alone. The greatest beneficiaries of the war were the trades unionists, and some of the capitalists, though not by any means all. It is the great middle classes who suffered the most and got nothing at all out of it who would probably be the most unwilling to see their country embarked on another period of war. Their voice, however, is not heard above the clamor made by the representatives of organized labor, which, after all, is by no means a majority of the community, but, on the other hand, a relatively small portion. Organized labor in Great Britain has, since the war, been frankly out to get everything it could possibly extort, and has not been afraid, in this endeavor, to attempt the complete paralysis of the country. The great transportation strike should have taught their representatives that when they go in opposition to the general public they are comparatively powerless, and it is quite possible that in making their threats of a general strike in the event of Britain taking action in Poland, they did so with their tongues in their cheeks. As a matter of fact, the British Prime Minister says that the aims of the Government and the aims of the Council of Action are practically the same, but he plainly and positively states that were they not, "dictation would be resisted by all means in the power of the Government." Trades unions can serve an excellent purpose, and have been instrumental in making life a more pleasant thing for the trades unionist. When they start to assume the role of the Government it is time to call a halt. While every right-minded person wishes to see labor, both organized and unorganized, get all the good out of life that it is possible to obtain, no sane person wishes to see any minority of the people holding a club over the rest. Lloyd George is to be congratulated on his uncompromising stand against such coercion.

The Engineer's Opportunity

THE organization of the Federated Engineering Societies at their recent conference at Washington, D.C., is certainly a step in the right direction.

About 75 branches of the engineering profession were represented, these including Civil, Mechanical, Mining, Electrical, Sanitary, Heating, Marine, Agricultural, Radio, Refrigerating, Fire Protection, Industrial, Automotive, Military Engineers, Architects and Geologists, etc.

The need of such a body has been felt for years, but the problem was to successfully affiliate the various interests. The action taken at Washington has removed the only remaining nigger in the woodpile.

The object of this newly formed body is both ambitious and essential. They desire to raise the standing of engineers generally, and to teach the public how much they really depend upon the engineering profession. Any society, club or organization, the chief object of which is the advancement of the knowledge and practice of engineering and the application of applied sciences, and which is not organized for commercial purposes, is eligible for membership.

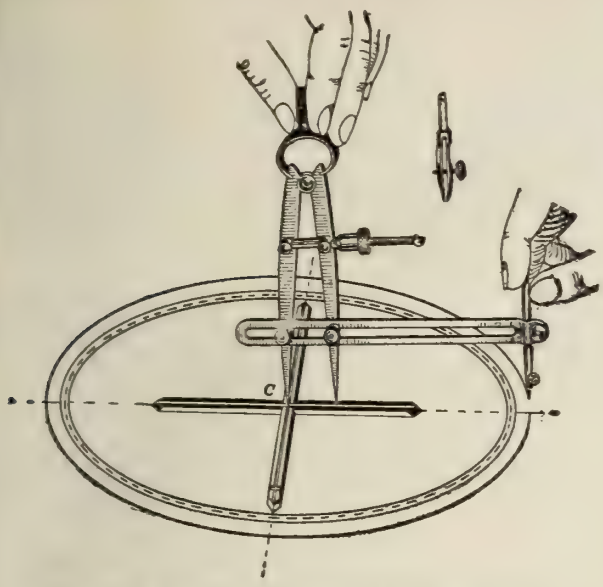
The success of this society, as we see it from our side of the line, depends entirely upon the engineers themselves. With proper support this body should grow to be a powerful influence and will form the official mouthpiece, so to speak, for engineers all over the country.

To our mind the forming of this society should be greeted with great enthusiasm by engineers in general and they should rally to its support. An opportunity such as this affords is not to be treated lightly. We will watch with interest the development of the organization, and once more emphasize the necessity of every engineer becoming a live member and actual booster.

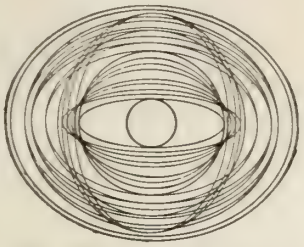
—Thomas in the Detroit "News."
"City folks get themselves into the durnedest messes."

REID ELLIPSOGRAPH

Daniel C. Reid, 2717 N. Croskey Street, Philadelphia, Pa., has placed on the market what is known as the Reid Ellipsograph. This instrument is claimed to draw all kinds of ellipses or ovals, from 1½ in. up to 12 in. major axis, and describes a perfect ellipse in one operation.



THIS VIEW SHOWS THE INSTRUMENT IN USE.

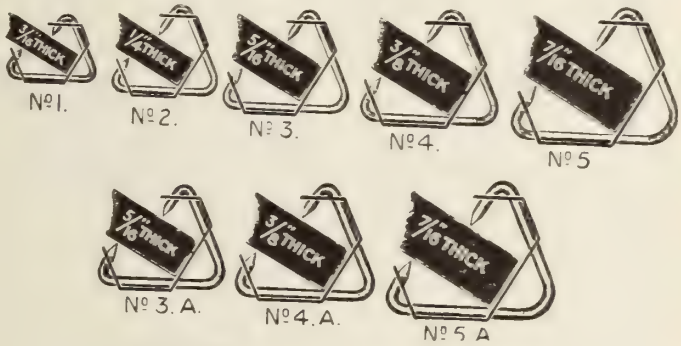


THE WORK ACCOMPLISHED

The instrument is provided with pen and pen parts, and can also be used for drawing circles up to 12 in. diam. It can also be used as an ordinary divider. This announcement will no doubt appeal to draftsmen, designers, illustrators, architects, etc. To illustrate its construction we show the illustrations herewith.

UNIVERSAL BELT FASTENERS

An improved type of belt fastener, known as the "Universal," has been placed on the Canadian market by the Climax Company, of 244 Lemoine Street, Montreal. These fasteners are the result of careful study and exhaustive experiment on the part of the makers, and are universal in character. They are equally efficient in rubber, balata, leather or cotton belting, and are made in six-inch lengths, of sizes varying to take belts from 3-16 to 7-16 inch in thickness.

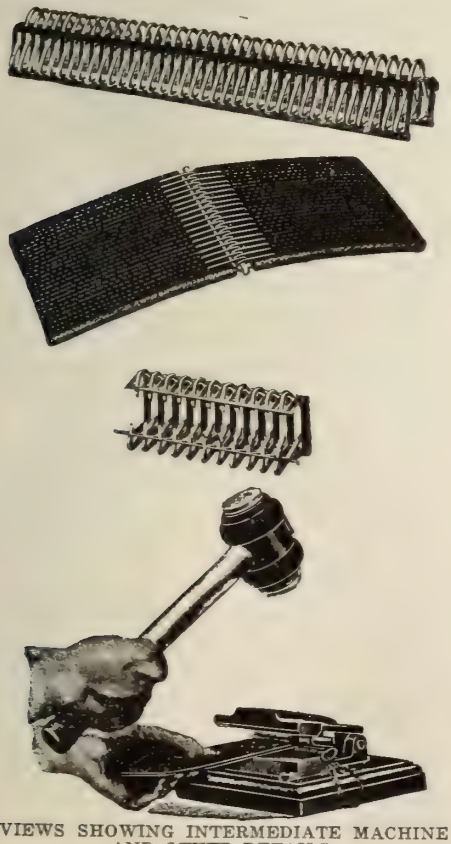


VIEW SHOWING THE VARIOUS SIZE HOOKS.

The individual hooks are held in position by a metal frame which retains the hooks in the same relative position all the time the hooks are being forced into the belt. When the hooks are flush with the belt the frame slips off freely. The fasteners are made in two gauges of wire, the larger sizes being adapted to meet the requirements of the user who has extra heavy belts running over small pulleys.

On the intermediate fasteners the wire can be laced into the belt with a simple hammering tool, economically and efficiently. For the larger sizes, a special lacing machine is preferable. On the smallest sizes, the lacing can be performed by using a hammer and a wooden block, the metal frame assuring perfect alignment during the operation. The great advantage of the metal frame is that it prevents the hooks from twisting to one side or the other while being forced into the belt. The fasteners are made with a series of hooks having long and short legs, the short legs entering the belt on the pulley side, this method minimizing the metal contact on the pulley and reducing the possible slip. The hooks do not meet in the belt, but are individually staggered, thus increasing the effective pull.

The fasteners can be cut to any desired length without fear of wasted ends, as the metal frame keeps the pieces intact. A pair of narrow scissors are provided for cutting the metal frame.



VIEWS SHOWING INTERMEDIATE MACHINE AND OTHER DETAILS.

THE HEAVIER TYPE MACHINE.

We have received Bulletin B-410 of the Yarnall-Waring Co., describing the Yarway seatless and Yarway double tightening blow-off valves. There is an interesting diagram showing the cost of leaky blow-off valves. This shows by means of a curve loss in water and coal in dollars per month and per year, and water loss in thousands of gallons per month. These valves are constructed to conform to the A. S. M. E. standards. The double tightening valve was originally made to use in conjunction with the Yarway seatless valve in places where the boiler laws require the use of two valves. Anybody interested in blow-off valves can obtain a copy of the bulletin by requesting one from the makers, Yarnall & Waring Co., Chestnut Hill, Philadelphia.

Want To Get Heat.—A strong committee has been appointed by the Board of Directors of the Chamber of Commerce of Chatham, to meet representatives of the Chatham Heating Co. The object of the committee is to try and prevent a repetition of last year's experience, when business suffered to a considerable extent due to a lack of heat, which it is claimed the company failed to supply.

TRADE GOSSIP

The Canadian Pacific Railway Company announce the apopintment of Mr. F. S. Rosseter to be acting Superintendent, Chapleau Division, with headquarters at Chapleau, vice Mr. W. R. Boucher, who has received a month's leave of absence.

Want To Export Coal. — The chairman of the Dominion Railway Commission is receiving many applications for permission to export coal. There has been an order against the export of any coal from August 1st, and the applicants claim that they had the contracts made and vessels chartered to carry the coal before the order came out. They, therefore, claim that they should be allowed to export those orders.

Car Shops for Toronto.—It is understood that representatives of car-building firms have been looking over the ground with a view to establishing a street car building shop in Toronto. This is irrespective of the continuation of the Toronto Street Railway's shops for car manufacturing. There is a probability also that the plant of the Dominion Shipbuilding Co. may be utilised for this purpose.

Alberta's Coal Export Increased. — The output of the Alberta mines for the six months ending July 31st was 3,043,940 tons, as compared with 2,068,-907 tons for the same period last year. There has been more coal marketed during the six months period than in any corresponding period in the history of coal mining in Alberta. The exportations for the six months show a 50 per cent. increase.

Coal Situation Better.—According to Mr. J. D. A. Morrow, vice-president of the National Coal Association in the United States, and who has just returned from a ten days' trip, the situation is better than it was. Due to the increased car supply, a big increase in the coal shipped to New England and the North-West besides other parts of the country had taken place. The production for last week, he estimated, was about 11 000 000 tons, which is still 1,000,000 tons under the normal requirements.

Hydro Business Last Year. — In a statement made by the Hydro Electric Commissioners, the following figures are given. The number of municipalities taking power has increased in ten years from 12 to 115, and the power distributed from 25,000 to 225,000. There are 12 rural systems, 23 companies, and five Government industries. The total assets at the Falls and in the municipalities amount to $40.693,070 and the accumulated reserves $7,654,370 and the surplus $2,177,934.

Mine Sells Entire Output.—The Blue Diamond Coal Mines at Brule, Alta., have contracted their entire output for the next six months, according to J. P. Bickell. Mr. Bickell is a director of the McIntyre Porcupine Mines, Ltd., which has just purchased the coal mining company. The contract is for the west, and the entire capacity is required, even if it exceeds 2,000 tons per day. The output is at present about 600 tons per day, and it will require over a year to bring the output up to 2,000 tons per day.

Starting in Vancouver.—The Britannia Wire Rope Co., is getting in shape to operate at their plant on Granville Island, B.C. The machinery for most of the plant is now on the way from England. C. H. Gill is the British director, and Robert Gibson, managing director.

Conference in Fall.—The second great Industrial Conference will be held in Canada some time in October or November. An appropriation was made by Parliament at last session to cover the expenses of the conferences, and it is expected that the experience gained at the last conference will result in making this one an even more representative gathering of labor, capital and the general public.

New Rates Contract. — The Special Scale Committee of coal operators and miners sitting in District 18, Calgary, have completed their labors. The agreement is between the Western Canada Coal Operators' Association and District 18, of the United Mine Workers of America. The agreement provides for an all-round increase, and is in force till April next, and retroactive from March last.

Baldwin Plant Ready Soon. — The plant at Ashbridge's Bay will be ready for operation in about three weeks' time. it is expected. There will be a staff of between eight and nine hundred men employed at the beginning, and when the plant has worked up to full capacity it will employ 6,000. A large number of the men are coming direct from the works in Wales and incidentally among these are included some who were in Moscow with the general manager of the plant here, Mr. Cound.

Bounty for Iron Industry.—The Hon. William Sloane, Minister of Mines for the Province of British Columbia, speaking about the possibility of an iron smelting industry in the Pacific Coast Province, pointed out that the present bounty offered by the Provincial Government would amount on a 300-ton plan to something like $1,000,000. He stated that Mr. Fleming, of the Canadian Collieries (Dunsmuir), was looking into the situation, as their company thought of entering into the industry. As to the claim that there would be no market for the product, Mr. Sloan thought there would be no difficulty on that score, as the Pacific Coast could be supplied at prices beyond the competition of eastern furnaces. In any case, he thought the Federal Government could be induced to build extensive car shops for the National Railways at one of the western terminals, which would absorb a large percentage of the output of a 300-ton furnace.

Herbert Johnson, of the Armstrong Whitworth Company of Canada, has been appointed general superintendent of the plant at Longueuil. Lawrence Russell, the general manager, will be in charge of the sales.

Have Bought Factory.—The Dominion Cone Company have sold their factory at 14 Morrow Avenue to Tarbox Bros., specialty manufacturers. The building is of two storey brick, with a basement, the total floor space being 12,500 square feet. The frontage is 40 feet The deal was closed through Robins, Ltd.

Brantford City Engineer.—Mr. Frank Adams, city engineer of Chatham, has been appointed city engineer of Brantford, at a salary of $3,600 for the present year, and $4,000 for next year. Mr. Adams is an old Brantford boy, and well acquainted with the locality, and its special problems. He will take up his duties on September 15th next, succeeding the late Major Harry Jones.

ACCIDENT PREVENTION

Accidents and accident prevention in machine building are discussed in Bulletin No. 256 published by the United States Bureau of Labour Statistics. The booklet gives the result of an investigation to ascertain the frequency and severity of accidents in the machine-building industry, and to study and analyse these accidents in such a way as to supply the information necessary for effective safety work, To this end the report seeks, as far as possible, to locate the accident hazards in particular departments and occupations, to discover the reason and causes for the occurrence of accidents, and to point out some of the more successful methods for their prevention. The investigation was limited to certain selected plants representing the more important classes of product, and covered in all 194 plants. Accident rates are analysed for the industry as a whole, by character of products, and by departments. Inability to speak English as related to accidents, safety organization, direct safeguarding methods in machine building, and machine design as a factor of safety, are among the subjects discussed.

OPTICAL INSTRUMENTS

Optical equipment for the inspection of flat surfaces and the comparison of standards, is a line of tools now being placed on the market by the Van Keuren Company of Boston, Mass. By means of these instruments comparisons can be made to one-half a wave length of light, which for daylight is approximately 0.00001 inch. It is claimed that the working flats of the set will register an accuracy of 0.000005 inch and that of the master flat to within 0.00000025 inch. Full instructions are included with the instruments and the equipment is intended for shop use.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse	base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	10%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	15
Stove bolts	55
Wrought washers	25
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

Gross

METALS	Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

CONE PULLEY BELT SHIFTERS

Speaking on the above subject before the summer conference of the National Safety Council (Engineering Section), Mr. H. E. Somes, electrical engineer of the Chevrolet Motor Co., made the following statements:

At your last meeting, I volunteered to obtain time studies on mechanical belt shifters for cone pulley belts and on the hand method. After going through a number of large machine shops, I was very much surprised to find that, with the exception of an isolated instance, belt shifter devices for cone pulley belts were not used; and due to that fact, and also the short period of time left to investigate this subject, I have been unable as yet to obtain the time studies. One of our factory managers who has a successful belt shifter installed expressed it as his opinion that a green workman can shift cone pulley belts by means of the belt shifter as rapidly as an experienced workmen can shift them by hand —with the additional advantage that in doing so he is safeguarded from injury. However, in my investigations on this subject, I have been convinced of the fact that mechanical belt shifters can be developed that will shift belts on cone pulleys more rapidly than by means of the hand shifting method—much more safely and efficiently and without serious injury to the belt itself. Possibly such shifters have already been developed.

The problem, however, seems to be where should cone pulley belt shifters be required? Such a shifter has its maximum value when it is installed on a machine where belts are shifted many times per day. If a saving can be realized in the workman's time, due to an improved method of shifting belts and the machine itself has a greater capacity, these advantages will become more apparent as the number of belt changes increases. Usually the advantages become of lesser importance as the number of shiftings decreases.

I would submit, therefore, at this time that mechanical belt shifters for cone pulleys are particularly adapted to shop installations where frequent shiftings of the belts from one step cone to another is necessary. Among such installations we find the tool room, the maintenance or the repair shops, and many other types of manufacturing machine shops which can possibly be classified wherein belt shifting is a necessity.

Considering the modern manufacturing machine shop, such as the automobile manufacturing plant, we are struck at once by the fact that belt shifting is very uncommon, and in fact in many cases, if the manufacturer could obtain them, single purpose machines would be purchased.

In a shop of the type commonly called production machine shop, we find that an individual machine is tooled up for a single job, and that frequently this machine runs several years without having any change made in the method of manufacture or the speed of either feed or spindle.

Illustrating this point, I was in Flint, Mich., recently and went to our plant to see a screw machine which had been fitted with a mechanical belt shifter. I asked the operator what he thought of the shifter in question and how he found he could shift the belt by means of the shifter. He replied that he had been employed on that particular job for approximately eight months; he thought the belt shifter was very satisfactory, but that he never used it to shift belts with, excepting to satisfy himself that the shifter would work. This condition exists throughout that entire plant.

The field where the belt shifter would give greater service would undoubtedly be in a shop not engaged in production manufacturing, but rather where on account of the special nature of the different jobs, wide variations in the spindle speeds are necessary. This would also apply to drill press operations where the step cone pulleys are not on the machine itself and where one is exposed within twelve or eighteen inches of the floor. Drill presses, excepting where they are used over long periods of time on a single operation, require a large number of changes throughout the working day, owing to the different sizes of drills which may be used on an individual job.

While observing a belt shifter at Flint, several days ago, I noticed that it seemed to be very satisfactory in shifting from high to low; but in shifting from low to high speeds, I noted that the belt curled and that it was very difficult to make this shifting. The plant engineer advised me that the shifter had been thoroughly satisfactory until the belt became oil soaked from long use.

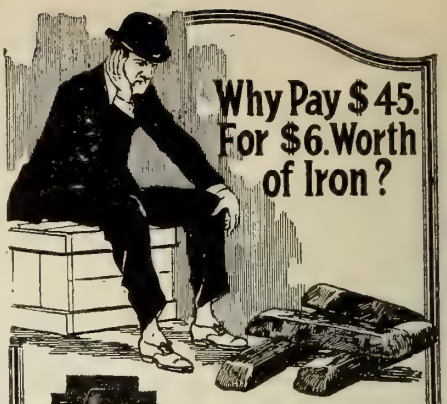
In order, however, that we may obtain accurate information as to the advantages of using mechanical belt shifters over the hand shifting method, and also in order that we may know definitely whether a satisfactory shifter has been developed, our company has arranged to conduct a test on several types of shifters. This test will be strictly impartial, and as a result, we hope to learn whether by using a mechanical shifter the belt is injured, and whether the shifters are satisfactory after the belt has become thoroughly oil soaked and very pliable.

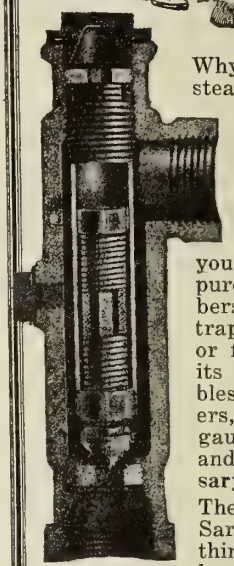
WANTED—CRANES and CUPOLA

Cranes—Two 40 ft. x 20 ton, 3-motor electric travelling cranes.

Cupola One modern grey iron cupola about 42 in. inside lining with fan and equipment.

Apply E. Leonard & Sons, Limited
London, Canada





Why pay $1.50, instead of 2¼c a pound for about 286 pounds of superfluous iron in a steam trap? That is literally what you do when you purchase a cumbersome steam trap of the bucket or float type, with its array of troublesome floats, levers, valves, water gauges, bowls, and other **unnecessary** parts.

The Steam Trap Sarco does everything that the larger, heavier and more complicated traps do. Yet, it has but one moving part and weighs about 6% as much.

STEAM TRAP SARCO

because of its simplicity and light weight, sells for about one-third the price of other makes.

A Sarco saves money in the purchase price as well as in installation cost, for it requires no platform building, no supports, no pit digging. Can be easily and quickly installed at any point on the line.

Let us send you a Sarco on 30 days' trial. If you are willing to part with it at the end of that time, send it back and the trial will cost you nothing.

Write for Booklet J-17 and full information.

SARCO CO., INC.
239 Broadway, New York

Buffalo Cleveland Philadelphia
Chicago Detroit Peacock Bros. Montreal

15 Sales Offices Backed by the 100% Standard of Quality

THE Canadian Fairbanks-Morse Company Limited reaches out to you through its sales houses and offers the service and satisfaction that is assured by its 100% standard of quality and service.

To be able to turn to an institution that dominates its field in the industrial world is to safeguard the character of the merchandise you buy. To deal with an organizationthat is doing business at your very door puts upon the man you know that "responsibility which is the conscience of business."

Every one of these 15 offices has been established to bring to you the full advantages and benefit that have made The Canadian Fairbanks-Morse Co. Limited a national institution. Here in these offices is offered everything mechanical that your business requires — they centralize your purchasing—group your orders—bulk your shipments and send but one invoice. And when you buy from The Canadian Fairbanks-Morse Co. Limited you are guaranteed the 100% standard of quality and service in product and organization.

Make our nearest office your buying centre—our catalogue is your buying guide —our 100% quality seal your guarantee.

The Canadian Fairbanks-Morse Co., Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal
Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg
Regina Saskatoon Calgary
Vancouver Victoria

2

WHY DO YOU ADVERTISE

When You Are Behind In Deliveries ?

THIS seems to be a very natural question, and the answer involves the discussion of a vital policy of this business—a policy that is fundamental.

If we were building a business for to-day our policy would vary from day to day with the temporary changes with which every business has to contend.

But we are building for the time to come and we hope that this business will become many times greater than it is to-day. Without the proper foundation it would undergo violent changes dependent upon temporary national, local or even imaginary conditions.

If we should permit ourselves to become inflated with self-confidence when business conditions are favorable, restricting our selling and advertising activities, and go down in the dumps when conditions are not so favorable, this business would not amount to any more than the existing conditions would make of it.

We say right now, without reservations, that we hope, regardless of how aggressive and efficient our manufacturing department may be, that it will never be able to catch up with our selling organization.

If our efforts should be halted in the middle of the road in times of liberal buying to wait on the manufacturing department, there might come a time when the manufacturing department would have to suspend operations while waiting on the sales organization.

With such a policy we would be running around in a circle, disorganizing one day and reorganizing the next.

The greater the demand for our product, the quicker the turnover for merchants; and the more frequent the turnovers, the larger is the volume of profit.

In this business advertising is a sales policy—the same as our policy of maintaining a sales organization—and we might as well consider the elimination of one as the other. Neither will be eliminated, as this business needs both if we are building for the future.

We hope the idea will never creep into this organization that there will be any let-up in aggressive methods, which might suggest that when business is good there is no occasion for work and when business is poor it is too hard to get.

We constantly have in mind that the American people are much more concerned in their own affairs than in ours, and if we should restrict our selling and advertising activities they will begin to forget us—and this would be our fault.

We are going ahead with the idea of increasing the present momentum in favor of our goods; and if conditions should turn face about, our dealers and ourselves will be in a better position to hurdle obstacles than if we originated a policy for each condition as it arose.

Reprinted from "GRAPHITE," a monthly magazine published by Joseph Dixon Crucible Co., Jersey City, N.J.

Gates Engineering Co.
Limited

MR. JOHN W. GATES wishes to announce the opening of the Gates Engineering Co., Limited. This new organization will be under the direct supervision of Mr. Gates, who is well known as an expert on boiler settings and furnace brickwork.

Consult us when you are about to make any changes on your boiler settings or furnaces. No jobs too large, none too small. Prompt service, quality work, insuring the maximum of efficiency.

Our engineers are at your service. Consult them freely on any problems—without obligation.

Head Office:

348 St. James St., Montreal

Experts

Specializing in Boiler and Furnace Brickwork

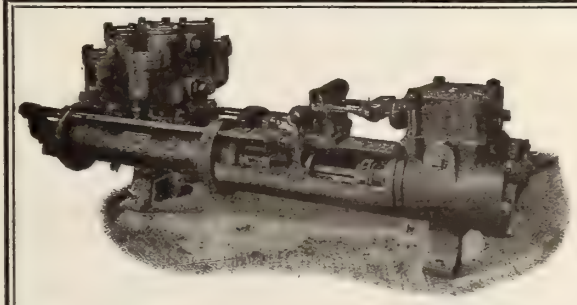
WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300



PUMPS

that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited

Hamilton, Canada

HINTS TO BUYERS

LANCO BALATA BELTING

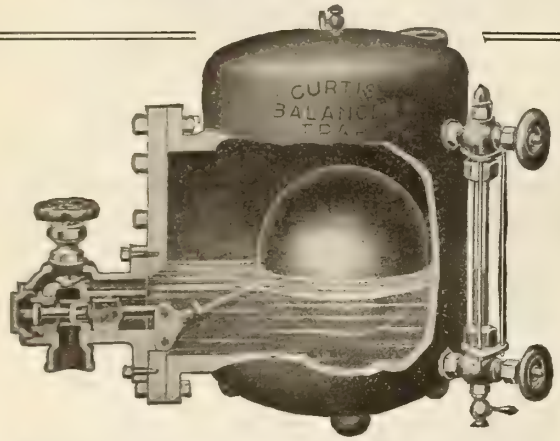
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties.
Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14 Mass.
Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings ***Forgings***
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. ***Write for our latest catalogue.***
Patterns ***Machine Work***

Head Fireman Wanted

Extensive experience on Taylor and other types of underfeed stokers. 7,000 horse-power plant. Give age, experience, reference and wages.

Box 72220

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR

Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers.. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

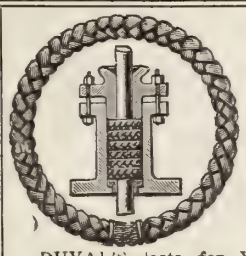
MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts. It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

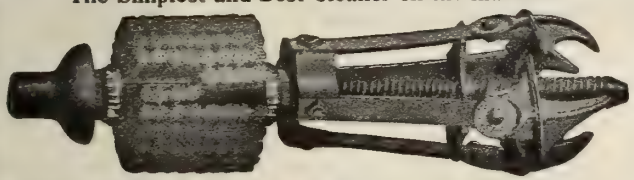
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

ECONOMIC Carling BLOWERS SUPERIOR

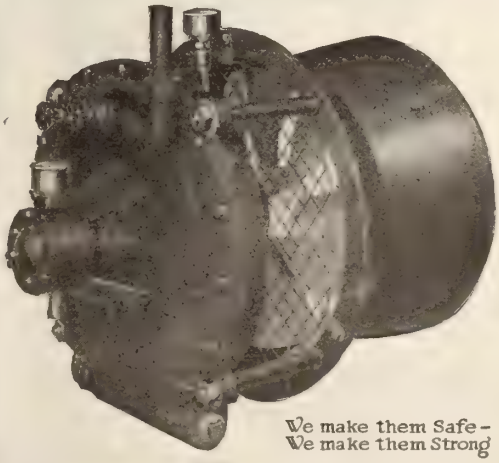
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

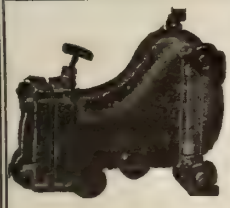
Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers **WORCESTER, MASS**
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong



McDANIEL IMPROVED STEAM TRAP

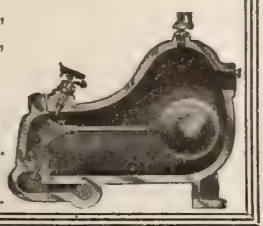
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

THE ANDERSON
MODEL "D" STEAM TRAP
Allows No Escape Of Live Steam.

The valve is always locked with at least three inches of water, thus the escape of live steam is rendered impossible.

The **Anderson** will lift water at any back pressure five pounds less than the pressure at the trap:

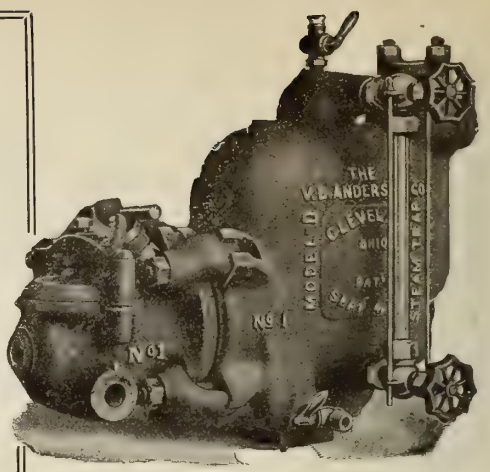
A strainer and sediment chamber prevents sediment and scale from getting into the valve.

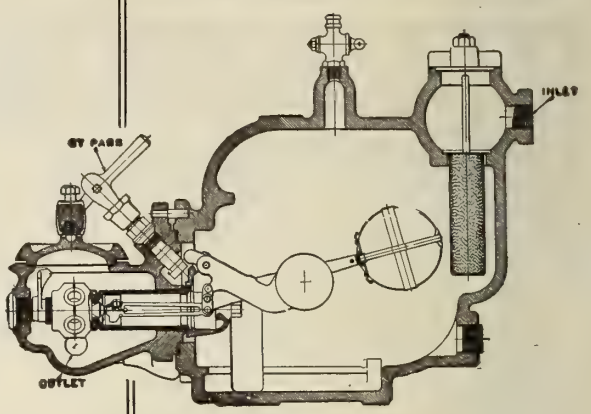
To ascertain whether the trap is working properly, a glance at the gauge glass, fitted to the trap, is sufficient.

The valve and valve seat can both be removed without breaking a steam joint or pipe connection.

The **Anderson Model "D" Steam Trap** is accurate in every detail. Built of materials best suited for the purpose. Every part interchangeable.

Full particulars of these and other points will be forwarded immediately upon receipt of your request.



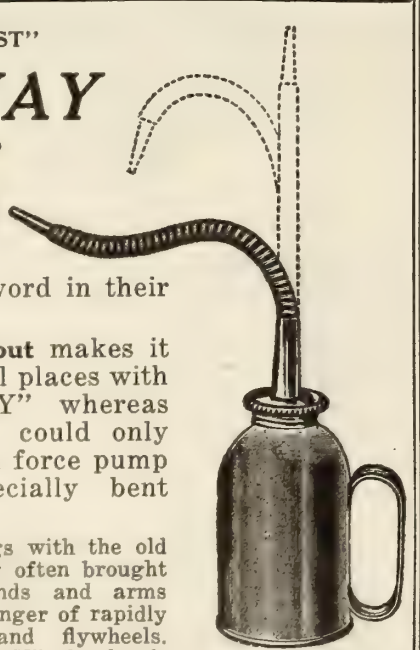


The V. D. Anderson & Company

1935 West 96th St., Cleveland, Ohio.

"SAFETY FIRST"

ALL-WAY
RAILROAD
OILERS



are the latest word in their line.

The **flexible spout** makes it possible to oil all places with one "ALL-WAY" whereas previously they could only be reached with force pump cans with specially bent spouts.

Lubricating bearings with the old straight spout oiler often brought the engineer's hands and arms very close to the danger of rapidly revolving gears and flywheels. With the "ALL-WAY" the bending of the spout removes this danger. Sizes No. 4, 1 pint—10 in. spout. No. 5, 1 quart—11 in. spout.

If your dealer cannot supply you write us.

We also manufacture the well-known "All-Way" Oil Can—saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS

BOILERS & TANKS, WATER FILTERS THERMOMETERS, GAUGES

E. J. Philip & Sons, Engineers, 57 Queen Street, West
Toronto, Canada

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S. MANNY Co
27 COTE St MONTREAL, QUE

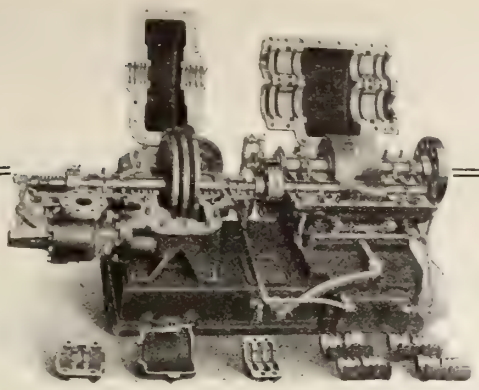
Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED
London Liverpool Cardiff, Etc.

Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
Stocks Carried in All Sizes TEL. No. MAIN 2387



The Design of Moore Steam Turbines Prevents Steam Leaks

Ample surfaces at the joints have been provided to prevent leakage of steam—also the number of vertical joints have been reduced to a minimum. In a turbine having numerous vertical joints it is almost impossible to prevent leakage and consequent loss of efficiency in operation.

The careful designing to prevent all steam leakage is but one feature of Moore Steam Turbines. Send for our booklet. It explains fully the others.

Moore Steam Turbine Corporation

Wellsville New York U.S.A.

HOMESTEAD VALVES

Positive-Acting Quarter-Turn Valves

Homesteads are "positive-acting" in each position. When open there is a straight, unobstructed flow. When closed they are positively tight. All Homesteads are constructed with the patented Homestead principle, which locks the valve tightly to the seat when closed.

One-quarter of a turn only is necessary to open and close Homestead Valves. Adopt them. You'll save time, trouble and expense.

Our catalog contains some interesting information.

Homestead Valve Mfg. Company

Homestead, Pa.

CRANE VALVES

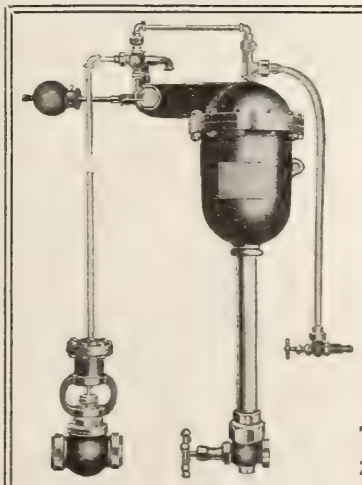
CRANE

LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST

MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices : Halifax, Quebec, Ottawa, Calgary



The Safe Way

Vigilant Water-Feed Regulators

There need be no worry on the part of you or your men in feeding boilers.

The "Vigilant" will automatically hold the water level at middle gauge—the safe, desirable point at which the boiler contains the maximum steam liberating surface.

Write for full particulars to-day?

The Chaplin-Fulton Mfg. Co
28-34 Penn Avenue, Pittsburgh, Penn.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of a advertising contract.

AIR COCKS
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

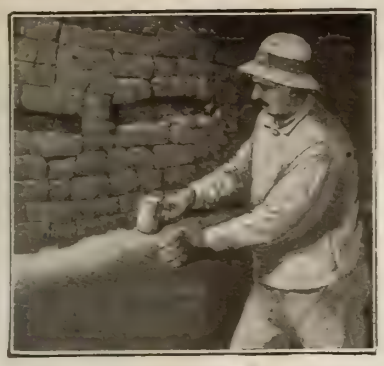
CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.



Showing ease with which Plibrico is laid in place.

PLIBRICO IS PLASTIC

and particularly adapted for Jointless, one-piece front-door arches, bridge walls, side walls, combustion chamber walls and baffles.

BETTER THAN FIRE BRICK

Can you see the advantage and economy?

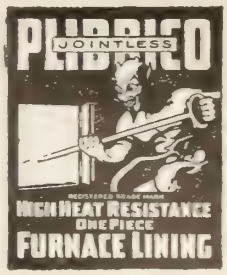
Write for book on furnace building

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.
Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.



Trade Mark
Reg. U.S. Pat Office

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

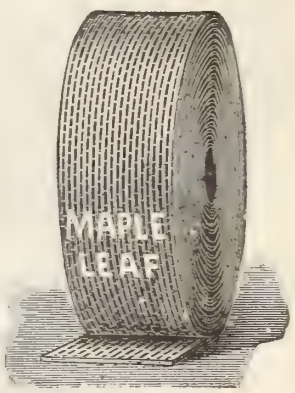
Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata; as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MAKINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

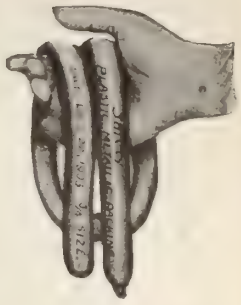
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

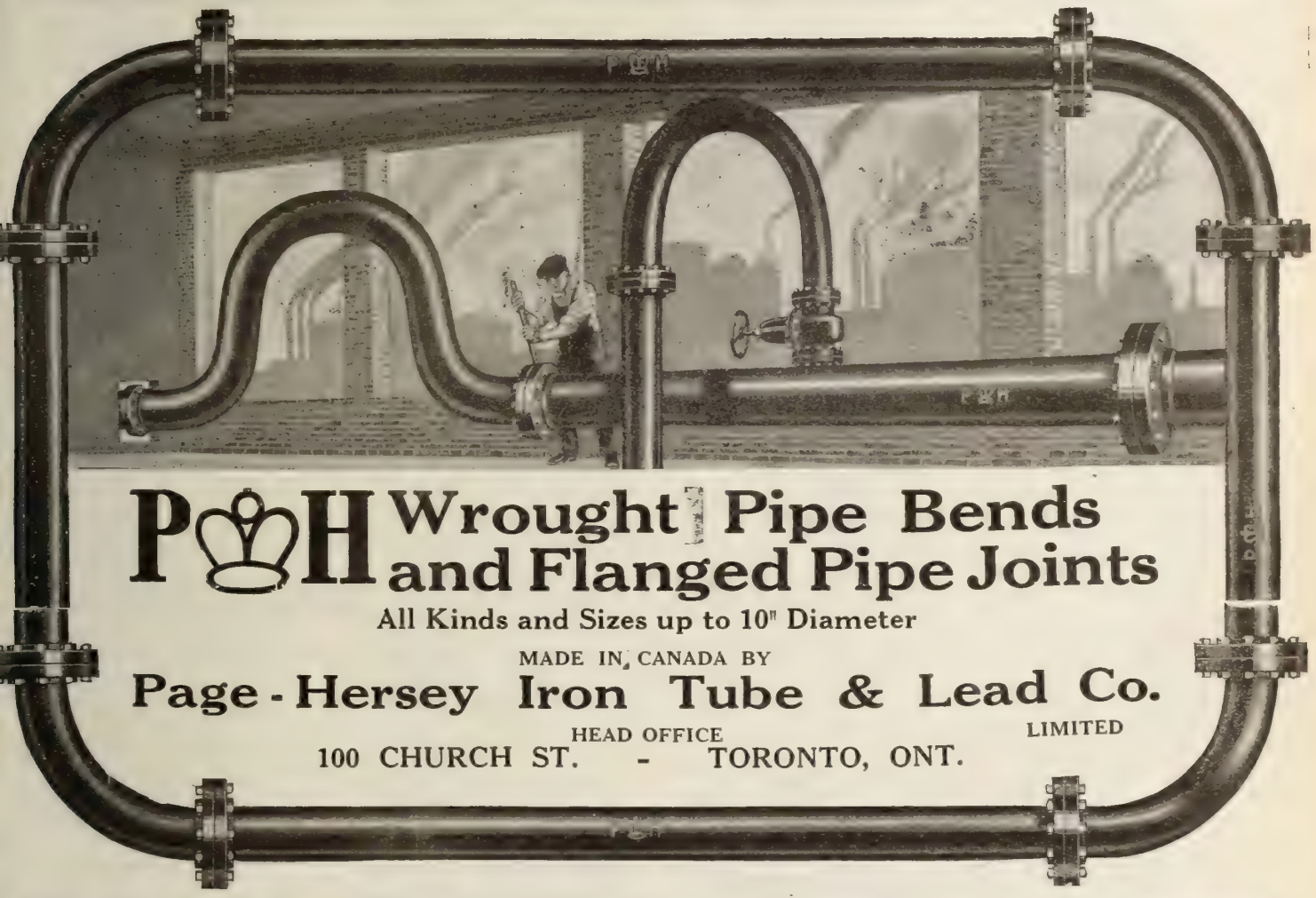
STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes



P&H Wrought Pipe Bends and Flanged Pipe Joints

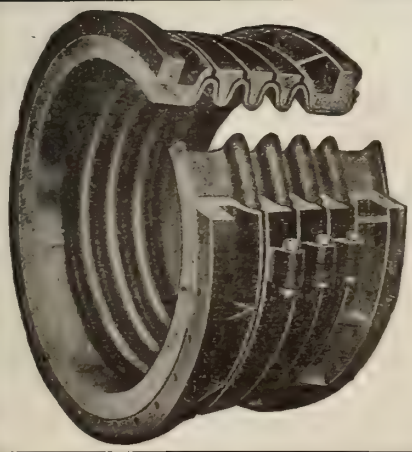
All Kinds and Sizes up to 10" Diameter

MADE IN CANADA BY

Page-Hersey Iron Tube & Lead Co. LIMITED

HEAD OFFICE

100 CHURCH ST. - TORONTO, ONT.



BADGER SERVICE

Badger Self Equalizing Expansion Joints will absolutely take care of changes of length in a pipe line, due to changes of temperature, and when once installed require no attention.

E. B. Badger & Sons Co.

101 Park Ave. New York

Pitts St., Boston

616 S. Michigan Ave. Chicago

Canadian Agents:

FRASER & CHALMERS OF CANADA, LIMITED, Beaver Hall Hill, Montreal, Canada

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Piller Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. I. Philip & Sons Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Manco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

ROBB

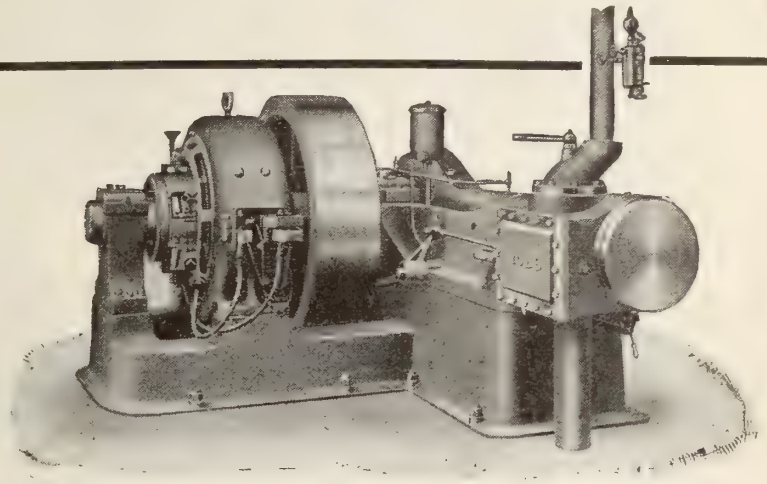
For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.

WATER TUBE BOILER

The Ladd Water Tube Boiler

is built in all sizes and for any of the many methods of firing—stoker, oil, gas, powered coal, etc.

Write our engineering department about your requirements.

Catalogue on request.

THE GEORGE T. LADD COMPANY

First National Bank Building, Pittsburgh, Pa.
Chicago Office: 528 McCormick Bldg.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Phillip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Phillip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Phillip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wallace & Tiernan Co., Inc., The, Montreal

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Heat Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can, Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd. Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd. Sarnia.
Valve Engineering Company.

The Green's Line Means 10% to 15% Off Your Coal Bill

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for

Type "E" Underfeed Stokers
Coxe Travelling Grate Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LTD.
TORONTO

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilsen Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

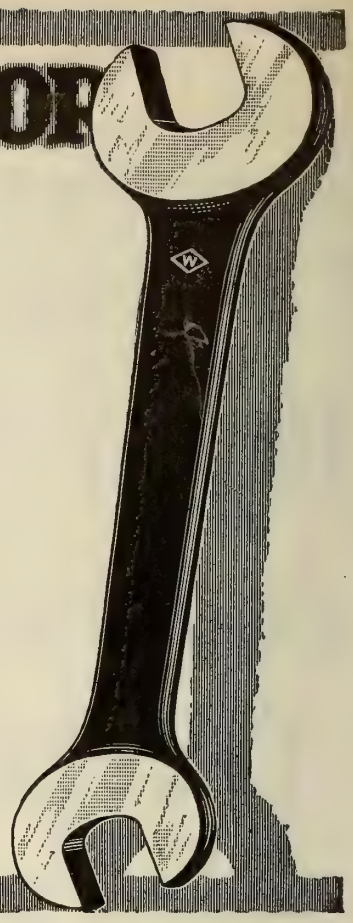
WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES



Better tools make better workmen—

And you can't buy a better wrench than a Williams'

J. H. WILLIAMS & CO.
"The Wrench People"

CHICAGO	BUFFALO	BROOKLYN
1078 W. 120th St.	78 Vulcan St.	78 Richards St.

INDEX TO ADVERTISERS

All-Way Oiler Manufacturing Co. 56
Anderson, The V. D. 56

Badger & Sons Co., E. B. 61
Betson Plastic Fire Brick Co. 16
Bishop & Co., S. C. 63
Busch-Sulzer Bros.—Diesel Engine Wks. 59

Can. Consolidated Rubber Co., Ltd. ... 7
Canadian Link-Belt Co., Ltd. 9
Can. Fairbanks-Morse Co. 51
Can. Mead-Morrison Co. 4
Carling Turbine Blower Co. 55
Chaplin-Fulton Manufacturing Co. ... 57
Cole, Limited, Geo. W. 8
Coppus Eng. and Equipment Co. 13
Crane, Limited 57

Darling Bros. 54
Dart Union Company ...Inside front cover
Department of Labor 55
D'Este Company, Julian 54
Dominion Belting Company 59
Durabla Manufacturing Company ... 12

Electric Welding Company, The 53
Eng. and Mach. Works of Canada, Ltd. 8
Federal Engineering Company 54

Gates Engineering Co. 53
Gates, W. W. 12
Gilman, Frank 63
Goldie & McCulloch Co. 22
Green's Economizer, Ltd. 67

Holden Co., Ltd., The 14
Homestead Valve Manufacturing Co... 57
Hoyt Metal Company 54

Imperial Oil Company 3

Jeffrey Manufacturing Co. 10
Jenkins Bros., Ltd. 21
Jointless Fire Brick Co. 59

Ladd Co., The George T. 63
Laurie & Lamb 55
Leitch Co., The Arthur S. 1
Leonard & Sons, E. 50
Lunkenheimer Company 6

Manny Co., The E. S. ..... 56 and 54
Mason Regulator and Engr. Co. 2
McLaren, D. K. ..... Inside back cover
Ministry of Munitions 65
Moore Steam Turbine Co. 57
Morrison Brass Manufacturing Co., Jas. Outside back cover
Murphy Iron Works 11

Norwalk Iron Works Company ..... Inside front cover

Page-Hersey Iron, Tube and Lead Co... 61
Penberthy Injector Co., Ltd. .. Front cover
Philip & Sons, E. J. 56
Pilley Packing and Flue Brush Mfg. Co. 55

Robb Engineering Works 63

Sanford-Riley Stoker Company 11
Sarco Company, Inc. 50
Scaife, Wm. B., & Sons Co. 68
Shell-Bar Boico Supply, Ltd. 15
Smart-Turner Mach. Co. 53
Starrett Co., L. S. 15
Steel Mill Packing Company 61
Sterling Engine Company 15

Tagliabue Company, C. J. 16
Taylor Instrument Company 53
Tuck & Co., Limited 56

Underfeed Stoker Co. of Can., Ltd., The 17, 18, 19 and 20
Uehling Instrument Co. 12

Victoria Foundry Company 54

Wall, J. W. 55
Watson & McDaniel Co. 55
Williams Co., J. H. 68
Worthington Pump and Mach. Co. 5
Why do you advertise? 52

York Manufacturing Company 11

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

D. K. McLaren Leather Belting

Belting trouble ends where D. K. McLaren's Belting begins

What Experienced Users Think of D. K. McLaren's Leather Belting is a Sure Guide as to What It Will Do For You!

Get in touch with some of these users. Write us; we'll gladly furnish you with some names and addresses.

No secret is made of the process by which McLaren Leather Belting is made. In fact we wish everyone to know the quality of each feature.

The Hide. The hides are cut from the **backs** of the choicest steers. The back is the strongest part and of even strength and elasticity throughout.

The Tanning. The genuine British Oak Tanning Process gives McLaren's Belting that mighty toughness. No better method is known for treating leather for belts.

The value of these two features is apparent the moment the belting is installed. Slipping reduced to a minimum, thus saving considerable power, and lack of stretch—these are the results.

GENUINE OAK

D·K·McLAREN LIMITED

HEAD OFFICE AND FACTORY:

351 ST. JAMES ST., MONTREAL, P.Q., CANADA

TORONTO, ONT.	ST. JOHN, N.B.	VANCOUVER, B. C.
194 King St. West	90 Germain St.	334 Cordova St. W.

MORRISON

Boiler Mountings

Steam Specialties

"Beaver" Globe Valve
Bronze

"Light gains make heavy purses."

There are many ways of securing such gains. The installation of Morrison Steam Specialties is one. They will not make any phenomenal leap in your profits. But, they offer an economical, care-free service which is well worth investigation.

Some of the Morrison Lines

Stop Valves	General Boiler	Vacuum Gauges
Check Valves	Mountings	Ammonia Gauges
Gate Valves	Injectors	Gauge Board Outfits
Safety Valves	Ejectors	Lubricators
Relief Valves	Inspirators	Pipe Fittings
Reducing Valves	Jet Pumps	Steam Whistles
Steam Traps	Steam Gauges	Engine Indicators
	Pipe, Tools, etc.	

Full particulars of these and the other Morrison products will be found in the Morrison catalog. Send for a copy.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 17. Publication Office, Toronto—Sept. 5, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

TRADE PENBERTHY MARK.

Strong where others are weak

The Increasing Demand for Penberthy Valves

is sure proof that they are giving better satisfaction than any other make of valve on the market.

A Penberthy Valve
is always worth the price you pay for it.

We Make :

The Compodisk Line (with the Renewable Disc)
Gov't. approved for 175 lbs. steam pressure.

The Regrinding Line (with the Metal Disc.)
Gov't. approved for 200 lbs. steam pressure.

Brass Gate Valves (with the solid Wedge Disc.)
Gov't. approved for 150 lbs. steam pressure.

USED BY THE BEST ENGINEERS THROUGHOUT CANADA

BE SURE THIS NAME IS ON THE VALVE YOU BUY

Stocked By Leading Jobbers

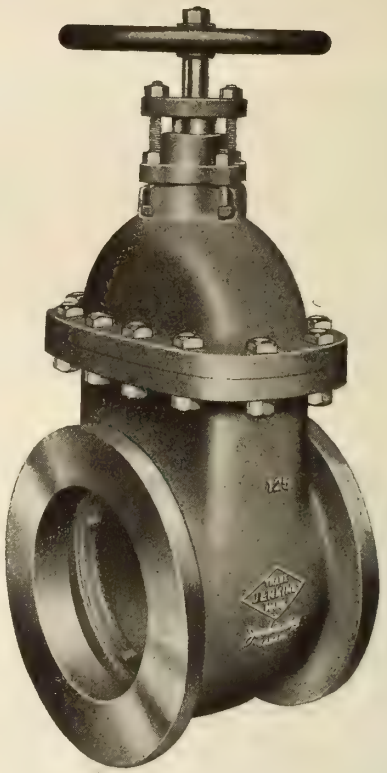
Manufactured by

Penberthy Injector Company, Limited - Windsor, Ont.

A DEPENDABLE VALVE FOR EVERY PURPOSE

The Valve Test That Safeguards A 56 Years' Reputation

We might well depend solely upon the care used in their designing and the high-grade materials from which they are made to maintain the high standard of value established by Jenkins Valves some 56 years ago.



—but that our enviable reputation may be preserved unimpaired we see to it that every valve bearing our well-known Diamond Trade-Mark is **thoroughly tested before leaving the plant.**

So that the valve purchaser who specifies Jenkins Valves is insured against the losses inherent with the cheap imitations of the genuine Jenkins, a host of which is now on the market.

Therefore—look for the Diamond Trade-Mark on the body of the valves you buy. It is your guarantee of long and satisfactory service, even where conditions of usage are more than ordinarily severe.

Stocks at all good dealers.
Write for Catalog No. 8.

TRADE JENKINS MARK

Jenkins Bros.
LIMITED

TRADE JENKINS MARK

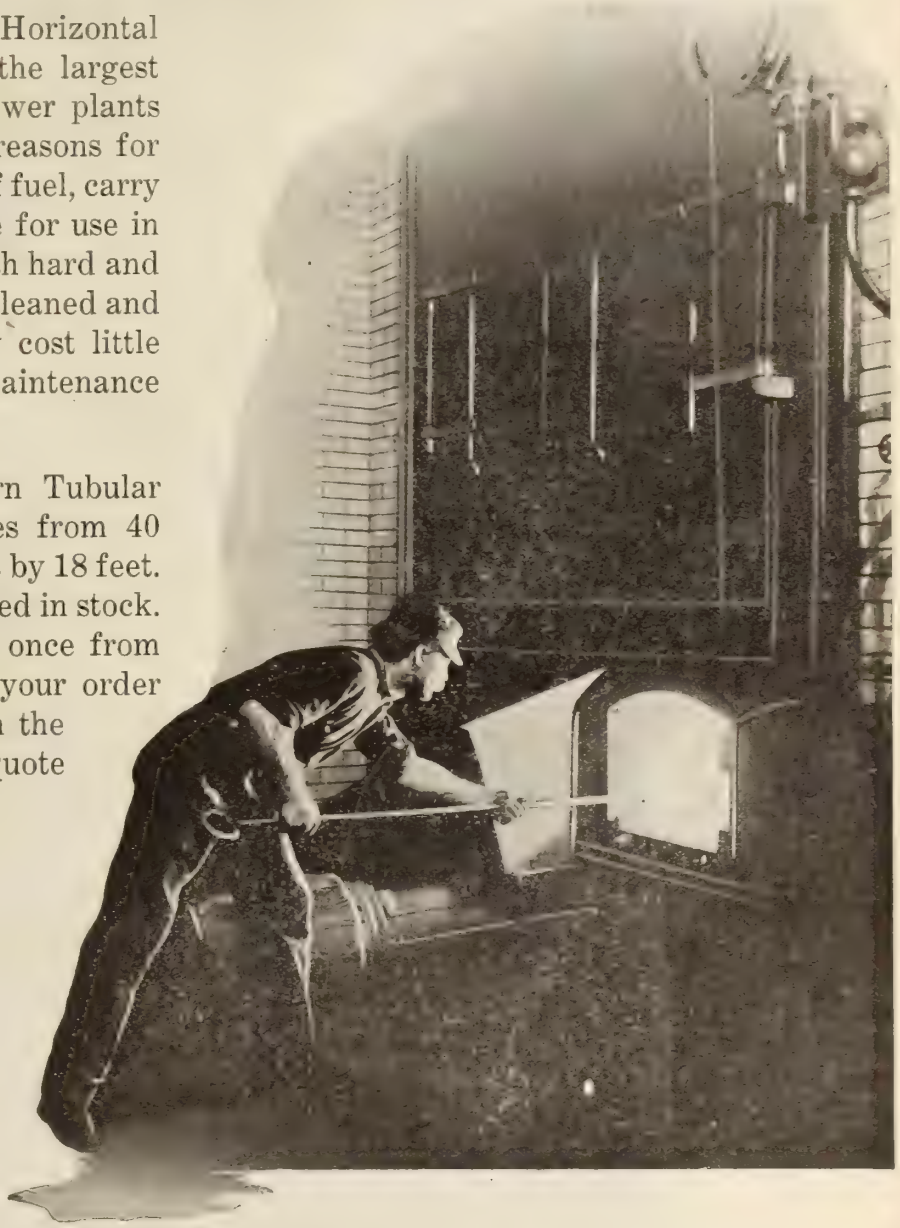
Head Office and Works: 103 St. Remi St. Montreal, can.
Jenkins Bros EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG. Jenkins Bros
Agencies in all the Principal Countries of the World

BOILERS

FOR POWER AND HEATING PURPOSES

You will find Waterous Horizontal Return Tubular Boilers in the largest industrial and municipal power plants in the country. There are reasons for this. They are economical of fuel, carry a big reserve steam pressure for use in emergencies, can be used with hard and dirty water, and are readily cleaned and easily taken care of. They cost little new; their upkeep and maintenance expense is negligible.

Waterous Horizontal Return Tubular Boilers are built in all sizes from 40 inches by 10 feet to 72 inches by 18 feet. Most standard sizes are carried in stock. If we cannot supply you at once from our yards we can turn out your order for you in quick time. On the next boiler you need let us quote you prices and delivery.



Boilers in Stock

1—54 x 14 Horizontal
2—60 x 14 "
4—66 x 16 "
14—72 x 18 "
2—40 H. P. Locomotive

Waterous

BRANTFORD, ONTARIO, CANADA

POWER HOUSE. September 5, 1920. Vol. XIII., No. 17. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

A Simple Thoroughly Tested Vacuum Pump

Every Nash Hytor Vacuum Pump is carefully tested as to capacity, vacuum and horsepower before it leaves the factory. These pumps are manufactured on the limit system, with Johansson measuring blocks as a reference. Interchangeability of all parts is assured.

Nash Hytor Vacuum Pumps have only one moving part—the rotor, and it is supported on a very heavy, carefully proportioned shaft. All valves, sliding vanes, pistons, gears, crank shafts, cams and rubbing surfaces are eliminated.

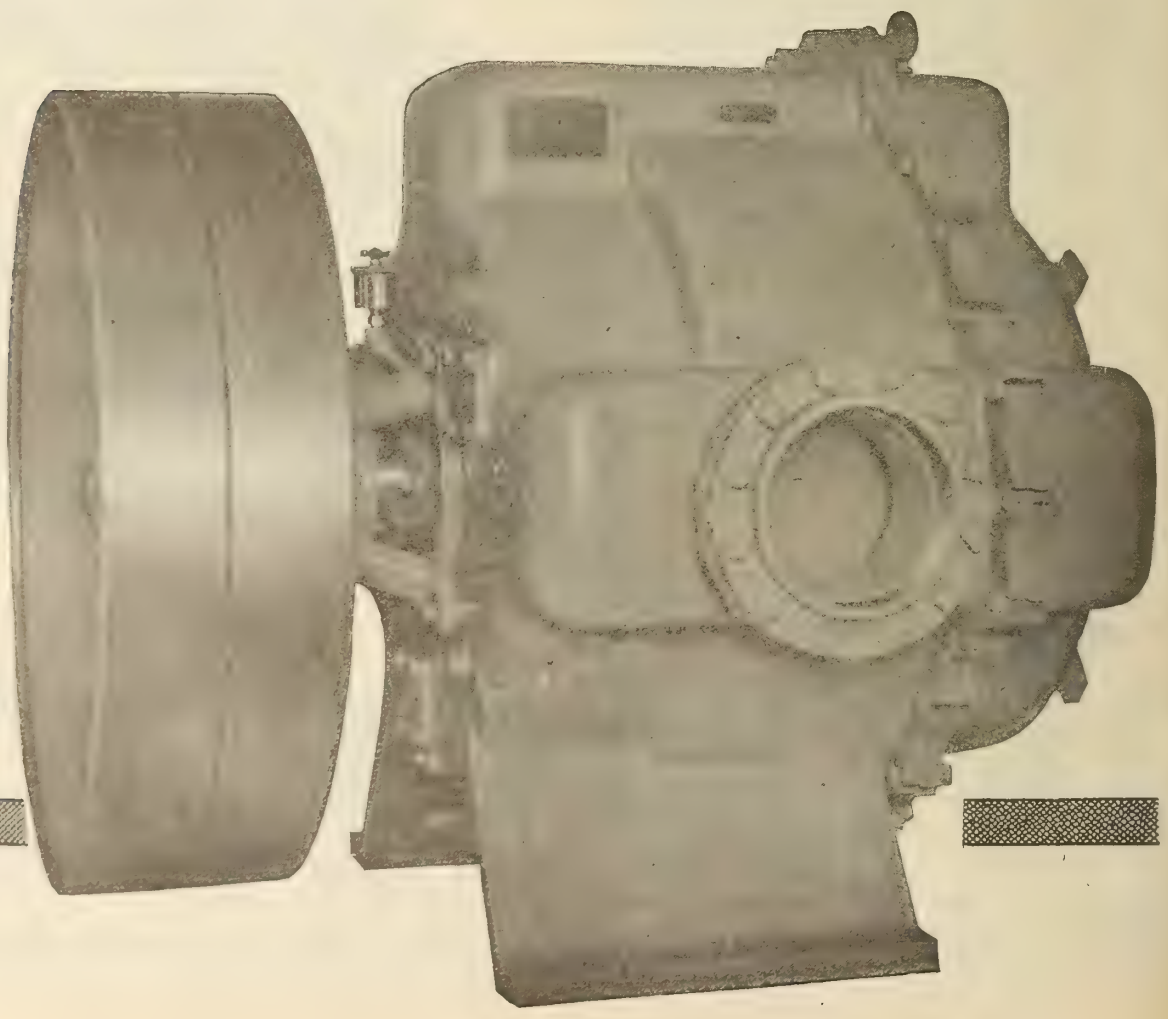
The fact that the Nash Hytor Pumps are in extensive use in many of the largest engineering plants is evidence of their superiority.

If you are interested in learning more about the many valuable features of these pumps, write us. **Send for Bulletin No. 11.**

The
Arthur S. Leitch Co.
1001-2 Kent Building
TORONTO - ONT.

Nash Hytor

Vacuum Pump for Air or Gas

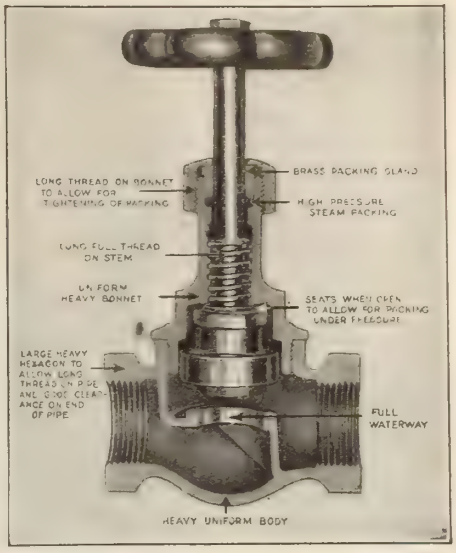


Size No. 7, capacity 1,350 cubic feet per minute at a vacuum of 12 in. mercury.

"EMCO" Hydraulic Tested

When installing new equipment or overhauling your present plant put in the best valve — "Emco." Note its nine "better" points. "Emco" is made of the choicest Bronze Metal. It is thoroughly Hydraulic Tested for a working pressure of 175 pounds. Its design is approved and registered throughout Canada by Inspectors of Steam Boilers.

You buy the best when you select "EMCO" A-840


LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
BRASS PACKING GLAND
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREADS ON PIPE AND GIVE CLEARANCE ON END OF PIPE
FULL WATERWAY
HEAVY UNIFORM BODY

Cross Section "EMCO" A-840

"EMCO"

(An Empire Product)

This superior valve is registered in the Provinces of Canada as follows:—

Globe Valve A-840

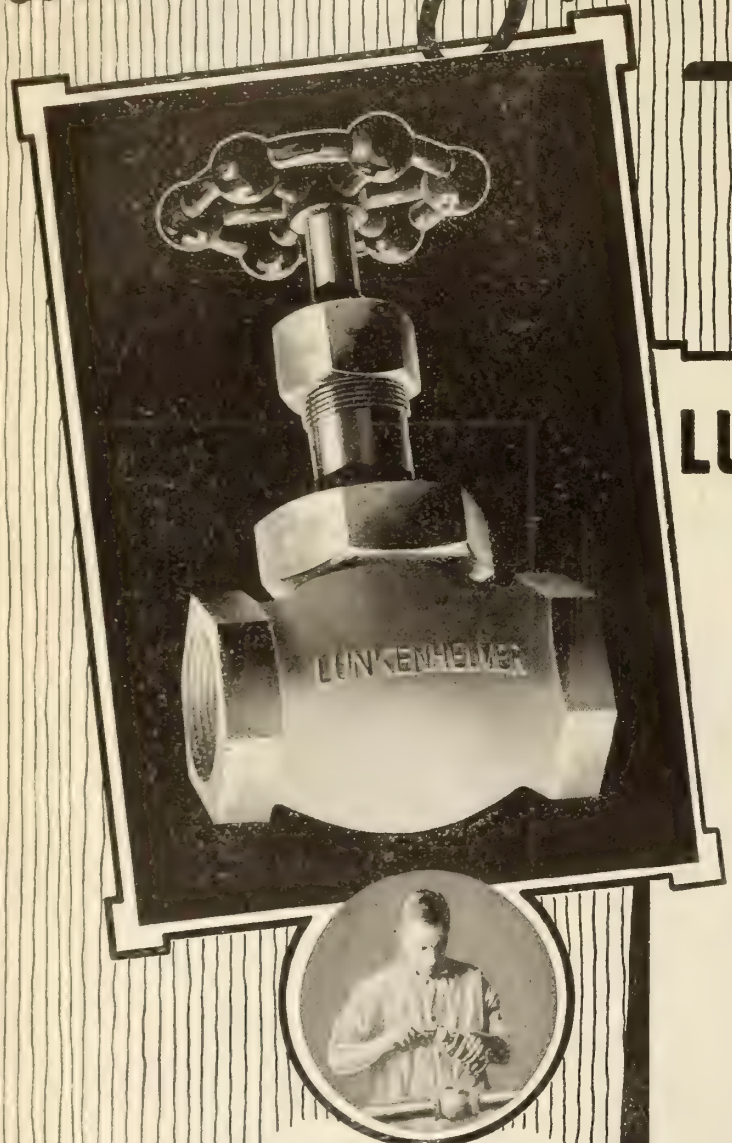
British Columbia	No. 2590
Alberta	No. 1102
Saskatchewan	No. 2356
Ontario	No. 1755

When buying specify our lines. They are carried in stock by the larger and more progressive jobbers in Canada.

EMPIRE MANUFACTURING CO., LIMITED

LONDON and TORONTO, CANADA

Superiority—unfailing performance—service



The original Regrinding Valve

AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862

LUNKENHEIMER REGRINDING VALVES

have firmly established their unparalleled merit by the successful results they have given through many years of satisfactory service.

The metal to metal seat—ground to a tight fit, forms the ideal seating surface to resist the wearing action of steam at high velocity. And the fact that the seating surfaces can be reground (an inexpensive operation easily accomplished) makes the renewal of parts wholly unnecessary.

Their extreme durability due to correctly proportioned parts, high quality materials and expert workmanship insures economy in maintenance.

Globe, Angle and Cross Valves with Inside Screw and with Outside Screw and Yoke; and Horizontal, Angle, Vertical and Swing-Check Valves for 200 and 300 pounds working steam pressure.

Specify **Lunkenheimer** and insist on their installation. Distributors of Lunkenheimer Products situated in every commercial centre.

Write for descriptive booklet No. 517—DC

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI

New York Chicago Boston London

L

1-21-43

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

All intermediate grades of babbitts have the same fatal defect of low fusibility, as indicated below by figures of test made by the American Society for Testing Materials, and these figures apply as well to any composition that can be made within these limits:

Tin per cent.	Antimony per cent.	Lead per cent.	Copper per cent.	Melting point
78	12	10	3	365° "
65	15	18	2	365° "
20	15	63½	1½	365° "

The melting point of these quaternary alloys is lower than those of binary or trinary alloys.

It is a common occurrence for technically educated men, holding high positions in railroad and commercial concerns, to adopt and publish as their standards, babbitt alloys of these low melting points. Very likely certain tests were undertaken before a decision was made, or they may have taken the word of some alleged expert, but the fact remains, nevertheless, that either Genuine Babbitt or the right grade of lead base babbitt would have given better and more economical service than these other mixtures, and this they could have discovered had they made the proper comparative tests and carried them to a definite determination.

In cases where thin, loose shell bearings are used and malleability is paramount to all other considerations, the use of Genuine is warranted; but in all other cases where the lining is anchored to the shell by recesses or soldering, a good lead base metal will give, by far, the best service, and this also applies to many patterns of bushings.

(Continued Next Month)

For copy of complete article :
"New Truths and Old Fallacies"
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.
Office and Factory :
Montreal : 225 St. Ambroise St.

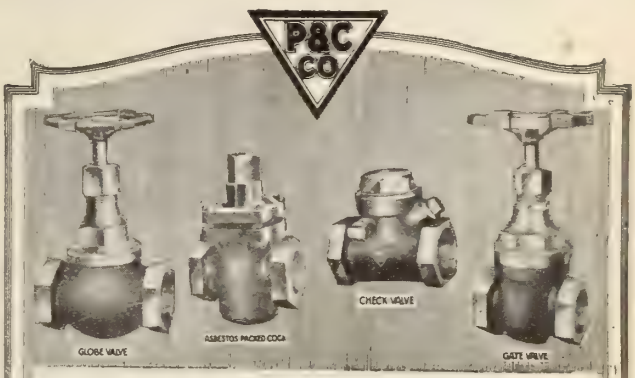
BOSS!

Exactly! From the floor, without the aid of a ladder or other risky prop the **Babbitt Adjustable Sprocket Rim With Chain Guide** easily, quickly and safely controls every movement of every overhead out-of-reach-valve.
You need this practical, low-cost, easy-to-attach (5 minute) valve-controlling device.

Get Bulletin!

Babbitt Steam Specialty Co.
NEW BEDFORD, MASS.
Western Distributors:
Jenkins Bros., 300 W. Lake St., Chicago, Ill.
Canadian Agents:
Engineering Specialties Co., Ltd., Toronto, Ont., Can.

Babbitt



Pratt & Cady Valves Built For Lasting Service

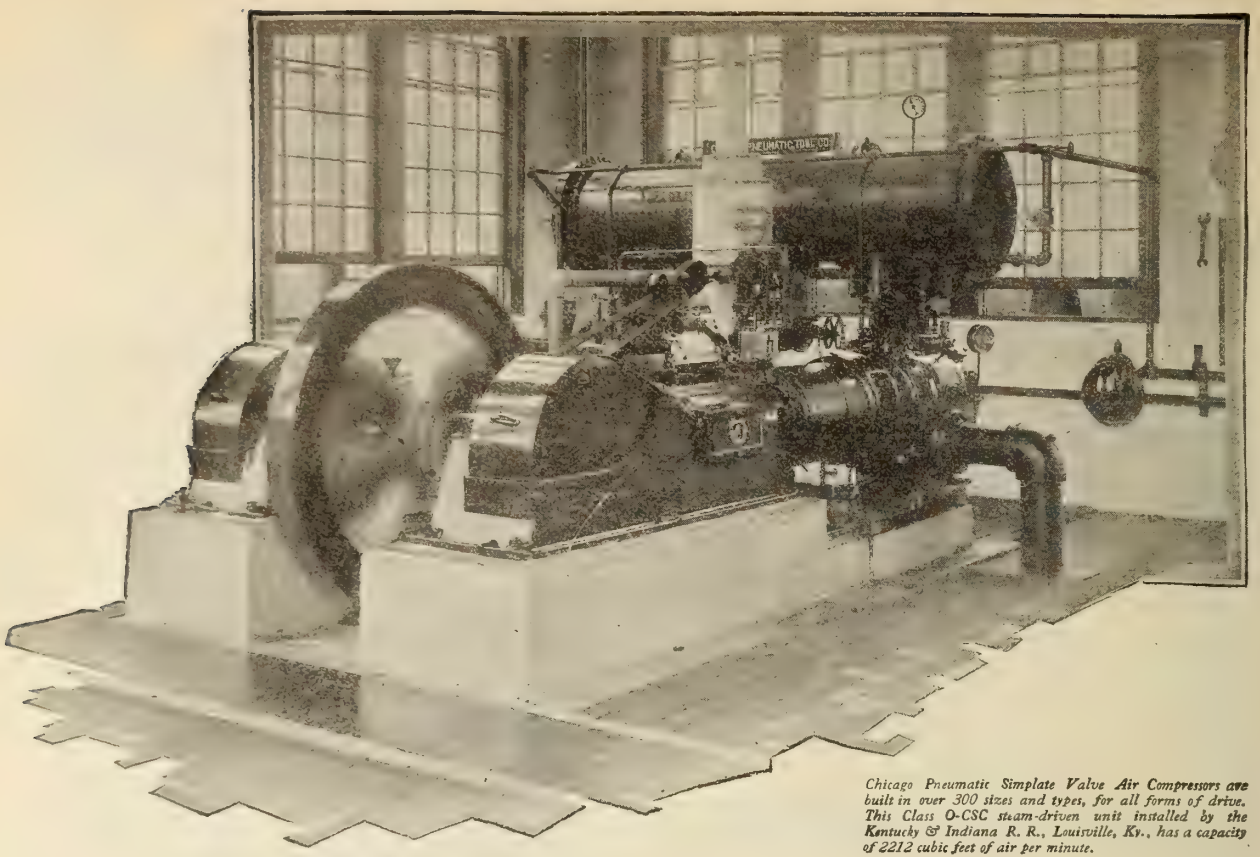
Almost half a century ago we started to build valves in a little shop that would seem insignificant to-day. But though our quarters were small our ideas were big. Also our ideals.
Correct design, high grade materials, conscientious workmanship—these were the slogans of our early days. As the result of adherence to our ideals we often come across a Pratt & Cady valve that has been in service for an amazing stretch of time—practically as good as new.
Throughout the long years there has been no drop in our standards. In 1920, just the same as a generation ago, the P & C Trade Mark is your assurance of the right goods that stands for lasting service.

Write for booklet

BOSTON CHICAGO CLEVELAND DETROIT HARTFORD

PRATT & CADY CO., INC.

NEW YORK PHILADELPHIA PITTSBURGH ROCHESTER SAN FRANCISCO



Chicago Pneumatic Simplate Valve Air Compressors are built in over 300 sizes and types, for all forms of drive. This Class O-CSC steam-driven unit installed by the Kentucky & Indiana R. R., Louisville, Ky., has a capacity of 2212 cubic feet of air per minute.

Another way in which Chicago Pneumatics save power

FROM no-load to full-load, Chicago Pneumatic Air Compressors economize power.

Under all load conditions the cylinder ratio of stage machines is unchanged. This insures highest power economy under variable air demands.

Under no load the inlet valves are automatically held open, permitting free passage of air.

Chicago Pneumatics thus save power over those compressors using a "choked intake" with its resultant losses.

Bulletin 400 tells about this and other Chicago Pneumatic economy features. May we send your copy?

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

H-69-O

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES · ROCK DRILLS · COAL DRILLS

CHICAGO PNEUMATIC

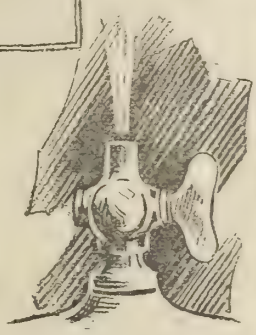
The Compressor with the Simplate Valve

Pet Cocks and Steam Traps

WHEN used as indicators of how a steam trap is operating pet cocks are all right. But, as outlets for air and steam, pet cocks often waste more than the actual cost of the steam trap.

Johns-Manville Steam Traps discharge air through their discharge outlet as well as water and without the loss of steam.

1. *Pet cock discharges water: —indicates that trap is not operating properly due to overload or obstruction.*



2. *Pet cock discharges air: —indicates trap is full of air, which if not discharged will air-bind trap and system.*

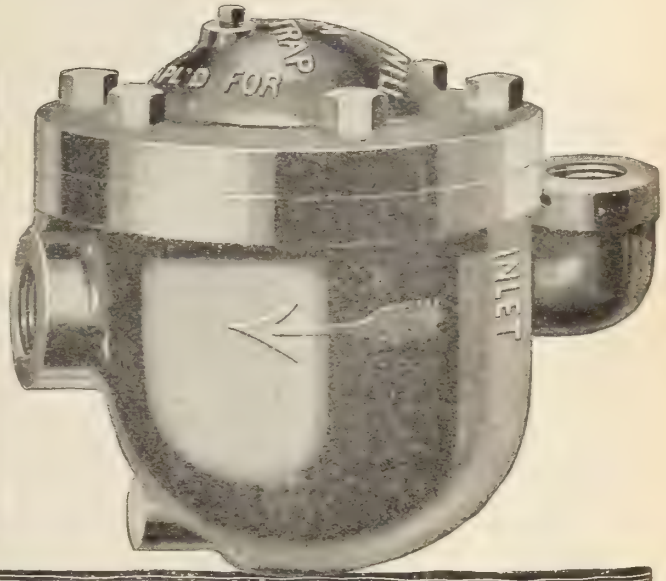
3. *Pet cock discharges steam:—indicates trap is properly discharging all air and water and that system is clear.*

A little leak that costs a lot

This partially open pet cock is an inefficient remedy for "trap air binding"—it provides an outlet for air which the trap will not discharge, but allows steam to continually leak out and be wasted.

Note—At 100 lbs. pressure a round hole only 1/32" in diameter will allow about 40,800 lbs. of steam to escape every year—an approximate waste of $19 00 worth of coal.

The Johns-Manville Steam Trap



CANADIAN JOHNS - MANVILLE CO., LIMITED

Toronto Montreal Winnipeg
Vancouver London Hamilton
Ottawa Windsor

JOHNS MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE

POWER PLANT MATERIALS

For Outside Drives—
KLINGTITE—an All-Weather Belt

The service given on outside drives by Goodyear Klingtite Belting (formerly Extra Power) is unusual enough to be of interest to every belt user.

Not because there are a great number of outside drives—but because the outside drive is just about the ultimate test of a belt's ability.

The specially designed fabric of Goodyear Belting gives it the strength to withstand brutal outside service.

But the best of cotton will rot and whip to pieces outdoors if not protected.

So we have forced generous quantities of high-grade rubber through and through the plies of Goodyear Klingtite Belting, forming one solid unit, proof against weather and ply separation, yet flexible, pulley-hugging, efficient.

The special friction surface on Goodyear Klingtite Belts (formerly Extra Power) grips through dust or moisture and prevents slipping.

How well these belts serve is evidenced by this letter from the Beaver River Lumber Co. regarding their Extra Power Belt (now Klingtite). At last report (June, 1920) *this belt was still in service after 32 months' use,* when this mill was burned recently.

In their letter the Beaver River Lumber Co. say: "The belt driving the conveyor runs direct from a small engine to the conveyor drive. It is subject to steam and heat in the engine room and to cold and dampness on the outside. Under these conditions, there is no sign of deterioration and there is no slippage."

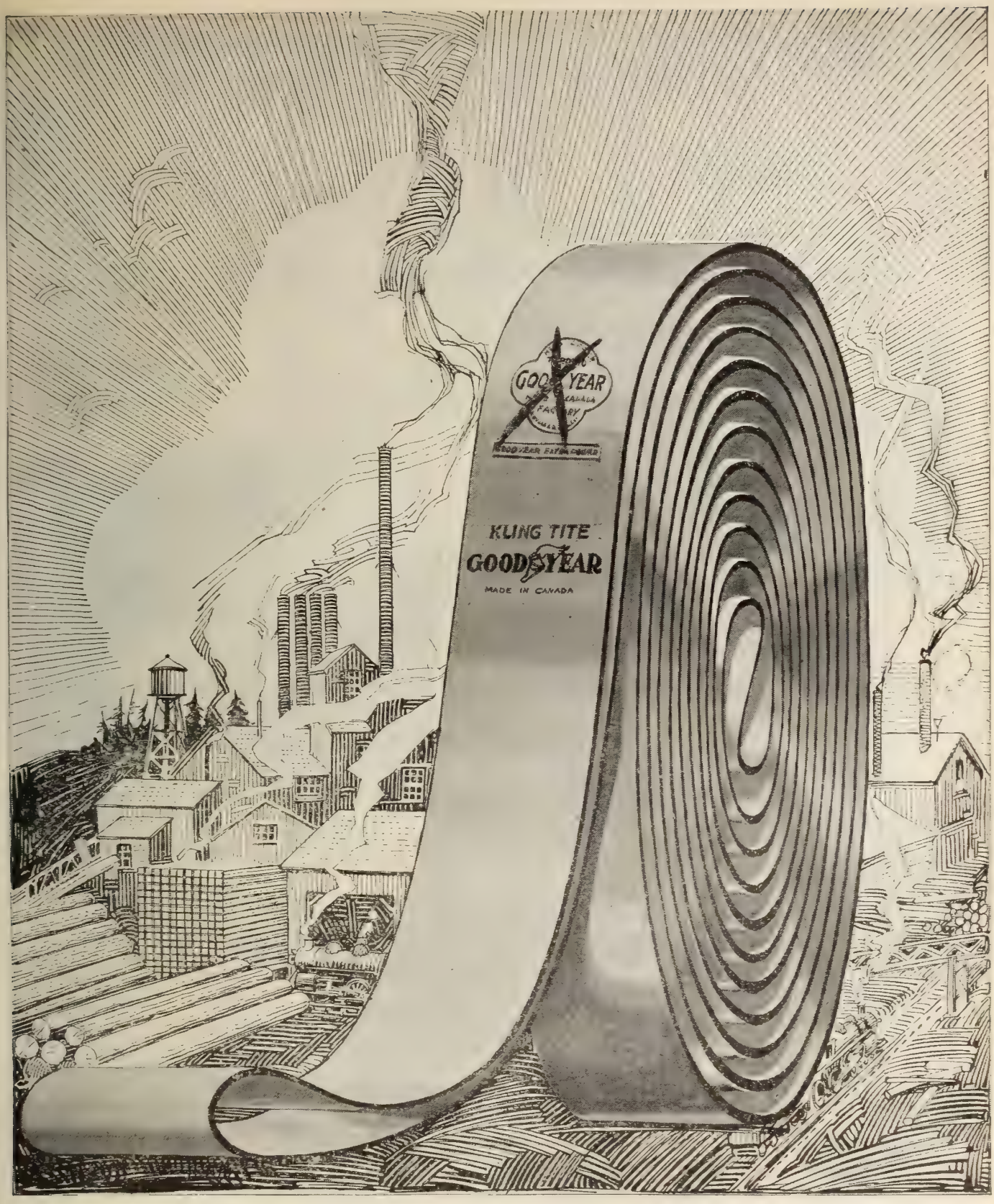
The same testimony is advanced by hundreds of farmers and threshermen who bought Goodyear Klingtite Belts (under their old name of Extra Power) for severe outside service on the farm.

If you have an outside drive, by all means investigate Goodyear Klingtite Belts. If you have *any* transmission drive, let a Goodyear Belting man show you how Goodyear Belts, which are good enough for outside service, will render heaping value on inside work. Phone, wire or write the nearest Goodyear Branch and a man will call without obligation to you.

The Goodyear Tire & Rubber Co. of Canada, Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Saskatoon, Regina, Calgary, Edmonton, Vancouver.

KLINGTITE BELT



GOODYEAR

MADE IN CANADA

LINDE

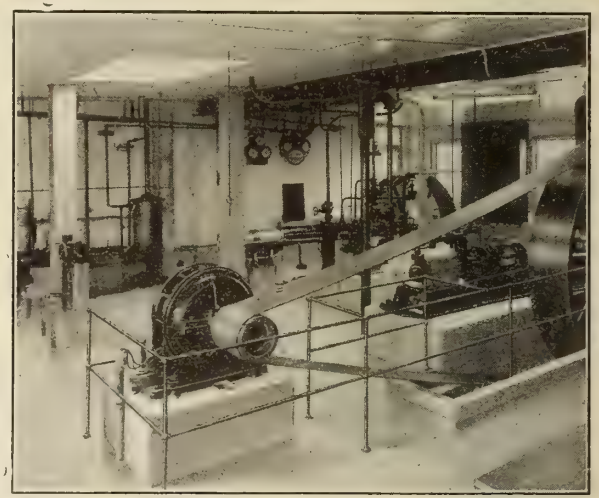
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

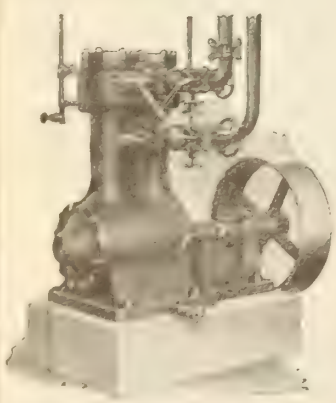


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

"Taking a Chance" Is Speculation— Not Business

YOU do not have to speculate when you buy insulation. The facts are all available and will be furnished you —the records of Nonpareil Corkboard for 20 years.

Get the facts—or better still, investigate for yourself any installation of Nonpareil Corkboard, preferably an old one. Find out whether it is still holding temperatures as well as when new. Is it wet? Has it decayed? Has it any odor? Do the owners feel that they got their money's worth and more? Then go after other insulating materials the same way. Compare results and decide on a business basis—with all the facts.

Ice storage, New State Ice Company, Oklahoma City, Oklahoma, insulated with mastic finish Nonpareil Corkboard.

Nonpareil Corkboard meets every insulation requirement and has been doing it for years. It is a known quantity. You can be *certain* of what it is and what to expect of it. "Why take a chance?"

To get the truth of insulating problems, write for "Nonpariel Corkboard Insulation," a book of real facts, which will be sent without charge on receipt of your request.

ARMSTRONG CORK & INSULATION COMPANY, 504 McGILL BUILDING, MONTREAL, QUEBEC, CANADA

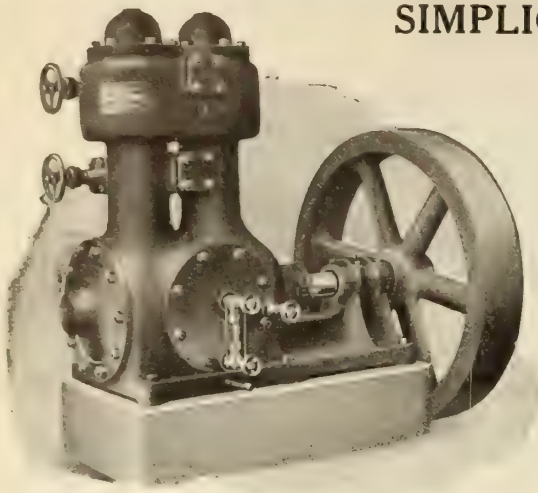
Also manufacturers of Nonpareil Cork Covering for cold pipes; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings; Nonpareil Cork Machinery Insulation for deadening the noise of machinery; Circle A Cork Brick for cold storage room floors; and Linotile for office floors, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permit them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

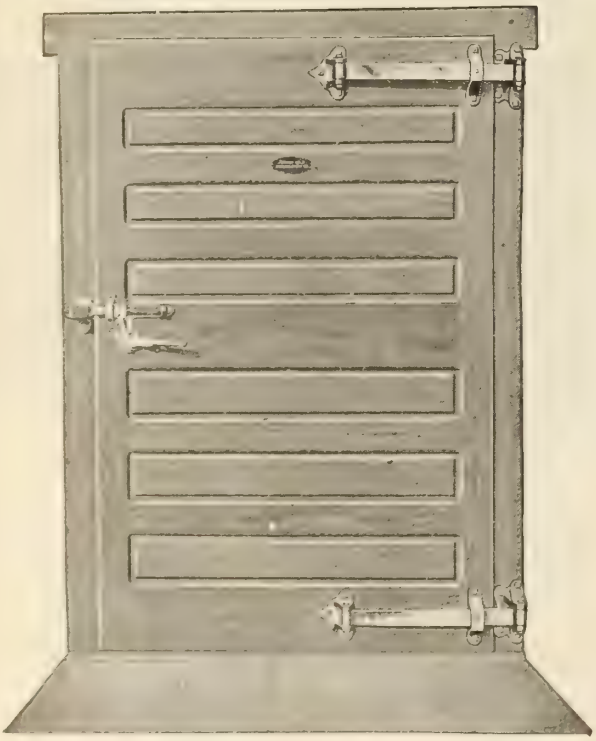
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

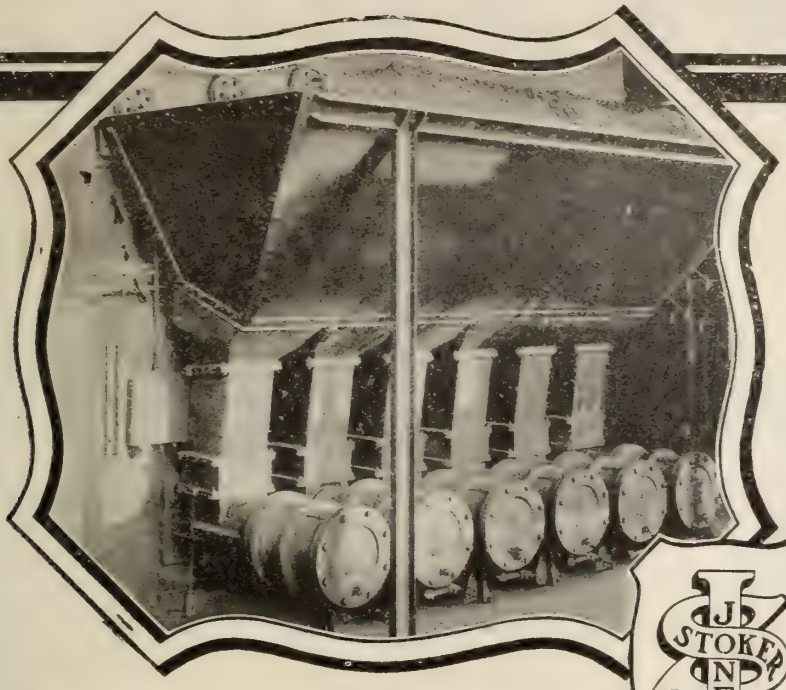
"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

Jones "A-C" (Automatic-Cleaning) Stoker



Interior and exterior of new power house equipped with Jones "A-C" Stokers.

Saves Coal

—The Big Item in Present-Day Production Costs

The Jones "A-C" is a high-duty stoker, not only in name, but in service. It will operate more efficiently and cost less per ton of coal burned because it fulfills a rigid set of requirements met by no other mechanical stoker.

Overload Capacity—Operated at highest boiler capacity for indefinite periods.

Fuel Economy—The under-feed principle of combustion (originated by this company) insures highest efficiency with any grade of coal. The automatic control of fuel and air, the automatic cleaning feature and the mechanical movement of the fuel bed are factors which combine to insure greatest economy of fuel.

Continuous Operation—The rugged simplicity means little or no shut-downs for repairs—lowest maintenance. Prevention of clinker formations on side walls and "automatic-cleaning" eliminates cleaning of fires which, in most stokers, causes slumps in boiler capacity.

Lowest Labor Costs—Operation is so completely automatic that one man can easily tend several boilers.

The extensive "A-C" catalog explains the many economic advantages of installing a real high-duty stoker.

The Under-Feed Stoker Co.
of Canada, Ltd.
81 Victoria St. Toronto

THE STOWE STOKER

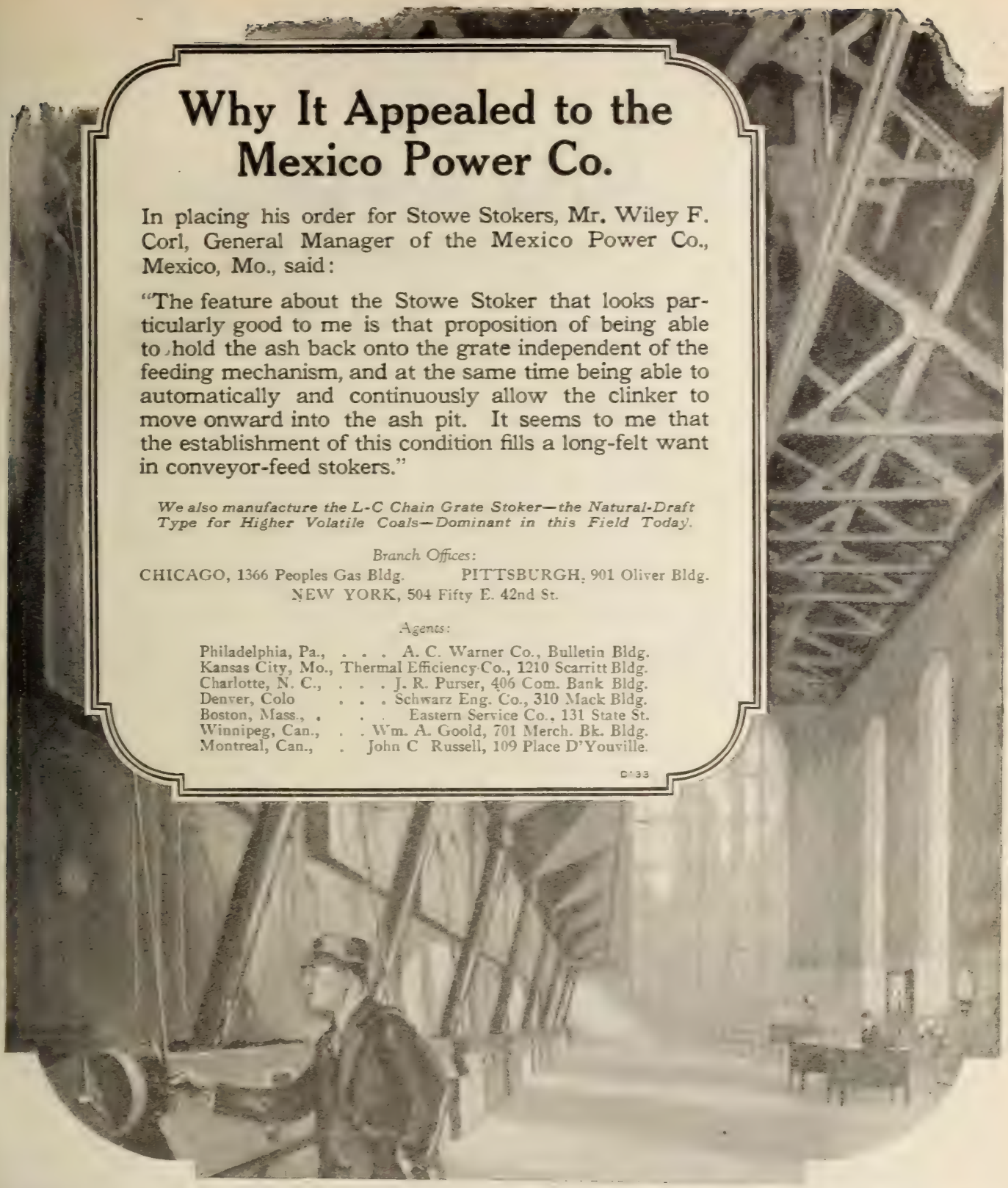
EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor-feed, positive in action from coal-hopper to ash-pit.

MEXICO POWER CO., MEXICO, MO.

LACLEDE

A BUSINESS INSTITUTION



Why It Appealed to the Mexico Power Co.

In placing his order for Stowe Stokers, Mr. Wiley F. Corl, General Manager of the Mexico Power Co., Mexico, Mo., said:

"The feature about the Stowe Stoker that looks particularly good to me is that proposition of being able to hold the ash back onto the grate independent of the feeding mechanism, and at the same time being able to automatically and continuously allow the clinker to move onward into the ash pit. It seems to me that the establishment of this condition fills a long-felt want in conveyor-feed stokers."

We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices:

CHICAGO, 1366 Peoples Gas Bldg. PITTSBURGH, 901 Oliver Bldg.
NEW YORK, 504 Fifty E. 42nd St.

Agents:

Philadelphia, Pa., . . . A. C. Warner Co., Bulletin Bldg.
Kansas City, Mo., Thermal Efficiency Co., 1210 Scarritt Bldg.
Charlotte, N. C., . . . J. R. Purser, 406 Com. Bank Bldg.
Denver, Colo . . . Schwarz Eng. Co., 310 Mack Bldg.
Boston, Mass., . . . Eastern Service Co., 131 State St.
Winnipeg, Can., . . Wm. A. Goold, 701 Merch. Bk. Bldg.
Montreal, Can., . John C Russell, 109 Place D'Youville.

D-33

CHRISTY

FOUNDED 1844 ST. LOUIS

Dependable Power Plant Equipment

We have the sole manufacturing rights in Canada for REES RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Jet Vacuum Pumps.

REES RoTURBo

Single and Multi-Stage

Centrifugal Pumps

REES RoTURBo Pumps give permanently efficient service on a wide range of duties. The low velocity of the water through all passages results in almost complete freedom from wear, even when gritty water is being pumped. Being self-regulating, the prime mover is insured against overloading.
The many other advantages of the Rees RoTURBo Patent Pressure Chamber pump are explained in detail in Catalog, a copy of which, along with the advice of expert Engineers, are yours for the asking.

The Goldie & McCulloch Co., Limited

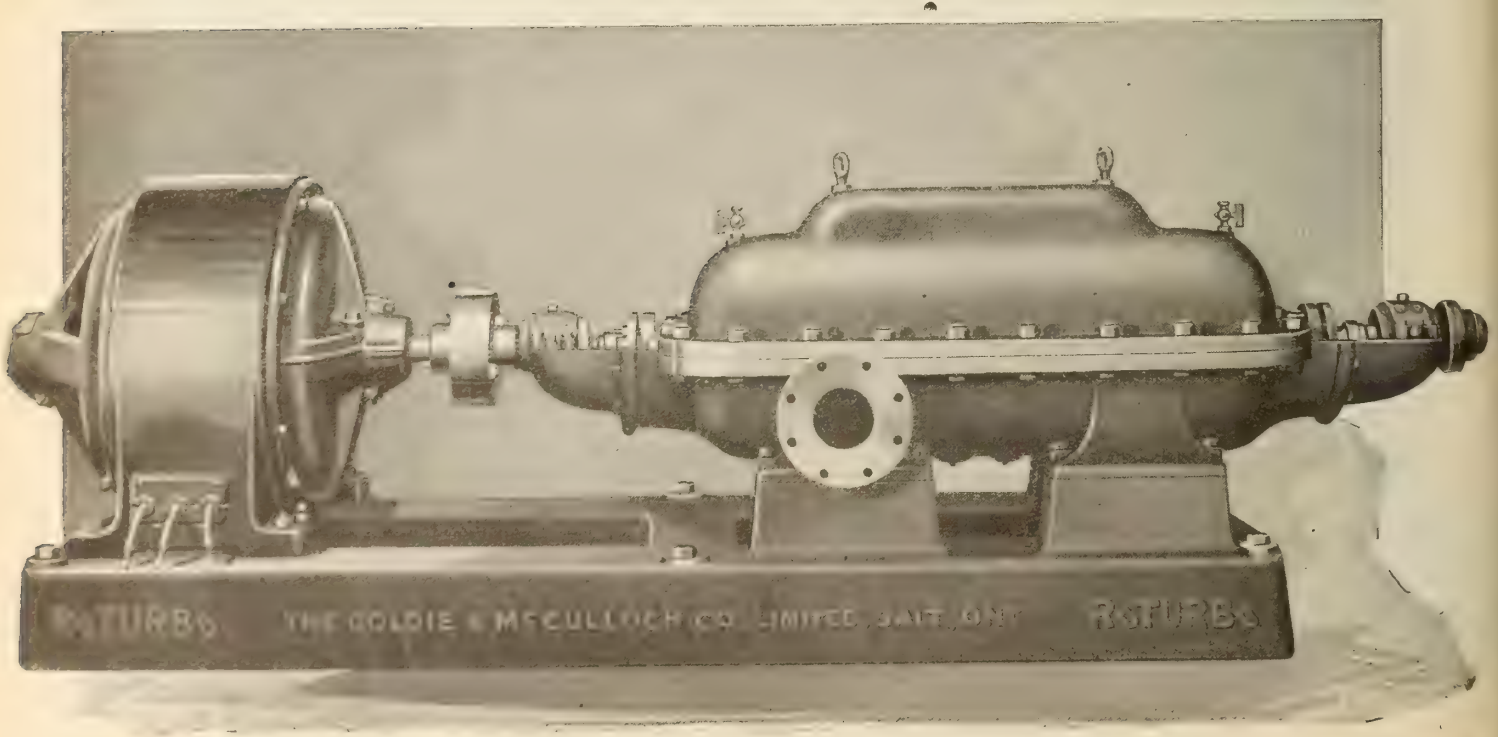
Head Office and Works: GALT, Ontario, Canada

Toronto Office:
Suite 1101-2 Bank of Hamilton Bldg.

Western Branch:
248 McDermott Ave., Winnipeg, Man.

Quebec Agents:
Ross & Greig, 469 St. James St., Montreal, Que.

British Columbia Agents:
Robt. Hamilton & Co., Vancouver, B.C.



POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Series of Articles on Power Plant Management

This Article Deals with Boiler Feed Water Heaters, the Merits of the Open and Closed Types Being Compared.

By ROBERT JUNE

THE gradual development in the use of pulverized coal in this country had its inception some thirty years ago in the application of this type of fuel to the production of cement. From cement furnaces its use gradually spread to metallurgical furnaces. Marked economies have been effected by its use in these fields, with the result that it is now being successfully applied to a great many types of furnaces, such as forging, continuous heating, busheling, puddling, and open hearth.

It is estimated that ten million tons of coal are burned in the United States annually in this manner. Its use, therefore, is not new, nor is its equipment in an undeveloped state.

This fact is of considerable importance in considering one of the newer aspects of the use of pulverized coal—that is, its application to steam boilers. The problem has been principally that of adapting processes and equipment, already well developed, to the peculiar needs of the boiler room. The incentive has been that of lowering the cost of power production. Owing to factors which will be discussed, the problem of lowering the cost of power production by means of pulverizing coal has not proven readily capable of solution. Power costs have been lowered in a great many cases, and the increasing cost of coal, together with the opportunities which pulverizing offers to use lower grades of coal, makes its wider application in the power field a certain event of the future.

Possibilities of Burning Lower Grade Coals

Practically any coal can be burned in pulverized form with a proper furnace and burner equipment. This means that coals from which very inefficient results have heretofore been obtained, can be brought within the reach of a great many consumers. For instance: the Western country from Texas to Alberta is underlaid with various grades of lignites, low grades of mineral coals with high moisture content, fuels of such a nature that the ash would melt or flow down on the grates if burned in the usual manner. The nature of these coals is such that they do not behave satisfactorily as gas producers. Consequently pulverizing offers unusual opportunities to burn these coals efficiently.

The following analyses are typical of these low-grade Western coals which may be burned in pulverized form:

Kind of coal	Fixed Carbon	Volatile	Ash	Moisture	B.t.u.
Mineral	45.22	26.39	20.38	8.01	10,940
McAlester ..	47.07	32.37	14.29	6.27	11,837
Lehigh	41.40	31.28	19.29	8.03	11,200
Lignite	25.50	33.95	7.58	32.97	7,548

The sulphur, separately determined, ranged from approximately 3 to 5 per cent. in the various soft coals.

There are, around the average steel mill, large quantities of waste fuel such as coke breeze. This fuel is being used to a certain extent on some forms of grates, with forced draft, but it can be burned to very much greater advantage in pulverized form. Another possible use for this method of combustion is in the anthracite field, where there are large quantities of coal in the form of dust and fine particles which accumulate as a result of washing and crushing operations, and which are then pumped back into the mines to fill up the old workings.

We do well to refer to the possibilities of burning low-grade coals in order to emphasize the wide application of the pulverizing process, but you must remember that its application is not necessarily limited to low-grade coals, but that there is a very real possibility that the process can be used advantageously in competition with stokers for high-grade coals.

What is Pulverized Coal?

Pulverized coal is not coal ground to powder. Pulverized coal, to be considered as such, must be properly dried, crushed, and pulverized so that the product contains a very high percentage of impalpable powder. To be satisfactorily burned by this process the coal must be ground so fine that at least 95 per cent. will pass through a 100-mesh screen, that is, a screen having 10,000 openings to the square inch, and at least 85 per cent. must pass through a 200-mesh screen, that is, a screen having 40,000 openings to the square inch.

The finer the coal is pulverized the more effectively will it be diffused when mixed with the air for combustion, and the higher will be its efficiency in the furnace.

When a cubic inch of coal is pulverized so that 95 per cent. passes through a 100-mesh screen, we have divided it into some 200,000,000 particles. Our original cubic inch of coal has a superficial area of 6 square inches, whereas the combined areas of this multitude of small particles is approximately 30 square feet, an increase of 700 times in exposed area. It is this exposed surface which permits perfect and instantaneous combustion.

Advantages and Disadvantages

Among the advantages of pulverized coal are the following:

1. Permits much wider variation in the quality of coal. The adaptability of stokers is limited. A stoker designed for one grade coal will not handle all other grades effectively. Pulverizing is of considerable advantage, therefore, where there are frequent variations in the grades of coal, or where much coal of low quality is encountered.

2. The pulverizing system is very flexible, permitting of very rapid increases of load. In this characteristic, pulverized coal resembles oil and natural gas.

3. Standby losses can be very materially reduced. By taking the load off the boiler, shutting off the fuel, and closing up the furnace, a condition of incandescence can be maintained with the boiler pressure practically up to normal, for a period of hours. By throwing a switch, the entire firing operation can be stopped, an advantage in case of accident or emergency.

4. In stokers the amount of coal that can be burned per square foot of grate area is limited, so that for increased capacity the boiler setting must be spread out to cover greater area. In using pulverized coal this condition does not exist, for proper furnace conditions can be obtained by increasing the height

5. Ash is easily handled. Being in the form of a dust or slag, it is readily removed. This fact makes it easy to

maintain constant furnace temperatures as there is no interference with firing conditions on account of cleaning fires.

6. There is no trouble with clinkering on the grates.

7. Pulverized coal as fired contains less than 1 per cent. of moisture, whereas with ordinary methods of firing, coal may contain from 1 to 10 per cent. of moisture.

8. Considerably less excess air is required for combustion. This is a point of the greatest importance. In this respect pulverized coal compares with fuel oil. The less excess air we have, the smaller volume of mechanical draft required, and the smaller the stack losses.

Among the disadvantages of pulverized coal are:

1. Cost of preparation.
2. Explosibility of coal dust.
3. Limitations of storage.
4. Depreciation of furnace linings
5. Discharge of large amounts of refuse through chimney.

Pulverized Fuel Equipment

A pulverizing plant consists of the following principal units: crusher, crushed coal dryer, pulverizer, storage and conveying apparatus, and burners. The size of the plant will determine the number of each of these various units to be employed.

In a typical installation the coal is dumped by gravity into a track hopper from which it is taken by a belt conveyor to a hopper located above the coal crusher. Magnetic separator pulleys are located between the track hopper and the crusher hopper to remove scrap metal, such as bolts, pick points, etc. After being crushed to about 1 in. in diameter the coal drops to an elevator pit, from whence it is taken by the elevator to the dryer storage bin.

The coal dryer is cylindrical in form, being rotated by a small motor, or by a pulley from a line shaft. It is usually heated by hand firing on grates. It must necessarily be of such a size to deliver the entire quantity of coal, thoroughly dried, for continuous operation of the power plant.

From the dryer the coal again falls into an elevator pit, from whence it is carried to the pulverizer hopper. In this process it is again carried over a magnetic separator pulley to remove any small pieces of metal which may not have been caught by the first magnet. By stops and gates the coal is fed to the pulverizer, which grinds it to the required fineness. From the pulverizer the coal is conveyed by screw conveyor or air pressure to the storage bins. The capacity of these bins must be determined with reference to the service required, bearing in mind that provision must be made for periods when the pulverizers may be out of commission.

Crushing Rolls

There are a number of good standard makes of crusher rolls on the market. That illustrated herewith is the Jeffrey (Fig. 1). The rolls are equipped with [illegible] springs and breaking shells are provided which permit them to separate under excessive strain. The crushing surface consists of segmental toothed or corrugated sections secured to a hexagonal drum, so that broken or worn-out sections can be replaced without renewing the entire roll.

Coal Dryer

Fig. 2 illustrates the Fuller-Lehigh indirect firing rotary coal dryer, which consists of an axially inclined cylindrical shell fitted with suitable rollers and

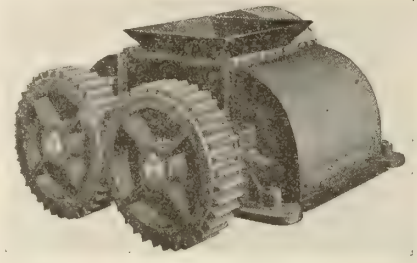


FIG. 1—COAL CRUSHER.

gearing to permit the shell being rotated on its longitudinal axis. The higher end of the dryer shell terminates in a brick housing which serves to support the stack required to discharge the waste products of combustion of the dryer furnace, and the vapor given off by the moist coal being dried. The lower end of the shell terminates in a steel hood. The furnace for heating the dryer is placed between the stack chamber and the hood. This furnace may be provided with one or two fireplaces, depending upon the size of the dryer. The furnace is provided with a large combustion chamber through which the dryer shell passes. The entire furnace is built of brick and the walls are securely bound together by means of buckstays and tie rods.

The moist coal is fed into the dryer shell through a feed spout located in the stack chamber. This spout enters the dryer shell and delivers the coal close to the bottom of the shell. A series of longitudinal shelves fastened to the inside of the dryer shell lifts the coal and drops it through the current of heated air passing through the inside of the dryer shell. Inasmuch as the revolving shell of the dryer is slightly inclined downward toward the discharge end, the coal travels the entire length of the shell and is finally discharged, perfectly dried, from the lower end of the dryer shell.

The hot gases from the furnace fire circulate around the outside of the dryer shell, passing through the combustion chamber of the furnace. They then leave the combustion chamber through the horizontal breeching and enter the top of the hood at the lower end of the dryer. From this hood the hot gases flow to the interior of the dryer shell, and come in direct contact with the coal in the dryer shell. After they pass through the interior of the dryer shell the hot gases enter the stack chamber at the upper end of the dryer and then escape to the atmosphere through the stack.

The Pulverizer

Pulverizing mills may be either the ball or the roller type. In the ball type illustrated herewith (Fig. 3) the material to be reduced is fed to the mill from an overhead bin by means of a screw feeder. The feeder is driven from the mill shaft by a belt running on a pair of three-step cones, thus permitting the operator to regulate the amount of material entering the pulverizer. The pulverizing elements consist of four large steel balls, rolling in a stationary, horizontal, concave, grinding ring. Material discharged by the feeder rails between the ball and the grinding ring in a uniform and continuous stream, and is reduced to the required fineness in one operation. Material is drawn through screens and discharged by means of fans.

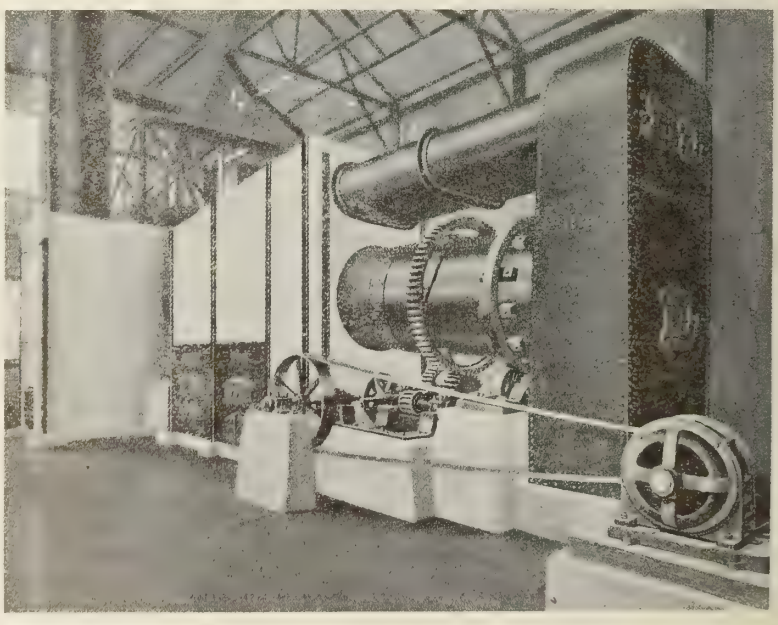
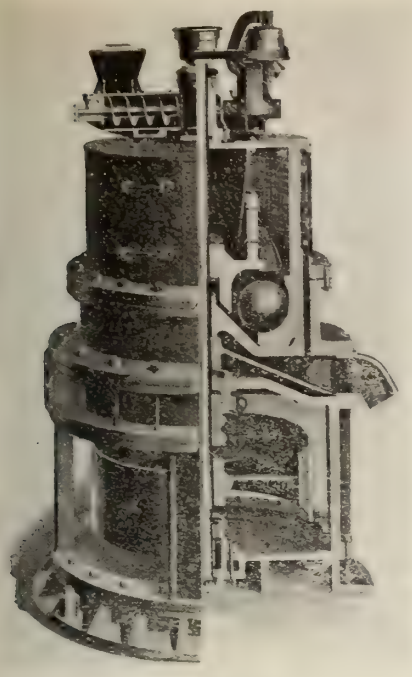


FIG. 2—COAL DRYER.



COAL PULVERIZER.

Feeders, Mixers and Burners

Figs. 4 and 5 illustrate the "Lopulco" feeders and burners. The functions and methods of operation will be evident from the illustrations. The essential requirements of pulverized fuel feeders and burners are:

1. Positive control of the fuel feed.
2. No flooding and clogging.
3. Ability to regulate temperature in furnace.
4. Adaptability to various grades of fuel.
5. Control of combustion and length of flame.

Cost of Pulverizing Coal

What does it cost to pulverize coal? Well, the cost of pulverizing is made up of a number of items, as follows:

1. Interest.
2. Depreciation.
3. Insurance and taxes.
4. Repairs and maintenance.
5. Power.
6. Labor.
7. Coal for drying.

Interest. This will depend upon the cost of installation, which is of course

LOPULCO FEEDER.

dependent upon its size and type. Mr. F. A. Scheffler is authority for the statement that, as a general proposition, the actual investment will vary from $12.80 per K.W.—output in a 5,000 K. W. plant, —down to $4.80 per K. W. in a 50,000 K. W. plant. If we assume that the 5,000 K. W. plant uses 100 tons of pulverized coal daily, and that the cost of the plant is approximately $64,000, we have a charge of 10 1-2c per ton for interest. A plant using a thousand tons daily would have its charge reduced to approximately 4c per ton.

Depreciation. If we assume the life of the equipment as ranging from 15 to 20 years, our depreciation in a hundred ton per day plant will be approximately 12c per ton, and in a thousand ton plant, approximately 4c per ton.

Insurance and Taxes. Assuming taxes and interest to amount to 2 per cent. on investment, we have a fixed charge of 3 1-3c per ton for a hundred ton plant, and 1 1-2c per ton for a thousand ton plant.

Repairs and Maintenance. Experience would indicate that repairs and maintenance will run from 10 to 20 cents per ton. This is, of course, a general statement, and there are, no doubt, plants in existence which show a lower cost of repairs. However, it would hardly be safe to figure on any less cost than 10c per ton in estimating the possibilities of a prospective plant.

Power. The power required to operate an up-to-date pulverized coal plant, consisting of crushers, dryer, and pulverizer, and including the transportation of coal from the track to the boilers, may be set down as ranging from 15 to 20 K. W.-hr. per net ton, with 17 or 18 K. W.-hr. as the probable average.

LOPULCO BURNER

If we assume the cost of power to be 3-4c per K. W.-hr., we have a charge of approximately 13c per ton for power.

Labor. This item varies so widely that it is extremely difficult to estimate the cost with any accuracy. For purposes of approximation we may assume that a hundred ton plant will require 40 hours of labor per day, which, at 50c per hour, would be equivalent to a charge of 20c per ton for this item. A thousand ton plant might be operated with 120 hours' labor, which, on the same basis, would amount to 6c per ton.

Coal for Drying. Coal required for drying may be rather closely estimated at 1 1-4 per cent. of the amount of coal heated. At $2.50 per ton for coal, the cost of drying would be 3c per ton, and at $5.00 per ton, the cost of drying would be 6c per ton.

Summing up these various items we have the following approximate costs:

COSTS OF PULVERIZING COAL PER NET TON AT THE ATLANTIC STEEL COMPANY

Table I.—Daily Output 100 Tons Per Day

	Cost Per Ton
Labor	$0.176
Repairs	0.19
Power	0.134
Dryer coal	0.0218
Total cost	$0.5218

Total coal pulverized Jan.-Feb., 1919...5,275 tons

Power —
17.9 kw.-hr. per ton coal pulverized at ¾c... .....5,275 tons

Labor—

1 man 16 hr., at $0.40	$ 6.40
2 men 16 hr., at $0.35	11.20
Daily cost	$17.60

(=$0.22 for 80 tons output, $0.195 for 90 tons, $0.176 for 100 tons).

Dryer coal—Cost of dryer fuel, 2.8c per ton, based on 2.6% moisture.

Coal at $5 per ton, 6 lb. evaporated per lb. of coal burned, or 8.7 lb. per ton of coal pulv.

Repairs—

Total repairs for Jan. and Feb.,	$1,412.16
Credit	409.69
Charged	$1,002.47

(=$0.19 per ton pulverized)

By way of comparison with the above approximate figures, we have the following actual costs of pulverizing a hundred tons per day at the Atlantic Steel Co. The figures given apply for the months of January-February, 1919, and it is, of course, probable that they would be higher today:

	Cost per ton 100-ton plant	Cost per ton 1,000-ton plant
Interest	$0.10½	$ .04
Depreciation	.12	.04
Insurance, taxes	.03 1-3	.01½
Repairs, maintenance	.15	.13
Power	.13	.13
Labor	.20	.06
Coal for drying	.05	.05
Total	$0.78 5-6	$0.43½

Conditions Governing Successful Use of Pulvarized Coal Under Boilers

The conditions governing the successful use of pulverized fuel under boilers are as follows :

1. Fineness of pulverization.
2. Proper design of combustion chamber.
3. Proper air openings.
4. Damper regulation.
5. Clean tubes.

Let us examine these points in order:

Fineness of Pulverization.—This is a factor which was discussed in our first article. It is absolutely essential that 95 per cent. of the pulverized fuel should be fine enough to pass through a 100-mesh screen. If the pulverized coal contains many heavy particles, these will tend to settle at the bottom of the combustion chamber, and will soon form a solid mass which can only be removed by mining operations.

Proper Design of Combustion Chamber.—It is extremely important in considering a pulverized fuel installation to know beforehand the probable rating at which the boilers are to be driven. On this rating depends the size of the combustion chambers. The safe rule is to figure what the maximum rating will be, and to build the combustion chamber to meet this rating. Our combustion chamber should have a capacity equivalent to approximately 50 cu. ft. per lb. of coal burned per minute.

If our combustion chamber is design-

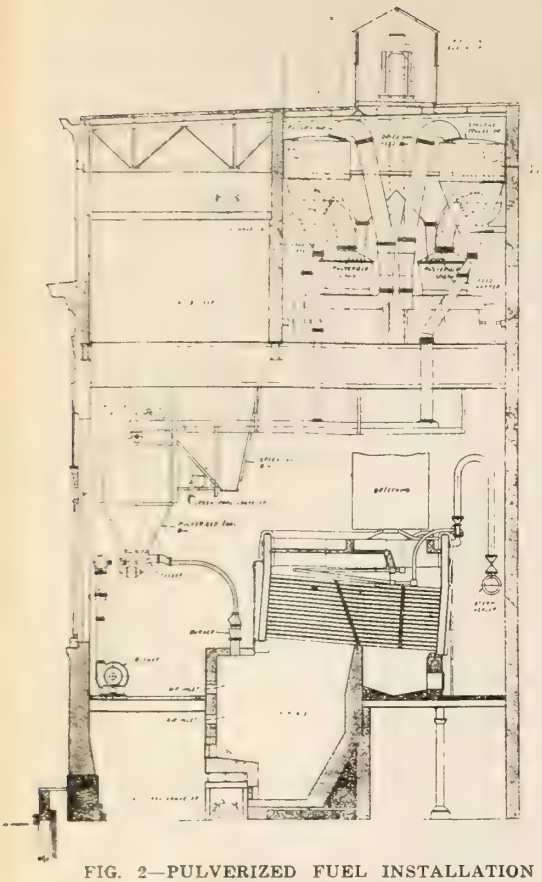


FIG. 2—PULVERIZED FUEL INSTALLATION ONEIDA BOILER PLANT.

ed on this basis, it is important to remember that, if we run the boiler at less than the maximum rating we have determined upon, the efficiency will not be perceptibly lowered. On the other hand if we attempt to run the boiler above the maximum rating, we do not have sufficient combustion space. Hence the flames will impinge on the brickwork and cut it away very rapidly. Furthermore, combustion will not be complete at the time the gases strike the boiler tubes, and there is very great probability that an appreciable proportion of the gases will pass up the stack unburned.

The combustion chamber should also be designed so that the velocity of gases passing through it does not exceed a speed of 6 ft. per second.

Proper Air Openings.—The pressure with which pulverized coal is put into the furnace is as low as can be used and still carry the fine coal in suspension, as the aim is not to blow but to breathe the coal in, and it is usual to find the pressure to be 1-2 oz. at the nozzle.

The importance of this low pressure lies in the necessity of mixing the coal dust and air intimately. Any mixing process that produces such agitation of the coal and air as to give a centrifugal effect will tend to separate and not to mix the materials. We can determine the thoroughness of the mixture by the length of the flame; the poorer the mixture, the longer the flame.

When the powdered coal is fired at high pressure and high velocity, combustion begins at a point 4 to 6 feet from the end of the burner. The action is similar to that of a plumber's blow torch when too much air is used; or in the bunsen burner when the gas pressure is too high. Not only is the combustion slowed down by high pressure firing, but there is a destructive action of the furnace as well. Thus it has been well established that whether oil or gas is used as a fuel, a blow torch effect due to firing or high pressure is always destructive to brickwork.

With powdered fuel this destructive action is increased since, in addition to the eroding effect of the gases at high velocity, there is a fluxing action by the melted ash.

Since our air pressure must be low, we must get the air required for combustion through additional openings. These openings, which are adjustable, are placed at the front, sides and bottom of the combustion chamber. Given openings in these locations, the fireman can, with a little experience, completely control the process of combustion.

Damper Regulation. Very accurate damper regulation is absolutely essential to the successful use of pulverized fuel, as only in this manner can we control the velocities of the gases passing through the combustion chamber. Damper regulation should provide for what will amount to balanced draft inside the combustion chamber, and to only a slight vacuum in the first pass, while at the damper itself we do not want more than .1 to .15 inches. If we have more vacuum than this it pulls our gases through the combustion chamber too fast, thus allowing them to reach the first row of tubes too fast, and causing the deposits to build up on these tubes very rapidly. The very small draft necessary at base of stack will allow us to use pulverized coal with stacks about 30-35 feet in height.

Clean tubes. If you want to attain high boiler efficiency you must keep your boiler tubes clean. This axiom applies to every boiler regardless of fuel used, whether ordinary lump coal, oil, or pulverized fuel is burned. This means that mechanical soot blowers are just as important, just as necessary, with pulverized fuel as with other types. As a matter of fact, in practically all successful installations where pulverized fuel is used, the boilers are equipped with mechanical soot blowers. The tubes should be cleaned by the blowers every 6 hours or oftener. As the temperatures are very high, the blowers should be constructed of some such material as calorized metal in order to withstand the hard service conditions. The regular use of mechanical soot blowers will save 4 to 8 per cent. of fuel, as well as a large amount of the labor required for cleaning.

Boiler Efficiency With Pulverized Coal

It has been said that a comparison of a number of tests of hand fired and pulverized coal furnaces shows a decided gain in efficiency of pulverized coal over the hand fired, where the fuel is of a low grade. The gain is said to become less marked with fuels of fair quality, and to disappear entirely with good coal and properly manipulated stokers. Tests of powdered coal installations are available showing boiler efficiencies of 77 to 81 per cent., but these results have, of course, been equalled with mechanical stokers. As a general proposition, however, we may assume that the average boiler efficiency with pulverized coal is higher than the average with stokers.

As indicating the results which may be obtained with pulverized coal, first in using low grade coals, and then in using coal of fair quality, we give herewith reports of two tests, one on eight 250 h.p. O'Brien boilers at the M. K. & T. railroad shop plant, at Parsons, Kansas; the other on five Edge Moor boilers at the Oneida street station of the Milwaukee Electric Railway & Light Company:

The M. K. & T. Test

With Texas lignite and an output of 110 per cent. rating, an equivalent evaporation of 7.26 lb. of water was obtained per lb. of coal fired, an equivalent evaporation of 8.81 lb. being obtained per lb. of combustible. The coal as fired had a heating value of 11,250 b.t.u. and contained 7 per cent. moisture, the dryer not being designed to handle this class of fuel regularly. The efficiency of the

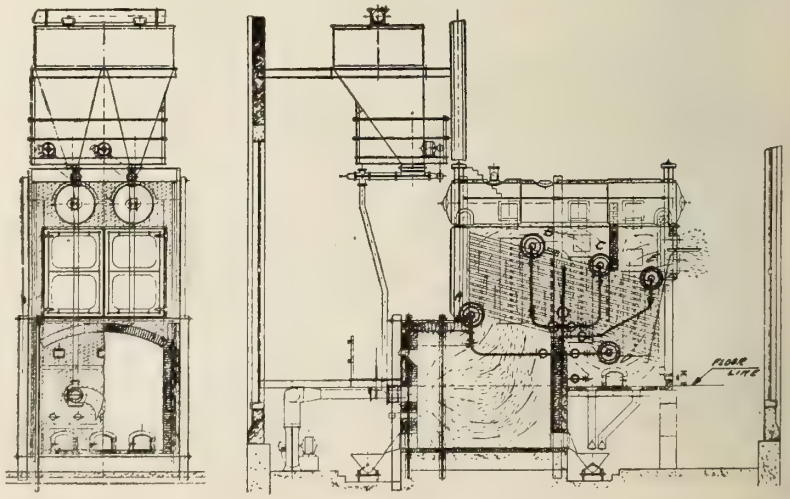


FIG. 1—TYPICAL PULVERIZED FUEL INSTALLATION SHOWING LOCATION OF SOOT BLOWER UNITS.

boiler was 67.3 per cent., the losses being as follows: 7 per cent. due to evaporation of moisture in the coal; 4.8 per cent. due to steam from hydrogen combustion; 11.8 per cent. carried away by dry flue gases, and 15.4 per cent. due to radiation and unaccounted for.

With the boiler operating at about 92 per cent. of rated capacity an equivalent evaporation of 8.38 lb. of water per lb. of coal fired was obtained with Mineral slack (Cherokee Co., Kansas), the fuel as fired containing one per cent. of moisture and having a heating value of 11,580 B.t.u. The equivalent evaporation per lb. of combustible was 10.9 lb. In this case the boiler showed an efficiency of 71.5 per cent., the losses being: .3 per cent., due to evaporation of moisture in the coal, 3.8 per cent. due to evaporation of moisture in the coal, 3.8 per cent. due to steam from hydrogen combustion; 10.8 per cent. in dry flue gases, and 13.6 per cent. radiation and unaccounted for. In neither case was there any CO loss.

Including the cost of pulverizing, which is about 35 cents per ton, the cost of Mineral coal delivered to the bins was $1.795. The cost of evaporating 1,000 lbs. of water as determined by this test was 11.6 cents. Using natural gas, the heating value of which is about 940 B.t.u. per cu. ft., the cost of evaporating 1,000 lbs. of water is 16 cents, with gas at 12.5 cents per 1,000 cu. ft.

The normal coal feed is arranged to develop about the rated capacity of the boiler. At maximum feed, however, the boilers may be forced to 142 per cent. of rated capacity. No difficulty has been experienced from abnormal furnace temperatures, which would tend to destroy the furnace walls. Even under forced conditions the furnace temperature does not exceed 2,350 deg. F., and under normal conditions it is about 2,100 deg. F.

The Future of Pulverized Coal

When we pulverize coal we change completely its common characteristics. Pulverized coal is a fuel of extreme flexibility. The amount burned can be varied within wide limits. Furthermore, to the characteristics of a rich fuel, developing a flame like oil or gas, is added a degree of control fully equivalent to, if not exceeding, that obtainable by burning either oil or gas.

Owing to the attitude of labor and the scarcity of securing skilled operatives, it is far more difficult than ever to secure high efficiency and good operation in either hand or stoker firing.

Either manual or stoker firing requires constant watchfulness, and hot, heavy, disagreeable work. As a substitute for these conditions, pulverized coal offers an ease of control such that the equipment can be operated by any intelligent man without much regard to his physical qualifications.

Pulverized coal permits of generally higher efficiencies than are now being obtained, with much less strenuous effort. It is, therefore, to be seriously considered.

THE MILWAUKEE ELECTRIC RY. & LIGHT TEST.

Summary of Results.

	Electric Energy and Fuel Consumption Per Ton of Coal Pulverized.	
1.	Energy consumed by conveyors, crushers, elevators, dryer, blowers and feeders, kw-hr.	5.73
2.	Energy consumed by pulverizer, kw-hr.	16.72
3.	Total energy, kw-hr.	22.45
4.	Coal equivalent at 1.5 lb. per kw-hr., lb.	33.68
5.	Coal consumed in dryer furnace, lb. per ton of fuel dried	25.66
6.	Total coal and equivalent, lb.	59.34
7.	Gross efficiency less deductions for total coal and equivalent—Item 6	78.36
	Cost of Fuel Preparation, Firing and Ash Disposal.	
8.	Labor—coal preparation	$0.143
9.	Labor—Firing	0.112
10.	Labor—Ash removal	0.025
11.	Dryer Fuel—Coal at $4 per ton	0.051
12.	Electrical energy—Coal per kw-hr. at 1.5 lb.	0.068
13.	Maintenance (labor at 3.6c, material at 2c, manufacturers' estimate, lubricants at 0.7c)	0.063
14.	Total cost of fuel preparation, firing, ash disposal and maintenance	0.462
15.	Price of coal as purchased, per ton	4.000
16.	Total cost	4.462
	Efficiencies.	
17.	Actual gross efficiency, per cent.	80.67
18.	Net efficiency after all incidental costs have been accounted for, per cent.	72.32

Conclusions can be best drawn from a comparison between pulverized-fuel burning equipment and mechanical stokers such as is given in Table II.

Table II.—Comparative Results with Pulverized Fuel and Underfeed Stoker Per Ton of Coal Burned.

	Pulv. Fuel System	Modern Stoker
Energy consumed by conveyors, crushers, elevators, dryers, fans and feeders, kw-hr.	5.73	10.94
Energy consumed by pulverizer, kw-hr.	16.72	.....
Total energy, kw-hr.	22.45	10.94
Coal equiv. at 1.5 lb. per kw-hr., lb.	33.68	16.41
Coal consumed in dryer furnace, lb.	25.66	.....
Total coal and equivalent, lb.	59.34	15.41
Cost of Fuel Preparation, Firing and Ash Disposal.		
Labor—Coal preparation	$0.143	$0.000
Labor—Firing	0.112	0.140
Labor—Ash removal (in plant)	0.025	0.064
Dryer fuel—coal at $4 per ton	0.051	0.000
Electric energy—coal per kw-hr. at 1.5 lb.	0.068	0.033
Maintenance: Labor at $0.036—material at $0.020, manufacturer's estimate—lubricants at $0.007. Labor at $0.046, material at $0.048, lubricants at $0.002. $0.097.	$0.063.	
Total cost of fuel preparation, firing, ash disposal and maintenance	$0.462	$0.334
Price of coal as purchased per ton	4.000	4.000
Total cost per ton	4.462	4.334
Cost per ton of coal in P.F. system over modern stoker	0.128	.....
Efficiency.		
Actual gross efficiency, per cent.	80.67	76.80
Net efficiency after all incidental costs have been accounted for, per cnt.	72.32	70.88
Difference in favor of pulverized fuel system, per cent.	1.44	.....

The tests were conducted by the engineers of the Milwaukee Electric Railway and Light Co., being directly supervised by Fred Dornbrook, chief engineer of the Commerce Street station, assisted by Messrs. Schubert & Mistele, test engineers. Paul W. Thompson, technical engineer of power plants, Detroit Edison Co., was present throughout the four days as an observer. The test was approved by John Anderson, chief engineer of power plants, for the company.

TRADE ANNOUNCEMENT

The Superheater Company, Limited, has recently been incorporated and will manufacture superheaters for all classes of service in Canada. The company's main office is in the Transportation Building, Montreal, and the manufacturing plant is located at Sherbrooke, Que.

They will manufacture the type of fire-tube superheaters now in general use in the locomotives of all Canadian railways, and also fire-tube superheaters for marine installations, of which there are now over two thousand in daily service.

In the case of water-tube boilers in marine service, the company designs and manufactures the superheater to suit each individual case. This, in fact, applies in all cases, and in particular in the design and construction of superheaters for stationary installation, either water-tube, fire-tube, or separately fired. The conditions are studied in each case with a view to supplying the most economical and effective installation.

The company employs a form of return bend, which is made by a forging process from the metal of the superheater pipes, making an exceptionally strong construction which is proof against high temperature. This form of return bend has also been considerably sought after for use in pipe coils for refrigerating purposes, condensers and other uses.

SOME SPEED

An average speed of a little over 172 miles per hour was made in a recent flight from Rome to Turin by Lieut. Brack-Papa in an A. R. F. biplane constructed by the Fiat Company and equipped with a 750-horsepower twelve cylinder Fiat engine. The machine started from the Mirafiori aerodrome, in the suburbs of Turin, at 11.45 a.m. on April 5, carrying two passengers in addition to the pilot, and landed on the Centocelle ground, just outside Rome, at exactly 2 p.m. The intervening distance of 388 miles was thus covered in two hours fifteen minutes. A few days previously the same machine was officially timed over the Mirafiori aerodrome and found to give an average speed of 161.5 m.p.h. with four passengers and a pilot. In this flight the effects of wind were, of course, eliminated, and the speed attained, we understand, constitutes a world's record.

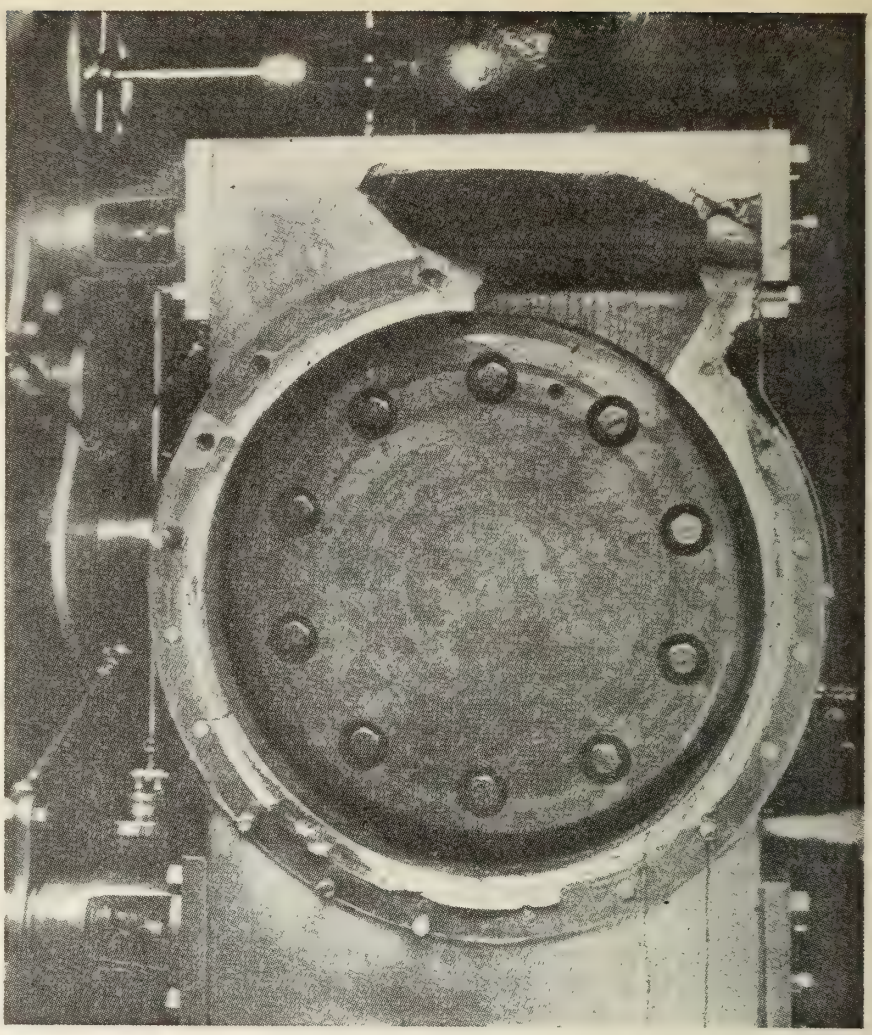
A MYSTERIOUS ENGINE ACCIDENT

THE accompanying illustrations show two views of an accident which occurred not long ago to the steam cylinder of an ammonia compressor. Fortunately no one was injured.

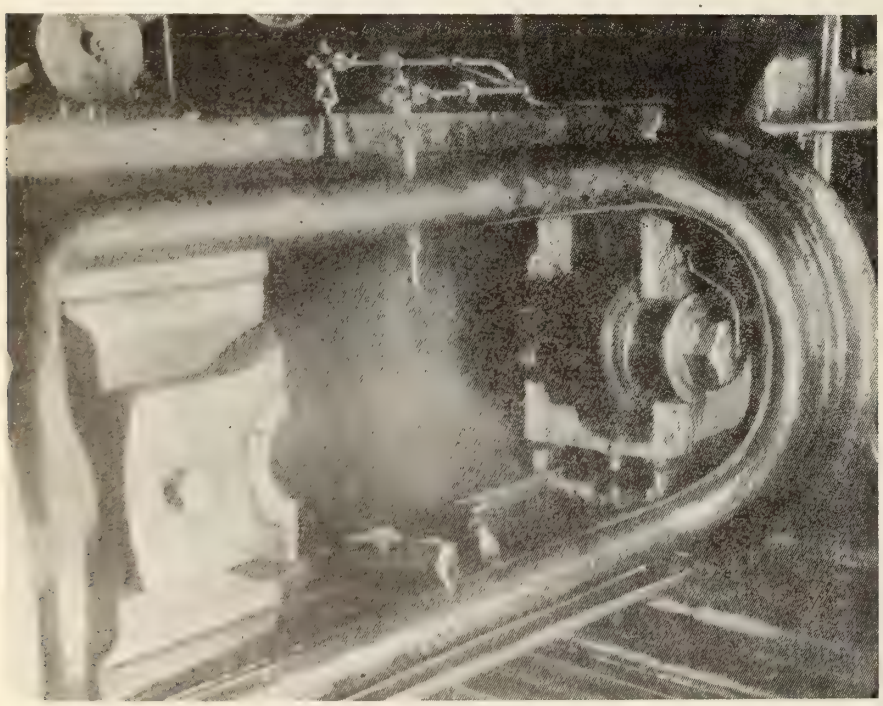
The machine in question consisted of a single horiozntal steam cylinder with two vertical compressor cylinders. The engineer had started this engine up shortly before noon of the day of the accident and, in conjunction with two other ice machines, it had been running smoothly and quietly up to the very instant of the accident. At 4.50 p.m., the engineer passed through the engine room and found everything to be operating to his satisfaction. Five minutes after he left the room the oiler, who was giving his attention to one of the other machines, heard just one crash without the slightest noise or fore-warning of any trouble. He immediately ran to the throttle of the machine and shut off the steam. The engineer arrived soon after and closed the throttle valves on the other two machines.

It was found that the machine had stopped on or very close to the crank end dead center. The cross-head was broken through the wrist pin hole, and apparently it was at this point that failure first took place. A piece of the cross head shoe was found lying on the bottom guide between the two broken parts of the cross-head, which fact might be taken to indicate that the crank-pin had passed dead center and was moving toward the head end when the accident occurred.

When the cross-head failed the steam pressure carried the piston, piston rod and half of the cross head with a high velocity toward the head end of the cylinder. The piston struck the cylinder head, drove it off and the latter was found lying on the floor immediately back of and to the right of the cylinder. The follower plate was cracked circumferentially through the bolt holes for a distance of about thirty inches and the cylinder casting, as is shown in the illustration, was fractured through the steam valve chest. Upon further examination the piston was found to be drawn off the rod, leaving a space of 3-16 in., and on the rod a collar of metal had been rolled up as though the piston had been driven onto the rod. This condition was probably caused by the following series of events: When the cross head failed the steam pressure carried the piston up against the cylinder head which caused it to let go and the cylinder casting to fail as shown. Before the head let go, however, the inertia of the rod and the half of the cross-head attached to it had carried the rod into the piston which caused the collar of metal to be rolled up. The force of these two actions, however, was not sufficient to bring the moving mass to rest so that, after the cylinder head blew out, the parts continued their motion until the nut on the cross-head end of the piston rod brought up against the stuffing box on the crank end of the cylinder. While this brought the rod and cross-head to rest the remaining inertia of the piston caused it to be carried off the rod as mentioned above.



SHOWING BREAK IN CYLINDER.



SHOWING BROKEN CROSSHEAD.

No satisfactory explanation has been given of the cause of this accident. The steam pipes were well drained and the traps found to be in good working order. The firemen reported that the water line in the boilers at the time of the accident was what they were accustomed to call a low one. There does not seem to have been any possibility, therefore, for water to have gotten into the steam cylinder.

The case serves to show that any engine may be subjected at some time to forces of unknown origin which may lead to a more or less severe accident and it furthermore emphasizes the need for engine insurance.

MECHANICAL STOKERS ON AMERICAN LOCOMOTIVES

More than 5100 locomotives on American railways are now fitted with mechanical stokers of six different types, but two of these types aggregate less than 200, while the others range from 500 to 2,195. These figures were given in a report at the annual meeting of the mechanical section of the American Railway Association. Practically all the engines have a tractive effort above 55,000 lb., and in most cases they can haul from 150 to 400 tons more in a train with as good performance as hand-fired engines with the lighter trains.

Although hand firing on large engines is very severe work, few railways employ assistant firemen, but several are using mechanical devices to feed the coal towards the footplate and thus lighten the fireman's work. Higher efficiency and capacity of the large locomotives are the main objects sought in introducing mechanical stokers, but stokers are a practical necessity when coal consumption averages more than 5000 lb. per hour. It is when the full efficiency of the engine cannot be obtained by hand firing that the mechanical stoker begins to show its advantages.

Greater total consumption per trip is the usual experience with machine-fired engines, but it is more than offset by the increased tonnage and load capacity. It is probable also that with further experience the total consumption will be no higher for mechanical than for hand firing. This result will follow from the designing of fire-boxes to suit the conditions of stoker firing and from the education of the firemen. At first there is a tendency to use too much coal, owing to the ease of firing.

Practically any kind of coal can be used on stoker engines, and almost every kind available is used among the 5126 engines now in service. Fine coal of poor quality, bituminous coal and anthracite are all employed, and even lignite has been handled successfully without increased throwing of sparks. It is the almost unanimous opinion of users of mechanical stokers that a crusher should be fitted on the tender, so that engine can work on different divisions where different grades of coal are supplied. But as the number of these engines increases it will become practicable to prepare the coal in advance, either at coaling stations or at some central point on the railway.

With the firing of the engines regulated by brain and thought instead of by muscular strength it is expected by most railways that a higher class of labour will be available for firemen, thus securing more efficient handling and providing a larger supply of men capable of becoming enginemen. At the same time, it must not be thought that the fireman has nothing to do on a stoker-fired engine. In order to secure efficiency and economy it is necessary for him to watch his fire and adjust it to varying conditions of speed, load, weather, and gradients. This is especially the case since the best results are obtained with a thin fire, and maintenance of such a fire needs constant attention. But it is attention of thought and skill instead of mere muscle. In fact, on one railway the blast pipes on the stoker engines have been so altered that the engines will not steam properly when the fire is more than about 6 in. thick.—The Engineer.

St. Thomas Gets Thrills.—The citizens at St. Thomas were evidently out for thrills during the recent convention of fire chiefs in that city. Two barrels partly filled with water, with six gallons of gasoline on top was the first thrill, a floor 12 by 14 feet, saturated with gasoline and kerosene was the second test, while the third thrill consisted of four boxes each 4 feet high and 3 feet wide, with a strip of gasoline three feet wide and 10 feet long leading to the boxes.

Last, but not least, as the circus barker would put it, came the spectacular feat. A structure of a frame of boards, 10 inches wide and 14 feet long, was erected in the shape of a triangle, the structure being open at all ends and the loose boards permitting draft from all sides. The floor was covered with excelsior and hay and a wagon load of hickory sticks, and an additional load of old lumber and boards was placed inside.

A barrel of gasoline was poured on the centre of this varied mass and the entire structure was saturated with the same material. A strip of gasoline, 15 feet, was led directly to the gasoline barrel which had been placed in the centre of the structure. All the above were duly ignited.

These tests were for a purpose, however, and not merely for display. The fire department used sand, soda and acid to extinguish the fires, but in all cases did not put them out. It was after such devices had tried to put an end to the blazes that the Canadian Foamite Firefoam, Ltd., who were conducting the tests, used their foamite firefoam with splendid success. In the last test a 40 gallon engine was used, this generating 320 gallons of foamite. In less than three minutes the fire was completely extinguished. The tests were conducted both for the benefit of the fire chiefs and manufacturers in general.

THE INTERCRYSTALLINE BRITTLENESS OF LEAD

According to an abstract in the "Journal of the Franklin Institute" of a U.S.A. Standard Bureau Note, sheet lead sometimes assumes a very brittle granular form during service, due to corrosion. An explanation which has been offered by previous investigators for this change in properties is that it is due to an allotropic transformation, the product resulting from the change being analogous to the well-known "grey tin." Contact with an electrolyte, particularly a weak acid solution of a lead salt, has been claimed to be the agency by which the transformation is brought about. Metallographic examination of the granular "allotropic" lead shows that each grain has the characteristic properties of the ordinary form of lead. The intercrystalline cohesion of the grains for one another, however, has been so weakened that the material has a granular appearance. The rate at which the intercrystalline brittleness is brought about is proportional to the amount of impurities and to the concentration of acid in the solution in which the lead is placed. Practically all the impurities which are found in lead are lodged in between the grain. The preferential attack by the corroding agent for these impurities and perhaps also for the "amorphous intercrystalline cement," accounts for the brittleness produced.

The Morse Chain Co., of Ithaca, N.Y., will have in their exhibit at the Sixth National Exposition of Chemical Industries a number of samples of different chains, showing the Morse Rocker Joint, from ½ in. pitch to 3 in. pitch, and in several widths illustrating the chain as used for ½ h.p. to 5,000 h.p.

The Rocker Joint will be shown in cross section and its fundamental, almost frictionless features, the guide links, and minimum oil requirements explained with reasons for the long life and success that has always followed the use of Morse drives for increasing production, and for difficult drives, where either dust, steam, gases, or moisture, ruin gears or leather belts and their slipping, taking up, and renewals, produce excessive costs.

Photographs of actual installations and results will be shown to those that are interested. Mr. T. G. Anderson, manager of the New York Office, will be in charge assisted by Mr. H. W. Evans, Sales Engineer. During the week, Mr. A. B. Wray, Chief Sales Engineer, and Mr. V. D. Morse, Manager of Sales, from the Ithaca office, will be present; while Mr. J. S. White, manager New England district; Mr. E. R. Morse, manager Baltimore office and Mr. M. H. Rodda, manager Philadelphia office will be there to greet their friends.

Their booth will be No. 611.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

N THE joint considered in the last article the plate strength was 68.75, while the rivet strength was only 41.72 A single riveted lap joint should be about 50 per cent. strength, so that there is evidently some factor that requires altering. As the plate strength is higher than the rivet strength, it is observed that the factor that is wrong is the pitch. This is arrived at by considering that the plate is of minimum thickness, and the rivet cannot be decreased in diameter. As the pitch is a divisor in the formula for finding rivet strength, it is plain that by decreasing this factor the rivet strength percentage will be brought up. How much must we alter it to get the required figure? We can find that out very easily.

The formula for rivet strength we have seen is:

$$\frac{a \times n}{p \times t} \times C \times 100 = \%\text{ of rivet strength}$$

Now, let us insert the quantities we know. We have 50 per cent. for rivet strength, the other factors, excepting p remaining the same, and it is p we want to find. So we have

$$\frac{5\times5\times.7854\times1\times.85\times100\times16}{8\times8\times p\times5}=50$$

Then, P is the unknown quantity. We will work this out. First by cancellation we simplify the expression and get

$$\frac{5\times5\times.7854\times.85}{p}=50$$

Transferring we get

$$50p=5\times5\times.7854\times.85\times5$$

$$p=\frac{5\times5\times.7854\times.85\times5}{50}$$

$$p=1.66$$

The nearest fraction to this is 1⅝. Let us see how this works out on the plate strength. We have

$$\frac{p-d}{p}\times100=\%\text{ of plate strength}$$

Substituting figures we get

$$\frac{1\frac{5}{8}-\frac{5}{8}}{1\frac{5}{8}}\times100=\%$$

This is simpler expressed in decimals, thus

$$\frac{1.625-.625}{1.625}\times100=61.53\%$$

This is about right ,and we have a better balanced joint, with 61.5% plate and 50% rivet strength.

Analysis of Riveted Joints

In considering riveted joints, the various ways in which they may fail must be considered. The joint we are dealing with, being the most simple kind, has the least possible ways of failing. It can fail through the shearing of the rivets, and as there is only one rivet in the pitch limit the resistance of the joint to failing in that way will be the shearing strength of one rivet. It may fail by the plate tearing between the rivet holes, or it may fail by the plate crushing in front of the rivets.

The resistance offered by the plate to tearing between the rivet holes will be

$$p-d\times t\times60{,}000$$

or $(1.625-.625)\times.3125\times60{,}000$

$$1\times.3125\times60{,}000=18{,}750$$

and the percentage to the solid section will be:

$$\frac{18{,}750\times100}{30468.75}=61.53\%$$

This is in exact agreement with the previous result.

We must now consider the plate crushing in front of the rivet holes. We will have a section of plate equal to the diameter of one rivet and the thickness of the plate. The crushing strength of good boiler plate is about 90,000 lbs., so that we have

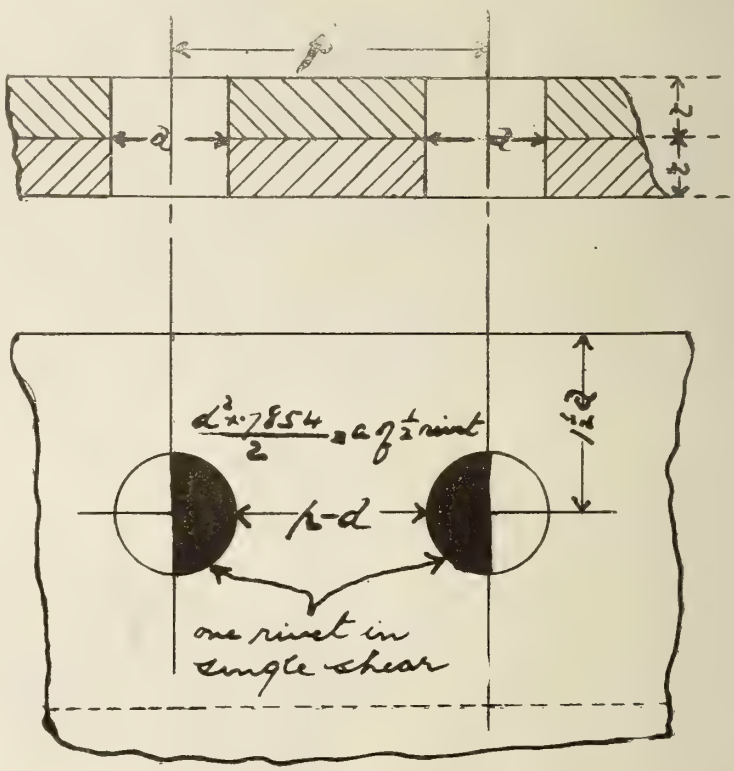
$$⅝\times5\text{-}16\times90{,}000=17571$$

This gives

$$\frac{17571\times100}{30468.75}=54.3\%$$

which is higher than the rivet stength percentage and may therefore be neglected.

We may say that a joint of this kind is practically never used in the longitudinal seams of a steam boiler, as its low percentage of strength would penalize every other part of the structure. However, they are sometimes met with



SINGLE RIVETED LAP JOINT

First of all consider the strength of the solid plate. We have a pitch of 1.625 inches, with a thickness of 5-16 of an inch, and a tensile strength of 60,000 lbs. per square inch. The strength of the section will then be

$$p\times t\times60{,}000$$

$$=1.625\times.3125\times60{,}000$$

$$=30468.75\text{ lbs.}$$

Then the strength of one rivet in single steel will be if tensile strength of rivet stub is 51,000 (.85 of plate strength) $⅝\times⅝\times.7854\times51{,}000$.

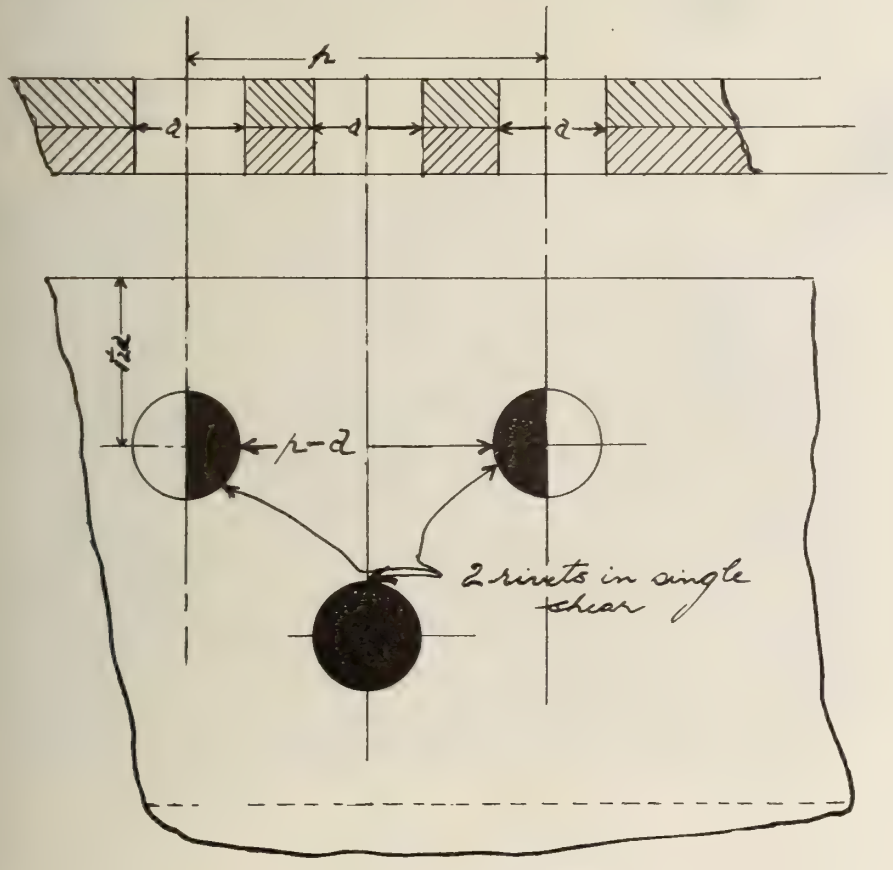
This worked out is 15,300 and the percentage to the solid plate is

$$\frac{15{,}300\times100}{30{,}468.75}=50.2\%$$

on steam domes, where the small diameter in comparison to weight of plate elbows allows a low percentage joint to be used. In tank work, where the thickness of plate is much more than is necessary to resist the pressure, a single riveted lap ojint is often used. For purely steam boiler work it is hardly to be considered. The next type of joint, and one very widely used, is the double riveted lap joint.

The Double Riveted Lap Joint

This joint has two rows of rivets, and two rivets in a pitch. It is usually designed for a strength of about 70 per cent. of the solid plate rivet strength and plate strength being approximately



DOUBLE RIVETED LAP JOINT.

equal. The same formulae are used in making the calculations, but a new factor is a formula for determining the distance between the rows of rivets. The Ontario regulations prohibit chain riveting, all rows of rivets having to be staggered, or zig-zag.

Let us take a concrete example and work it out, which is the best way of explaining it. Let us assume we want a boiler built of ⅜ inch plate and having a double riveted lap joint of about 2 per cent. strength. We want to get the other dimensions. The diameter of rivet may be taken as ¾ inch, or double the thickness of the plate. Very often in practice the rivet hole will be 13-16 in this size of plate, and of course the rivet size after driving will be the same as the diameter of the hole. Using the larger diameter in the calculations makes a slightly higher percentage of rivet strength and a slightly lower plate strength. However for our purpose we will consider the diameter as ¾. Now we want to find the pitch that will give the requisite strength with this diameter of rivet. We come back to the formula.

$$\frac{p-d}{p}\times 100 = \%\text{ of plate strength}$$

Substituting we get

$$\frac{p-d}{p} = .72$$

$$p-d = .72\ p$$

$$d = .28\ p$$

Then if d=.75 we get

$$.28\ p : p :: .75 : x$$

which gives

$$\frac{.75\ p}{.28\ p} = 2.679 \text{ inches}$$

as the pitch we require. Knowing the diameter of rivet and thickness of plate, and number of rivets in a pitch, we could have found the pitch from the formula for rivet strength, as we did in the case of the single riveted joint. We will in this case, see how the pitch we have found works out for rivet strength. We have

$$\frac{a\times n}{p\times t}\times C\times 100 = \%\text{ rivet strength}$$

Substituting figures we have, using .70 as the constant C in this case, and 2 11-16 as the pitch

$$\frac{3\times 3\times .7854\times 2\times 70\times 16\times 8\times 100}{4\times 4\times 43\times 3\times 100} = \%$$

This worked out gives a percentage of 61.37, which is too low. We wish to make our joint about even, though if the plate strength is a little higher than the rivet strength it is all to the good, as the plate strength may deteriorate in time, through the corrosion or thinning of the plate, which will not likely occur with the rivet.

We can use still another method if we wish, and that is to equate the two strengths to each other, and thus arrive at a pitch that will satisfy both.

This means that if the strength is to be equal, the two formulas must be equal to each other. Let us state this in the form of an equation. We have

$$\frac{p-d}{p}\times 100 = \% \text{ and } \frac{a\times n\times C}{p\times t}\times 100 = \%$$

If these % are equal the other sides must be equal, so we have

$$\frac{p-d}{p} = \frac{a\times n\times C}{p\times t}$$

$$p-d = \frac{a\times n\times C\times p}{p\times t}$$

$$p = \frac{a\times n\times C}{t} + d$$

Here we have arrived at an expression for pitch which should satisfy us. Let us substitute figures and see

$$p = \frac{3\times 3\times .7584\times 2\times 8\times 70}{4\times 4\times 3\times 100} + ¾$$

$$p = 2.39, \text{ say } 2.4$$

so we get 2.4 as a pitch. Let us try this again for our plate and rivet strength. First for plate percentage:

$$\frac{2.4-75}{2.4}\times 100 = 68.75$$

Then for rivet strength

$$\frac{3\times 3\times .7854\times 2\times 5\times 8\times 70\times 100}{4\times 4\times 12\times 3\times 100} = 68.72$$

Here we have got a perfectly evenly balanced joint, and though it is some 4% lower than we at first determined on, that is not a very serious matter.

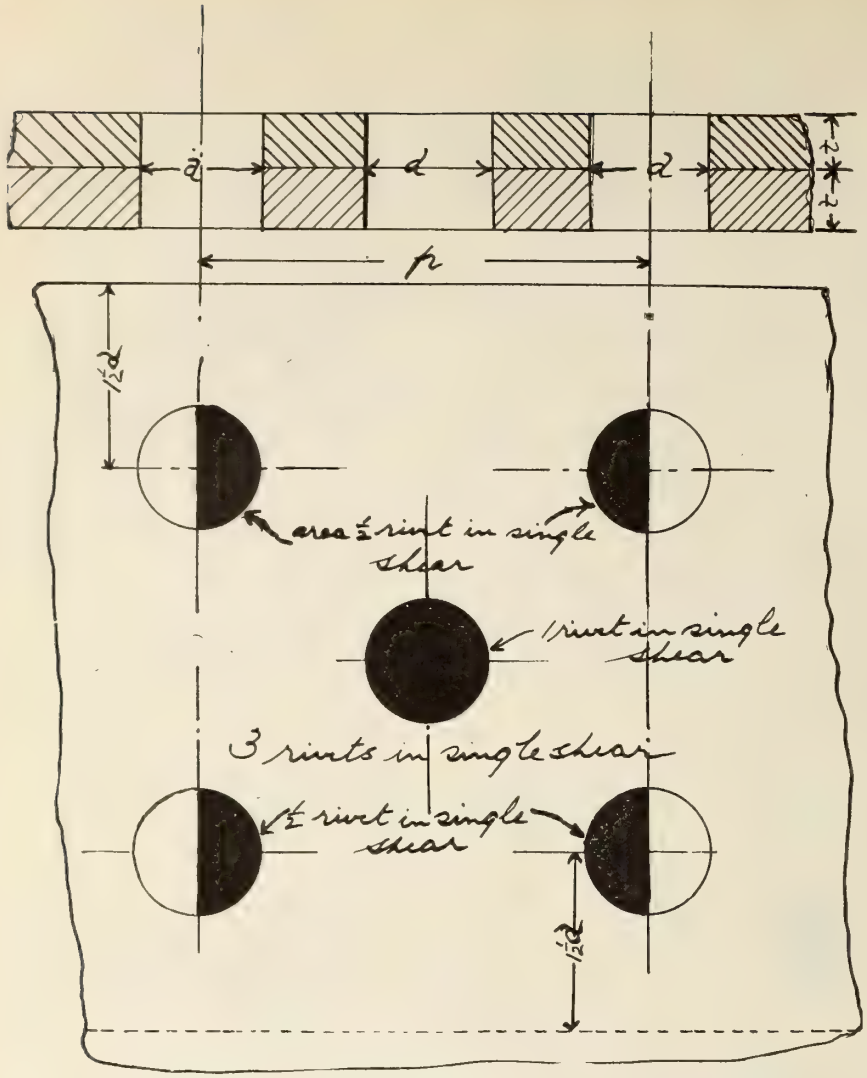
Let us see now how this joint stands comparison in its resistance to failure at different points. It may fail by rupturing between two rivet holes in the outer row and shearing one rivet. It may fail by shearing two rivets, or by tearing between the rivets on the inner row. It can also fail by crushing in front of the rivets in the outer row, and shearing the inner rivet, or by shearing the rivets in the outer row and crushing in front of the rivets in the second row. Let us take these in order. First the unit section is $p\times t\times 60{,}000$

$$2.4\times .375\times 60000 = 54{,}000$$

If the plate tears between two rivets on the outer row, and shears the rivet in the inner row it will have to overcome a resistance of

$$60000\ (p-d)\ t + a\times .7\times 60000$$

That is, the plate has diameter of one



TREBLE RIVETED LAP JOINT

rivet, plus the area of one rivet in single shear, whose resistance to shearing is .7 that of the plate tensile strength. Substituting figures we have

$$2.4—.75)\times.375\times60000+75^2\times.7854\times42000$$

which gives 74,250 or more than the solid plate. If it fails by shearing two rivets we have

$$a\times2\times42000$$
$$=.75\times.75\times.7854\times2\times42000$$
$$=37102 \text{ lbs.}$$

$$\text{which is } \frac{37102}{54000}\times100=68.7\%$$

of the solid

If it tears between two rivets on the inner row, we shall have again

$$\frac{(p—d)\times t\times60000}{(2.4—.75)\times.375\times60000}=68.7\%$$
$$54000$$

If it crushes the plate in front of the rivets in the outer row and shears one rivet in the inner row we have then

$$(d\times t\times90000)+(a\times42000)$$
$$(.75\times.375\times90000)+(.75^2\times.7584\times42000)=43872.3$$

$$\text{and } \frac{438723}{54000}\times100=81.2\%$$

which is much higher than either the plate or rivet %. The last two cases are exactly the same as each other so we see that 68.7% is the strength of the joint. The minimum distance between rows of rivets is found from the formula.

$$\frac{(11\frac{1}{2}+4\ d)\ (p+4\ d)}{10}=\text{minimum distance}$$

The treble riveted lap joint shown in the sketch is not very much used, as there is not much advantage in employing it. The percentage obtainable is not much greater than with the double riveted joint, and the cost of manufacture is increased. The calculations are made exactly in the same way as for a double riveted joint, excepting that there are three rivets in single shear instead of two. It may fail by the plate breaking between the outer rivets and shearing two rivets. It may crush the plate in front of one rivet and shear two rivets. It may shear three rivets. The plate may break between the rivets in the centre row and shear one rivet in the inner row. It may fail between the rivets in the inner row, and this of course is the weakest part, so that

$\frac{p—d}{p}$ is the governing factor.

The calculations would be as follows:

1st case — (p—d) t×60000+a×2×42000.

2nd case—d×t×90000+a×2×42000.

3rd case—a×3×42000.

4th case—(p×d) t×60000+a×42000.

42000.

5th case—(p—d) t×60000.

In the next article we will take up butt joints.

NEW USES FOR COMPRESSED AIR

It is not generally known that compressed air is used in various ways in the tobacco industry, yet such is the case, and the following description, which appeared in "Compressed Air Magazine" should be of special interest. The author is chief engineer of the R. J. Reynolds Tobacco Co., Winston-Salem, N.C., and he comments as follows:

"The regular tools such as the rock drills for concrete work, and the machine shop equipment for drilling and driving rivets, chippings, etc., and also a few hoists using compressed air are in use but do not require any further mention as they are of standard design. Compressed air is used for blowing motors and machinery in general, to remove the dust, and in places in automatic machines where the fine tobacco droppings have a tendency to gum and clog the machine in a few hours; a fine jet of air was placed to remove this dust, the trouble was removed, and the machine could run along its full time.

"The same principle is used in another process where it assists in drying and also blows away any dust, while a quick-drying paste is setting. This has very extensive application in plants and has made the installation of several large compressors necessary.

"In making the 'Prince Albert' can tops they are blown clear off the die by air pressure, and just to show that it's an ill wind that won't work both ways, sheets of tin used in making the cans are picked up by means of un-compressed air, or a vacuum.

"A battery of boilers is so placed that they are below any drainage or storm sewer line. When these boilers are blown down a few inches under pressure, no complications result, but when they are cooled down naturally, as they should be, and so have no steam pressure on them to blow out their water up to the sewer, a compressed air connection empties them very successfully.

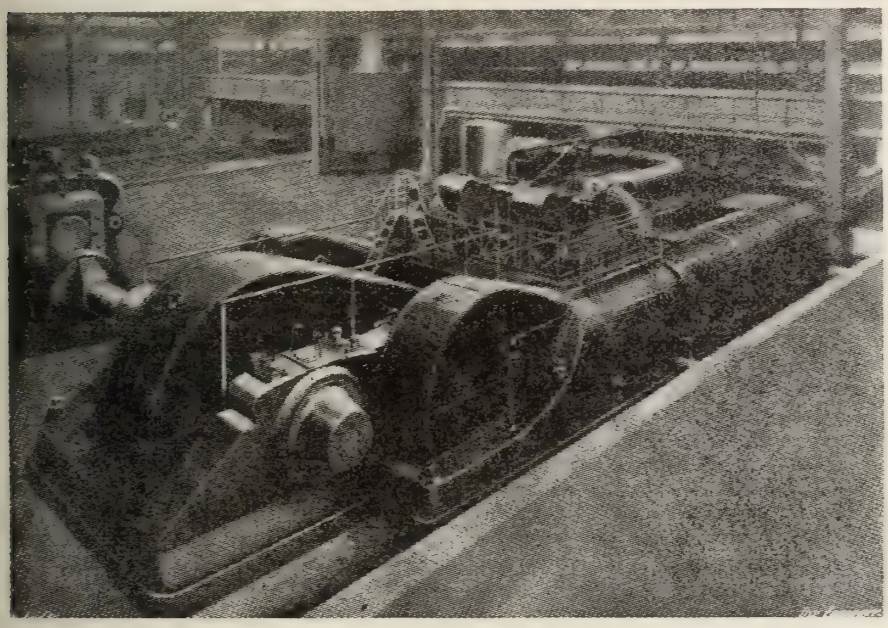
"The air is of great use and assistance in spraying liquids for conditioning dry tobaccos. The sprayer acts on the principle of the ejector and will pick up the liquid by suction for several feet rise.

"With a pressure-reducing valve in series, there is much use made of the compressed air, for the purpose of low pressure control of heating valves, humidity apparatus and similar equipment."

A 25,000 HORSE-POWER MILL ENGINE*

To meet the demand for plates from which the ends of large marine boilers can be cut in one piece, the Lukens Steel Company, of Coatesville, Pa., U. S.A., has recently installed a rolling mill measuring 17ft. between the housings and capable of rolling plates up to 16 ft. wide. The chilled iron working rolls are 34 in. in diameter, and are backed up by cast steel rolls 50 in. in diameter.

When the question of driving this mill arose, it was decided to adopt a steam engine in preference to electric motors, as, although the latter are generally accredited with the greater starting torque, installation of two 12,000 horsepower reversing motors and extensions to the power plant which would be required was considered too great an undertaking. An order was thus given to the Mesta Machine Company, of Pittsburg, for a 25,000 horse-power steam engine, a photograph of which we reproduce.



25,000 H.P. ENGINE.

The engine is of the horizontol twin-tandem geared type, having high-pressure steam cylinders, 46 inches diameter, low pressure steam cylinders, 70 in. dia., and a stroke of 60 in. The mill is driven from the jack shaft of the engine, which is connected with the main crank shaft by cast steel double helical cut gears, in the ratio of 2:1. The main shaft of the engine run normally at 150 revolutions per minute and the jack shaft 75 rev. per minute, the normal speed of the mill. The teeth in the reduction gears are 54 in. across the face and 7.625 in. circular pitch. The high pressure cylinders are designed for a steam pressure of 225 lb. per square inch and the low pressure cylinders for 100 lb. per square inch. The bed-plates are of the Tangye type. with bored guides, cast in one piece and are supported their entire length on the foundation. The weight of each of the bed-plates is 200,000 lb. The total weight of the engine is 1,400,000 lb. (about 625 tons.)

The link motion connecting up with the piston valves on the cylinders is of the Stephenson type. The link is carried directly on the valve stem guides for the high-pressure cylinders, thus minimizing lost motion and giving a direct drive from the eccentrics to the valves. The reversing mechanism consists of a steam-operated cylinder, directly connected by the same piston-rod to an oil check cylinder, the crosshead between being connected to the tumbling shaft. The reversing mechanism is also connected with and operates the throttle valve. The engine is controlled by a single lever in the operator's pulpit, and the links can be held without effort in any position. When the links are brought to their central position for either forward or backward running of the engine, the throttle valve automatically opens very rapidly so that the engine is always running on cut-off without any throttling of the steam. In the older types of reversing engines where two operating levers were employed, one for handling the reversing gear and the other for handling the throttle, it depends entirely upon the operator whether the engine is run economically by utilizing the expansions of the steam, or uneconomically by having the links always set in their extreme position and running on the throttle alone. The steam saved in operating a large engine of this kind by means of the single lever control arrangement ,may be, the makers say, as much as from 20 to 30 per cent. They also claim that the engine accelerates in less time than would ever be possible with a motor, on account of the comparatively light rotating masses, and reverses in about half the time that would be required for an electric motor operating the same mill. —*Engineering.

RARE METALS IN ONTARIO

In addition to being the premier mining province of Canada as regards gold and silver, Ontario produces other rare metals that are even more valuable than gold. During the past year platinum and palladium were recovered at Port Colborne, and also by the International Nickel Company at its Bayonne refinery. At the latter, 19,628 tons of Bessemer matts were treated during the year, from which platinum, palladium, rhodium, osmium, iridium and ruthenium were recovered. In all 1,770 fine ounces were obtained, the estimated value being $200,000. Quotations on the rarer metals are difficult to obtain, the average price of platinum for the year being $114 per fine ounce. Palladium has been valued at $1.30. Iridium is now quoted nominally at $500 per ounce troy. The average value of iridium imported into the United States in 1916 was $114, and for osmium it was $58 per ounce in 1917.

The Rich Tool Company, Chicago, announce that the Garlock-Walker Machinery Co., Ltd., with offices in Toronto, Montreal and Winnipeg, have been appointed their exclusive agents for Canada.

Report on Peat Possibilities.—The Hon. Harry Mills, Minister of Mines in the Ontario Government, has received an interim report from the officials investigating the Alfred peat bog. The report asks for a further extension of a year before a report in full is given. Mr. Mills, however, thinks that enough time has been spent to secure all information, and wants the complete report in this year.

Big Industry For Quebec.—A large amalgamation of British firms is contemplating the establishment of a large matchmaking factory in Quebec, according to a statement by Sir Alfred Maguire, who has been in Canada for some weeks investigating. There will be a 50 per cent. Canadian board, and the names of Sir Lomer Gouin and George Cahoon are mentioned as members of the board, which will consist of twelve.

PERSONAL

At a special meeting of the Chatham city council it was decided to engage C. H. R. Fuller, of Toronto, as city engineer at a salary of $3,000 a year. Mr. Fuller is a Bachelor of Applied Science at Toronto University and is at present being employed by the Imperial Oil Co. He served in France with the same company of railway troops as Major Frank P. Adams, the retiring city engineer, who assumes a similar post in Brantford.

Principles of Alternating Current Motors

The Fundamental Characteristics and Operating Features of the Synchronous Motor Are Discussed by the Author.

TERRELL CROFT

ALL alternating-current motors may be classified into two general divisions as shown below. Furthermore, asynchronous motors may be further sub-divided as indicated, thus:

- (1) Synchronous Motors
  - Single-Phase
  - Polyphase.
- (2) Asynchronous Motors—
  - (a) Induction Motors
    - Single-Phase
    - Polyphase.
  - (b) Commutator Motors (Single-Phase)
    - Series
    - Compound
    - Shunt
    - Repulsion

The fundamental operation principle is the same for all electric motors, both alternating current and direct current. That is, in every case, rotation of the rotor is due to the magnetic interaction between a current-carrying conductor and a magnetic field in the motor in which the conductor finds itself. In compliance with well-established laws there is always a magnetic force tending to thrust such a conductor from the field. It is this tendency which produces rotation of the rotor. Furthermore, in every motor (both a.c. and d.c.) the current, which is forced through the armature is limited by a counter or back e.m.f. value which is deevloped in some fashion or other in the motor. The e.m.f., which is actually effective in forcing current through the motor is, then, not the line voltage but it is the difference between the line voltage and this counter voltage which is produced in and by the motor. The value of the counter e.m.f. is always such that it tends to limit automatically the current compelling the motor to that value which is necessary to "pull" the load then on the motor. Thus, when the load on any electric motor is heavy, the counter e.m.f. then developed by the motor is relatively small. And a large current, whereby the load may be pulled, is permitted to flow. When the load is light the counter e.m.f. becomes small automatically. Thus current through the motor at light load is limited to a low intensity.

How the Synchronous Motor Works

Operation of the synchronous motor is due to the same general phenomena as that to which the operation of every other kind of electric motor is due. First an impressed or line e.m.f. (it must be an alternating e.m.f. for a synchronous motor) must be provided which will impel current through the armature of the machine. Then its rotor is caused to turn by virtue of the magnetic interaction between the current-carrying conductors on the armature and the magnetic field. A counter e.m.f. is produced by the armature conductors cutting through the field as the armature rotates. This limits the current through the armature. As the load on the motor becomes greater the counter e.m.f. decreases, permitting more current to flow to produce more power. If the load on the motor decreases the counter e.m.f. is correspondingly increased, decreasing proportionately the power taken by the motor. Always, however, the power in watts taken by the motor equals the product of the input current and the active or energy e.m.f. (not the line e.m.f. necessarily). An explanation of just how these phenomena produce rotation of a synchronous motor will be given in succeeding sects.

The construction of the synchronous motor is practically identical with that of the alternating-current generator. In fact, any commercial alternating current generator will operate as a synchronous motor. Hence it follows that synchronous motors may be of either the revolving-armature or the revolving field type. Furthermore, they may be single-phase or polyphase. However, practically all modern machines are revolving armature and three-phase. Figs. 1 and 2 show typical medium-capacity and large-capacity machines. The revolving field windings are excited with direct current impelled by an exciter. The single-phase synchronous motor is not self-starting but must, by some external means, be brought up to synchronous speed before it will carry its load. The polyphase motors can be made self starting where they can start without much load. Where a polyphase motor is to be self-starting, its rotor must be provided with a squirrel cage winding (Fig. 3). The constructions and characteristics just outlined will be treated in detail in sects. which follow.

The speed of a synchronous motor is always synchronous speed. Its speed regulation is 100 per cent. That is, the operating speed of such a motor is, for reasons which will be explained, determined wholly by the frequency of the supply circuit and the number of poles on the machine. There are certain rules and formulas whereby the synchronous speeds of alternating current generators and induction motors are computed. The same rules and formulas are used for finding the speeds of synchronous motors. If a load greater than its capacity is imposed on a synchronous motor, it will then not operate at a speed lower than the synchronous, but will merely "drop out of step" and stop. Why the same formulas are used for computing the speeds of alternating current generators and synchronous motors is explained in a succeeding sect.

Note.—A synchronous motor operates at the speed at which it would if it were driven as a generator have to operate to develop the frequency of its supply circuit. Thus a synchronous motor turing at synchronous speed is said to be operating in "synchronism" or in step with the generator which serves it.

The general characteristics of the

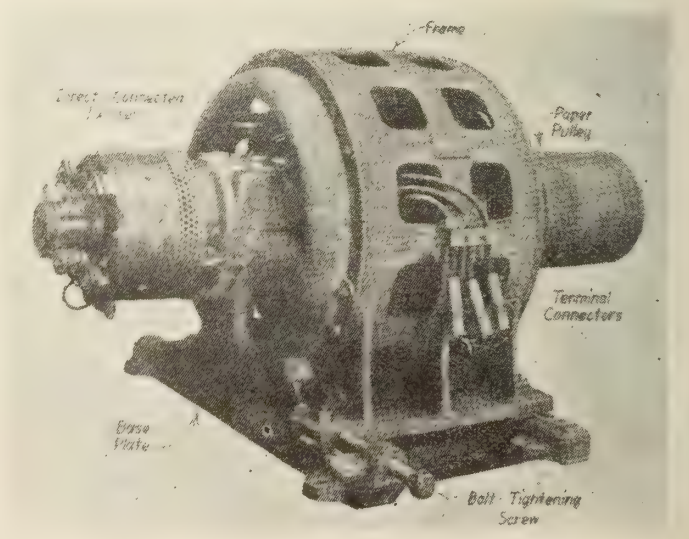


FIG. 1—Typical revolving-field, two-bearing, belted, synchronous motor. (This is a 187-h.p., 100 per cent. p.f., 900 r.p.m., 2300-volt, 3-phase, 60-cycle Allis-Chalmers machine. The exciter is direct connected.)

FIG.2—Typical three-bearing, belted, revolving-field, large-capacity synchronous motor. (A 200-h.p., 600-r.p.m., 2300-volt, 3-phase, 60-cycle machine of the Electrical Machinery Company, Minneapolis, Minn.)

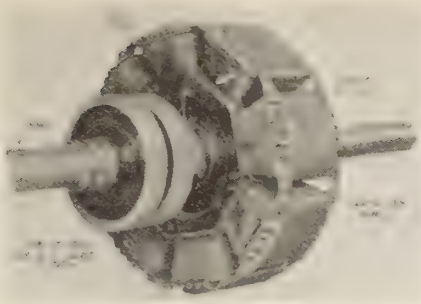


FIG. 3—Eight-pole, rotating field of a self-starting synchronous motor showing "squirrel-cage" starting winding in slots in pole faces. (Electrical Machinery Co., Minneapolis, Minn.)

synchronous motor (the why in each case will be explained below) are these:

(1) It is, as described above, primarily a constant speed motor.

(2) If the synchronous motor is overloaded its breakdown point or maximum output value is reached; its speed decreases and it stops.

(3) By varying the excitation of the direct-current field the motor can at will be made to take a leading or lagging current from the line. When under-excited, the current through it will be lagging. When over-excited, the current will be leading. When the current through an over-excited synchronous motor is leading, its effect on the circuit is then similar to that of a permittor or condensor in the circuit. Hence the machines when thus used are called synchronous condensers. By virtue of this characteristic synchronous motors or condensers can be utilized for the raising of the power factor of a circuit.

(4) The starting torque is small. The single-phase motor has no starting torque is small. The single-phase motor torque and the polyphase motors have a very low starting torque (about 25 per cent. full load torque) which is seldom sufficient to start a mechanical load of any consequence.

Advantages and disadvantages of the synchronous motor may be recited thus:

Advantages, which may, however, in certain cases be disadvantages:

(1) Constant-speed operation at all loads within its range, assuming the supply circuit to be of constant frequency.

(2) Power factor of the power which it takes is under control of the attendant.

(3) Can be used for raising the power factor of the circuit on which it operates. It can be used solely either for correcting power factor or for driving a mechanical load. Or it may be used for the simultaneous correcting of low power factor and the driving of a mechanical load.

Disadvantages

(1) Low starting torque.

(2) No possibility of speed control.

(3) Source of direct current required for field excitation.

Fundamental operating principles of the synchronous motor can be understood from a consideration of the arrangement of Fig. 4.

Explanation

A is a long, heavy stationary iron bar on which are mounted downwardly-projecting pole pieces, N. S., etc. These poles are excited by alternative current impelled by the alternator G. Although only five poles are shown, this bar with equidistantly-spaced poles on it is assumed to extend for an indefinite distance in each direction. The alternating current winding is reversed on alternate poles of A. Hence with the alternating current due to G considered at some given instant and in a certain direction (for example, in the direction shown in Fig. 4) the poles will be at that instant of different polarities, N, S, N, S, etc., along the bar indicated. But with each alternation of the alternating current the polarity of each pole will reverse.

F is a truck mounted on wheels and travelling on rails, R. Thus F may be moved along under the poles of A longitudinally either to the right or to the left. On the iron body of F are mounted four upwardly-projecting poles. The winding of these is energized with direct current from the exciting generator E, which is supposed to move with the truck. The winding is reversed on every other pole of F. Hence the polarities of these direct-current poles will be S, N, S, N, as shown. Since these poles are excited with direct current, their polarities will be always those indicated.

At the instant pictured in the illustration with the current from G in the direction shown, the unlike polarity poles on A and on F attract one another. There is, then, a force tending to move F toward the right at the instant shown. But if F is not thus shifted toward the right, then, when the current from G reverses in direction, the polarities of the poles on A will be such that there will be a force tending to shift F toward the left.

However, assume that F is moved toward the right by the attractive force of the unlike poles of F and A. Then if the alternating current which excites A reverses before P_2 attains a position under P_1, F will be forced back toward the left because the polarities of all of the poles of A will be reversed simultaneously. Again if P_2 shifts to the right and past P_1 before P_1 reverses then P_2 will be pulled back. But if P_2 reaches a position just under P_1 as the polarity of P_1 is changed by the reversal of the alternating current, then F will be forced ahead to the right.

Thus if F is started by some outside force toward the right at such a speed that it travels the distance D (Fig. 4) between any two adjacent poles on F in the time occupied for one alternation of the alternating current due to G, F will continue to move. If it is started toward the left at this speed it will continue to move toward the left. If it is started toward the right at this speed it will continue to move toward the right. If F is not started at the correct synchronous speed it will not continue to move longitudinally but will merely oscillate through the distance D.

The arrangement of Fig. 4 illustrates the principle of the synchronous motor. In actual synchronous motors the alternating current poles are inside of a stationary ring and the direct current poles are mounted on a rotor which rotates within the ring (see Fig. 8).

Why the synchronous motor can operate only a synchronous speed will be evident from a consideration of Figs. 5, 6, and 7. In these illustrations the truck F, of Fig. 4 has been replaced by a bar F_1, F_2, etc., which is supposed to extend indefinitely in each direction. Mounted under the bar at intervals are wheels upon which it can roll. The poles S, N, S, N, etc., carried on F are supposed to be excited by direct current to the polarities indicated. To simplify the illustration the exciting winding is not shown. In Figs. 5 and 6 it is assumed that the bar F is moving toward the right at synchronous speed. These two illustrations trace the movement during

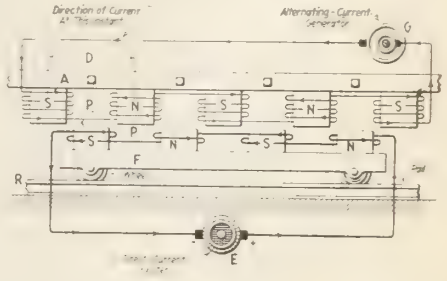


FIG. 4—ILLUSTRATING THE PRINCIPLE OF THE SYNCHRONOUS MOTOR.

one complete cycle. It is assumed that the frequency of the exciting current is 60 cycles, and that our examinaiton of the situation starts at exactly 2 o'clock p.m.

Concentrate attention on the pole S, which is cross-sectioned to identify it. 1/480 sec. after 2 p.m. the alternating current wave has passed through 45 deg. and the field F_2 has, by the magnetic interaction, been shifted to the right through 45 electrical degrees. Likewise, tracing the operation through the pictures III to VII it will be noted that the 60-cycle alternating current completes one cycle during 1-60 sec. and during that time the pole S is impelled through a distance equal to that between centres of unlike poles. That is, it is shifted (VII) through 360 electrical degrees. Conditions remaining the same, the field F would continue to shift to-

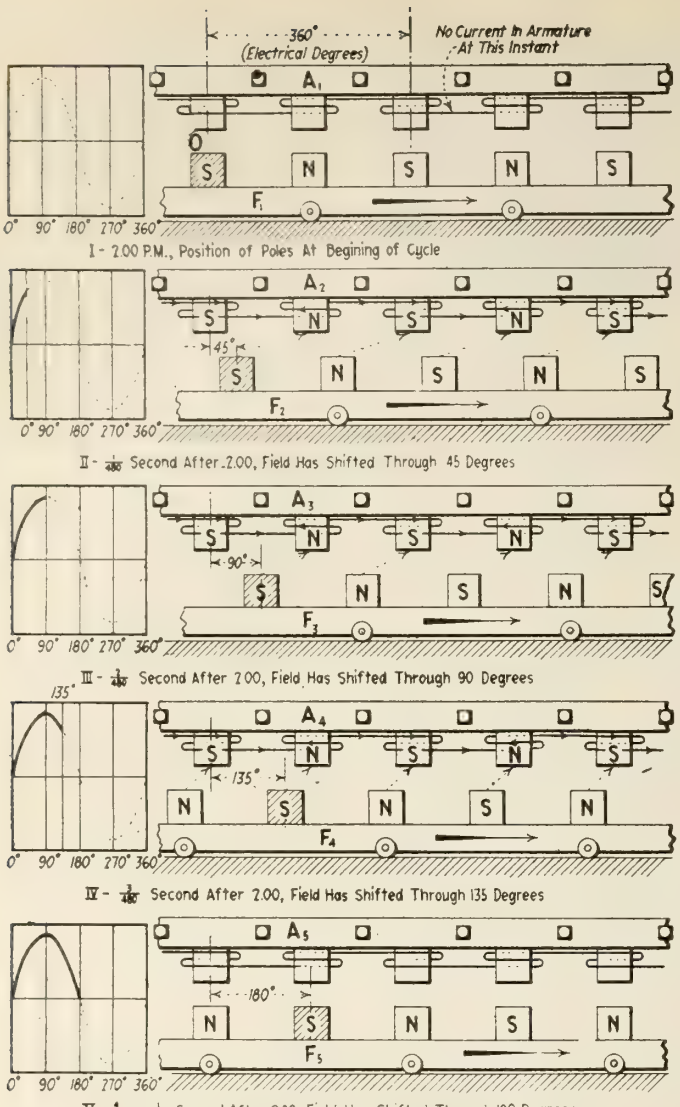

360° (Electrical Degrees)
No Current In Armature At This Instant
I - 2.00 P.M., Position of Poles At Begining of Cycle
II - 1/480 Second After 2.00, Field Has Shifted Through 45 Degrees
III - 1/240 Second After 2.00, Field Has Shifted Through 90 Degrees
IV - 1/160 Second After 2.00, Field Has Shifted Through 135 Degrees
V - 1/80 or 1/120 Second After 2.00, Field Has Shifted Through 180 Degrees

FIG. 5—Showing how the Moving Field of a Synchronous Motor must shift along at "Synchronous" speed. (On a 60-cycle circuit, conditions for which are pictured above, the direct-current-excited field, **F**, will, if it moves at synchronous speed—and it must move at synchronous speed if its operation is to continue—shift exactly the distance **OP** between centers of adjacent like poles in 1/60 second. This distance, **OP**, always equals 360 electrical degrees. But the actual spacing **OP** between like poles in inches or in feet in an actual motor depends on the size and speed of the machine.)

ward the right at the same speed as long as its excitation with direct current and the excitation of the armature A with alternating current continued.

A study of the illustrations of Figs. 5 and 6 will render it evident that the shifting could not be otherwise than at synchronous speed. Thus each direct current pole on F must shift through the distance between alternate poles (360 electrical degrees) of the armature A, in the same time that a field pole of the alternating current generator, which is supplying power, passes between two successive poles on its armature.

If, as suggested in Fig. 7, the field F had been shifted to the right through only 90 deg. while the current wave had passed through 225 deg. (as shown in the graph at the left) then the magnetic interaction at this instant between the like polarities would be such that the field bar would be impelled to the left instead of toward the right. Its motion would be reversed, showing that F must move at synchrous speed if its uniform motion in one direction is to continue.

The relation of speed, frequency and number of poles in a synchronous motor can be understood by a study of Fig. 8. Assume that a portion of the armature A of Fig. 5 with two extending poles, p_1 and p_2, on it is bent into a ring and shown in Fig. 8, I. Also assume that two of the direct current poles, N_1 and S_1, are mounted diametrically opposite one another on a shaft. Then, if p_1 and p_2 are excited with alternating current and N_1 and S_1 are excited with direct current, the rotor R thus formed will revolve within the armature if it is first brought up to synchronous speed. It is evident from what has been described in connection with Figs. 4 and 5 that in this two-pole machine the rotor R will complete one revolution (that is, pass through 360 electrical degrees, the distance between like poles) during one cycle of the alternating current supply.

If the frequency is 1 cycle per second the rotor R will make 1 revolution per second. Now, if a four-pole motor be arranged as at II (Fig. 8) it is evident that, during 1 cycle, a field pole will pass through only half revolution. Therefore, with this 4-pole machine and a frequency of 1 cycle per sec. the motor would make two revolutions per second. Thus, in making one complete revolution the field of any synchronous motors turns through 360 mechanical degrees. The number of electrical degrees through which it turns depends upon the number of poles. Obviously: rev. per sec. = cycles + (number of poles + 2). Or simplified: Rev. per sec. = (2 × cycles) + number of poles. Then the rev. per min. will (since there are 60 sec. in a minute) equal 60 × (2 × cycles) number of poles = (120 × cycles) + number of poles. It will be noted by referring to Art. 713 in the author's "Pracitcal Electricity" that the equation just given is the same as that, there derived, for determining the speed of an alternating current generator.

Example.—What is the speed of an eight-pole, 60-cycle, synchronous motor (Fig. I, 276, 2A)?

Solution.—Substitute in above equation: r.p.m. = (120 × cycles) + poles = (120 × 60) + 8 = 900 r.p.m.

Example.—It is desired to instal on a 60-cycle circuit a synchronous motor which will operate at 1,200 r.p.m. How many poles will this machine have?

Solution.—Substitute in equation:

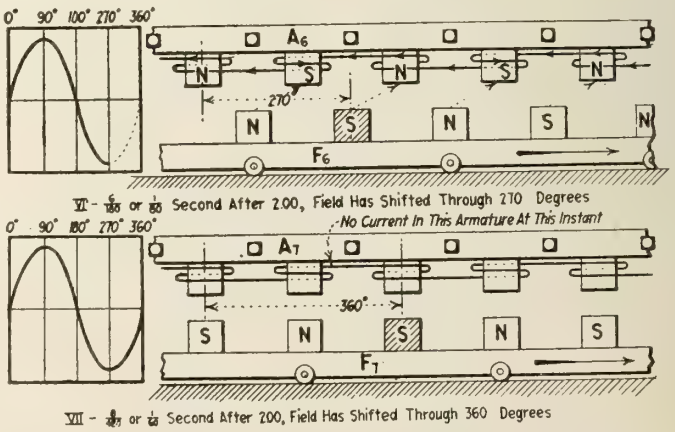

VI - 1/180 or 1/60 Second After 2.00, Field Has Shifted Through 270 Degrees
No Current In This Armature At This Instant
VII - 1/240 or 1/120 Second After 2.00, Field Has Shifted Through 360 Degrees

FIG. 6—A CONTINUATION OF FIG. 5, SHOWING OPERATION OF A SYNCHRONOUS MOTOR ON A 60-CYCLE CIRCUIT.

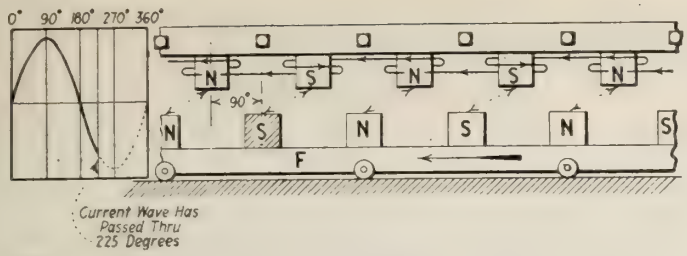


FIG. 7—Current wave has passed through 225 degrees, but slowly-moving field has passed through only 90 electrical degrees. Electro-magnetic repulsion tends to move the field toward the left.

number of poles (120 × cycles) + r.p.m. = (120 × 60) + 1200 = 6 poles.

Example.—It is known that a certain motor has 10 poles and that its operating speed is 300 r.p.m. What must be the frequency of the supply circuit upon which this machine is used?

Solution.—Substitute in the formula: Cycles = (poles × r.p.m.) + 120 = (10 × 300) + 120 = 25 cycles.

Note.—In the author's "American Electricians' Handbook" there is a table

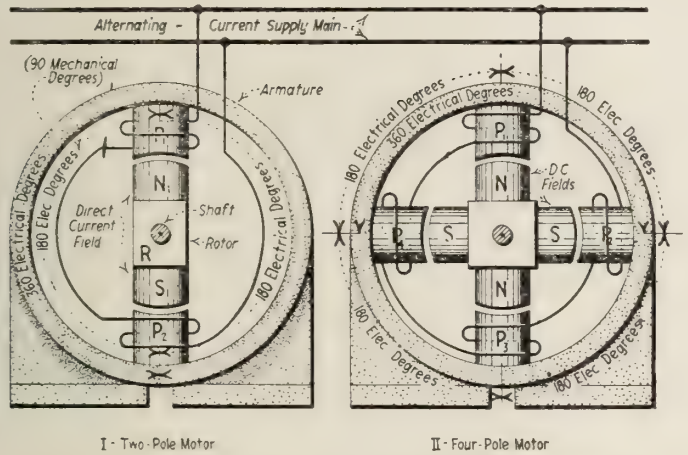


FIG. 8—ILLUSTRATING WHY THE SPEED OF A SYNCHRONOUS MOTOR IS DETERMINED BY THE NUMBER OF POLES.

of synchronous speeds of alternating current motors and generators for the commonly used frequencies between 25 and 133 cycles and for the commonly used numbers of poles between 2 and 100.

A HAIR-BREADTH ESCAPE

It has been very appropriately said that the number of boiler explosions that are prevented through the advice of inspectors can never be known. This fact, while fortunate for the community at large, detracts a great deal from the credit that properly belongs to the inspector if appearances are taken as the only criterion in judging the results of his labors. Every now and then however we meet with a situation where surely an explosion would have occurred involving heavy death toll and enormous property damage were it not for the inspector's timely advice based on his intimate familiarity with steam boilers and their appendages.

A short time ago the manager of a news-printing establishment in a Middle-Western city telephoned our local representative stating that the safety valve on their boiler was blowing continually but that they were unable to raise the pressure high enough to operate the engine. He further said that their engineer had attempted to adjust the safety valve until he had screwed it down to a point where the spring broke. The boiler had then been cooled down and a new safety valve set at the desired pressure was installed, but this gave no better results as regards pressure. The new valve continued to blow and still not enough pressure to run the engine.

As the printing of the first edition of the newspaper was being considerably delayed for lack of motive power, they desired to know whether it would not be all right to plug the safety-valve opening and station a man at the steam gauge to guard against over-pressure until the day's work was finished. Our representative, sensing the danger and instinctively, as it were, feeling what was wrong with the installation, requested that they immediately bank the fire and await the arrival of an inspector.

Upon looking over the installation the inspector found the steam gauge on the boiler registering 15 lbs. pressure and the engineer called his particular attention to the fact that the gauge in the engine room also showed 15 lbs. Two steam gauges registering the same. Was not that proof that the trouble must be elsewhere than with the gauges?

Our inspector found, however, that the two gauges were connected to a single pipe which led to the upper water column connection and that this connection was choked which prevented the steam gauges from indicating the actual boiler pressure. It is quite probable that the amount of over-pressure, at the time that the safety valve had been screwed down until the spring broke, was very great and in fact it may have been very close to the bursting pressure of the boiler. At any rate we feel that the persons that were near the boiler at the time the engineer was experimenting with the safety valve are to be congratulated with their escape from a violent death. As the boiler was located in the basement of a four storey building filled with people, the loss of life would undoubtedly have been very heavy.

It is really strange that any one, with even a slight knowledge of the make-up of a spring-safety-valve can imagine that such a valve will all of a sudden begin to relieve the boiler at a much lower pressure than that at which it is set, but somehow there appears to be a tendency in the human mind to regard the indications of the hand on the steam gauge dial as absolute. When a marked difference shows up between the pressure indicated by the steam gauge and the relieving pressure of the safety valve, the first inclination seems to have been, in a number of unfortunate cases, to go for the safety valve.

We cannot bear down with too much emphasis on the warning to **let the safety-valve adjustment alone** after it has once been set to relieve at the desired pressure, unless of course, a small change in the working pressure is expressly wanted under normal circumstances. One of the principal functions of the safety valve is to take care of just such conditions as the derangement of the steam gauge. Blind confidence in the steam gauge has been the direct cause of a number of boiler explosions on record and these explosions have been particularly violent. This, no doubt, is due to the fact that a very high pressure may be reached when the safety valve is overloaded and consequently an enormous amount of energy is stored up within the boiler.

One of these unfortunate cases was the explosion that took place on the U.S. gunboat "Bennington" on July 21st, 1905, while at anchor in the harbor of San Diego, Cal. In this instance a boiler was fired up from a cold condition. After the water in it had been brought to boiling temperature and the air had been blown out by the first formation of steam, one of the fire-room crew was ordered to go on top of the boiler and close the air cock. This he did, but it appears that he also closed the cock on the outlet leading to the steam gauge so that it failed to register the rapidly forming steam pressure.

No one suspected that anything was wrong with the gauge and the boiler was fired heavily in order to hasten the

(Continued on page 38)

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII TORONTO, SEPTEMBER 5, 1920 No. 17

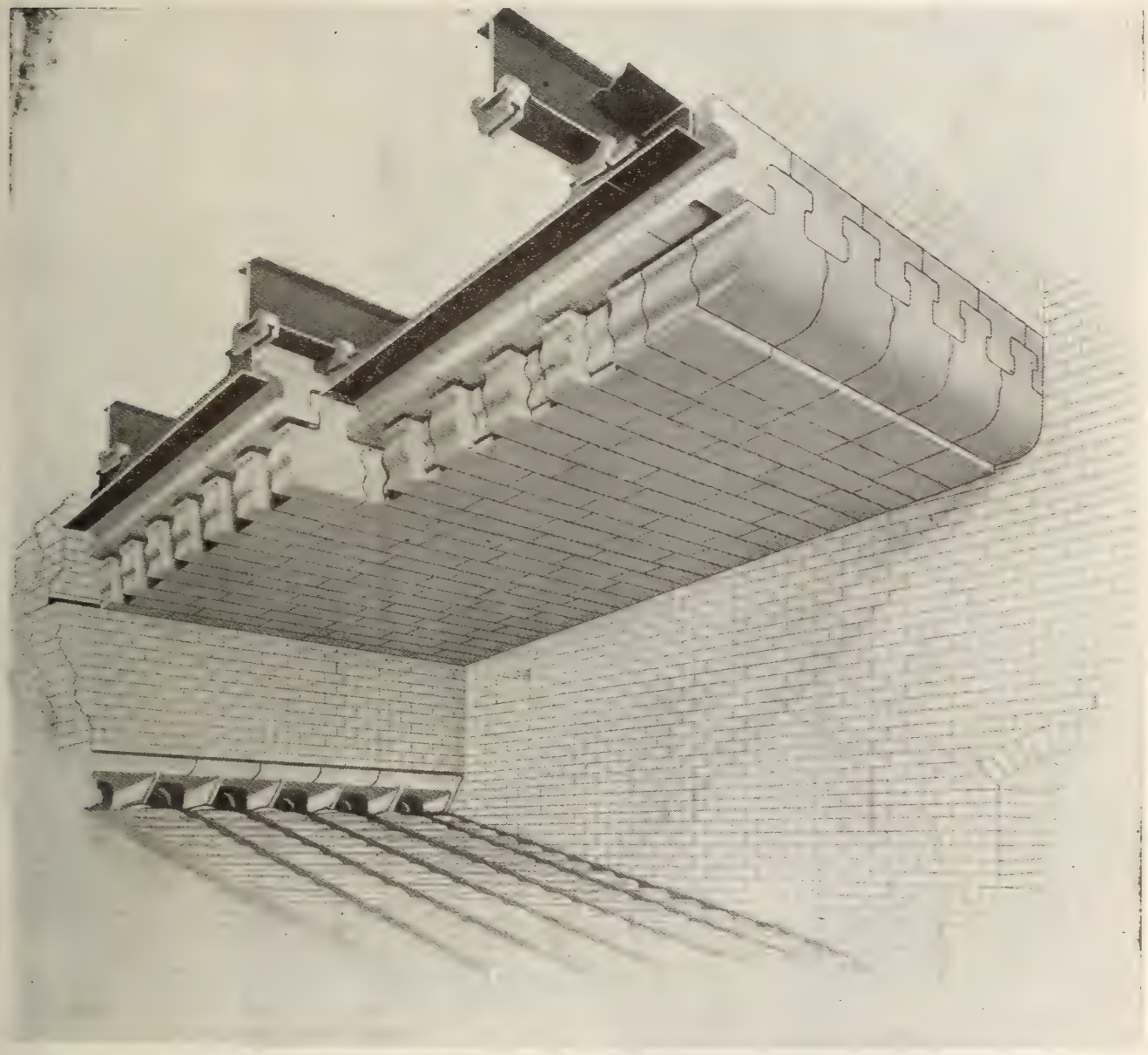
PRINCIPAL CONTENTS

Power Plant Management 395
A Mysterious Engine Accident 400
A Course of Instruction 403
A 25,000 H.P. Mill Engine 405
Alternating Current Motors 406
Editorial 410
Progress in New Equipment 411
Operator's Point of View 413

Uniflow or Compound Engines

AN interesting discussion is now going on in the technical press of the Old Country on the question of the relative merits of the uniflow engine as compared with the compound reciprocating engine. The discussion arose from a paper read before the Institute of Mechanical Engineers, and an editorial article in The Engineer, one of the leading English papers. In this article the writer stated that the high efficiency of the uniflow engine was something of a mystery, as there must be a great loss of heat from the large piston which is in contact with steam at practically the condensor pressure while exhaust is taking place, and is then in this cool state brought into contact with steam at admission temperature and pressure when the admission ports open. In a compound expansion engine the differences in admission and exhaust temperatures in each cylinder are very much less, as the uniflow engine has practically the same temperature range in one cylinder that the compound or triple expansion has in two or three. Another point mentioned by the writer of the editorial was that an engine having the high compression that is found in the uniflow engine, and having only a single crank, must be a very difficult engine to start. The writer concluded by giving his opinion that the uniflow engine had practically no advantage over the compound engine. Mr. Perry, the author of the paper, replied to this editorial in a letter, in which he defended the uniflow engine from the objections brought against it. With respect to the cooling effect of the piston, he argues that the cooling effect of the exhaust steam is only felt for 10 per cent. of the outward stroke and 10 per cent. of the inward stroke of the piston, while in the ordinary engine this cooling effect is in evidence for 90 per cent. of the stroke. The high compression which takes place in the uniflow engine, he claims, brings the piston up to the same temperature as the admission steam before admission takes place, thus eliminating condensation from that cause, and as the compression pressure is actually higher than the admission pressure, the steam is admitted into a space already filled with high temperature steam. With regard to the uniflow engine being almost invariably a single crank engine, Mr. Perry claims that this is because the single crank engine is easier to manufacture, and more economical than a two crank engine, and he states that there is no difficulty in starting as the compression can be relieved for this purpose. The question of unequal turning moment, he says, is merely a matter of weight of fly wheel. Thus far the defender of the uniflow type. Then comes Mr. Albert C. Pain, M.I.M.E., of the firm of Belliss & Morcom. Mr. Pain commences by stating that although the uniflow engine is claimed to be more economical than the ordinary compound expansion type, he knows of a case where a uniflow engine was installed in a power plant already equipped with triple expansion engines of the same capacity, and after prolonged tests the uniflow unit was found to require 17 per cent. more coal for the same loads than the triple expansion sets. Mr. Pain claims that it is not a good thing to concentrate all the loads and strains of a large engine on a single crank pin, and a single set of bearings, and a single set of valve motion. He asks if these facts do not account for the trouble often experienced with the bearings of uniflow engines and says it is necessary to flood these bearings with oil from a special pump before starting. He states that he knows of two cases where the metal has been run out of the bearings through neglecting this precaution. The heavy piston also requires a large amount of oil, and the engine generally is heavy on oil consumption. He claims that owing to the heavy piston used, mechanical efficiency of the uniflow engine is less than that of the compound expansion engine. He alludes to the fact that both cylinder and piston of the uniflow engine have to be bored taper on account of the difference in temperatures existing between the centre of the cylinder and the ends. He also claims that they do not stand up so well to high super-heats as the ordinary engine. It can only be built to run at low speeds. Mr. Pain comes to the conclusion that there are so many disadvantages connected with this type of engine that it will eventually disappear. Of course, Mr. Pain is not prejudiced in the favor of the uniflow type of engine by reasons of his business affiliations, and no doubt there will be a reply from Mr. Perry in an attempt to demolish these arguments. There is a good opportunity for those who are interested in this comparative newcomer to the ranks of prime movers to have its pros and cons well discussed by men eminently capable of doing so. It would seem to us that the proposed investigation which a committee of the Institute of Mechanical Engineers are about to make into the uniflow engine from a thermo dynamical and mechanical point should be of great value, and furnish a sound base from which the prospective purchaser of a steam engine can compare the merits of the different types, uniflow, compound expansion, and turbine.

Progress in New Equipment



THE LIPTAK ARCH.

THE LIPTAK ARCH

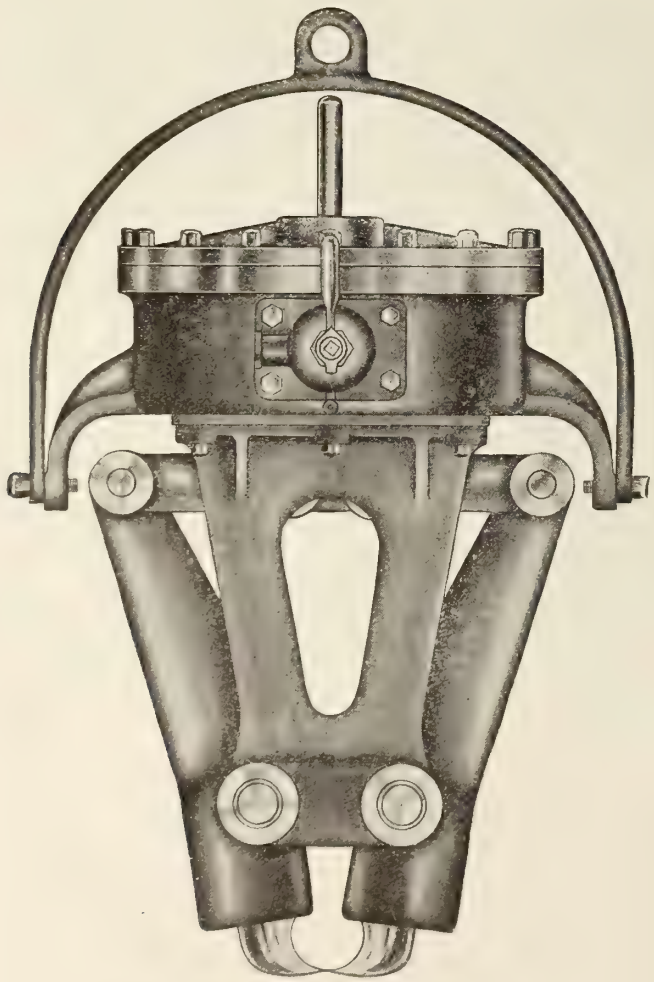
The accompanying cut illustrates the Liptak Arch for boiler furnaces. This is known as the Liptak Double Suspension Arch, and it is claimed that it successfully solves the problem of high upkeep cost of fire arches. A special feature of the arch is the ease with which the framework can be erected, the hangers being hung on the I beams by simply slipping them over as can be seen in the illustration. The T shaped cast channels are then slipped into the hangers, and the whole thing erected without the use of any tools of any kind. On the framework is hung first what is called the emergency arch, which only comes into use when the main arch is completely worn away, and allows the boiler to continue in use until a new main arch can be put in. The reserve arch acts as a protection to the framework, keeping the direct heat of the fire away from it, and therefore prolonging its life indefinitely. It is stated by the makers that crystallization or warping of the ironwork is unknown where the Liptak is used.

The blocks of the main arch, which are in direct contact with the fire, are arranged with staggered joints, which make the flame pursue a broken course, thereby minimizing the destructive action of the fire on the joints. The wave line joint at the ends makes the blocks retain their position until they are com-

pletely destroyed. This form of construction makes the use of fire clay or packing unnecessary, effecting a further saving of labor and material. Dead air spaces are provided between the emergency arch and the framework, and also between the main arch and emergency arch. It is claimed by the makers that a person can stand on top of the arch in bare feet when the furnace is at a high temperature, without suffering any inconvenience. This is a proof of highly efficient insulation. The end blocks are made with replaceable tips, and of special design to afford plenty of support to the apron wall. It is necessary to burn away two arches before the iron work is exposed to the fire. So far the makers have not been called upon to replace any iron work through burning, or to furnish a replaceable tip from the same cause. The Liptak arch is handled in Canada by the Green Economizer Co., Kent Building, Toronto, Ont.

STAYBOLT CUTTER

The Baird Pneumatic Tool Co., Kansas City, have placed on the market the staybolt cutter as shown in the illustration.



GENERAL VIEW OF THE STAY BOLT CUTTER.

It is said that this cutter will clip off staybolts up to 1⅛ in. diameter at the rate of 1,200 per hour.

The machine is composed of a 15 in. air cylinder, the piston head of which connects directly through toggle movement with a pair of lever arms, into which are fastened, but removable, a pair of cutter knives of sufficient strength to clip the stay bolts.

The machine is operated at a working pressure of 100 lbs. air pressure. It delivers 88 tons pressure on the knives and the blades are so designed that when placed against the crown sheet the stay bolt is cut off just the proper distance to allow for heading over.

The machine can be operated on modern rail stay, or marine boilers, and is capable of being held at the gravity point at any angle, being perfectly balanced. This feature allows it to be easily handled on either straight side or radial stay work. Different sized blades are used depending upon the nature and length of bolt to be cut.

The machine is so designed that it can be operated by one man, and all control valves are placed convenient to the operator. Apart from use in staybolt cutting, these machines can be used for the reclamation of scrap. Following are its principal specifications: Diameter of cylinder, 15 in.; travel toggle, 3 in.; maximum capacity between cutter knives, 1⅛ in.; air pressure required, 100 pounds; maximum tonnage on cutters, 88 tons; net weight complete, 430 pounds.

AIR OR STEAM ENGINE

A small engine that may be operated either by steam or air for driving portable mechanism, such as boring bars and drilling machines, has been developed by the H. B. Underwood Corporation, of Philadelphia, Pa. The working parts are inclosed in an oil-tight case which forms part of the engine base. The engine operates at a speed of 250 r.p.m. on a pressure of from 70 to 125 lbs. per square inch. These engines are made in two sizes, 3 and 5 H.P. Weight about 270 lbs.

CYLINDER REAMERS

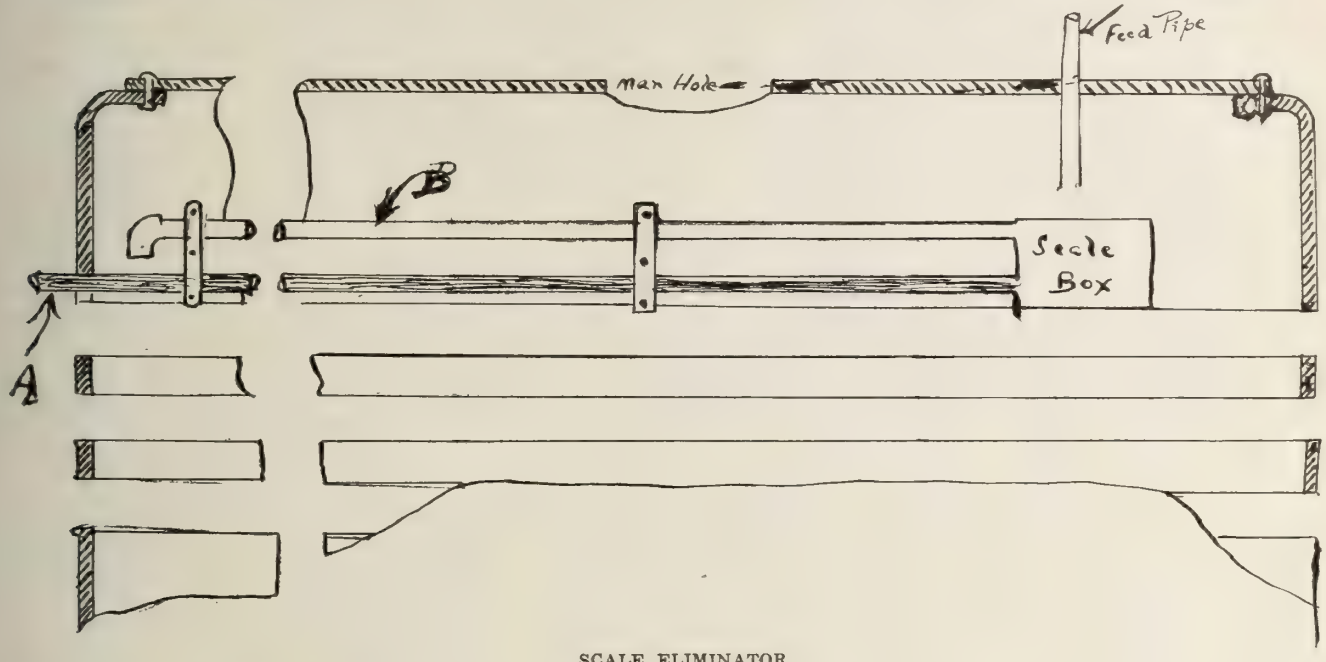
The Wetmore Reamer Company of Milwaukee, Wis., is placing on the market a special set of reamer tools, designed for the production of round, straight and thoroughly smooth holes in small cylinders. A set consists of three reamers, one for roughing, one for semi-finishing and the third for finishing. Suitable arbors are provided for all makes of machines. The finishing reamer is of the floating type. All cutter blades are made of high-speed steel and accurate adjustment is provided to 0.001 inch.

FRICTION CLUTCH

The Link-Belt Company, of Chicago, are now making a new design of "Twycone" friction clutch that embodies the following features:—One-point adjustment, perfect balance, and complete inclosure of all moving parts. The friction cones are lined with thermoid, and the clutch may be operated when running at full speed.

Mr. A. W. Wheatley, who was recently elected president of the Armstrong, Whitworth Co., of Canada, Limited, assumes his new duties well qualified for the position. After serving his apprenticeship with the S. E. Railway in England, Mr. Wheatley went to the United States, where after some fifteen years spent in the mechanical departments of several American railways he was appointed in 1907 to be general inspector of all plants for the American Locomotive Works, with headquarters at Schenectady, N.Y. He was here for only a short time when he came to Canada as manager of the Montreal Locomotive Works, where he remained until 1911 when he became manager of the Dunkirk plant of the American Locomotive Works. In 1912 he returned to Canada as vice-president and general manager of the Canadian Locomotive Company at Kingston, Ont., and continued in this position until 1916 when he was elected to the presidency of the Lima Locomotive Works, Lima, Ohio.

The Operators' Point of View



SCALE ELIMINATOR.

COPPER GASKET KEEPS STEAM ENGINE IN OPERATION

By W. S. STANDIFORD

A number of years ago the writer was roll-turner in a small mill, the roll lathe being driven by a 15-h.p. steam engine. While working on a breakdown job, the rubber gasket on the back end of the steam cylinder gave way allowing the steam to leak out to such an extent that the engine would barely operate the lathe without a tool in it. The writer shut the engine down and looked around the mill for another gasget, or a piece of rubber sheeting to make one, but none could be found.

The mill being located in a very small country town having no hardware store where some rubber sheeting could be gotten, it was necessary to either shut the lathe down until the gasket material could be obtained from a neighboring town, or to use a makeshift to keep the machine running so as to allow the job to be finished, the latter course being decided upon. A sheet of copper 1-32 of an inch thick and of sufficient diameter was found in the shop, and cut into circular shape to fit engine cylinder end, bolt-holes being cut to match those on cylinder. The copper gasket was put on engine when the cylinder was cold; the nuts on the bolts being screwed up as tightly as possible. On starting up the engine, a small wisp of steam issued out in one place, and as the cylinder heated up, the copper expanded and stopped the small leak entirely, thus enabling the turning to be finished with only a small delay. Since then, on other occasions, the writer has also found that two zinc sheets laid on top of one another can also be used in place of rubber gaskets in emergencies and give good satisfaction.

A SCALE ELIMINATOR

In former copies of Power House different methods have been described for feeding water to steam boilers. The inventor of the method shown in the enclosed sketch claims it is among the best ones ever made on the internal feed pipe system. The ordinary scale box is used with the addition of two pipes. The box is located near the front head, from the bottom of the box a pipe extends through the back head and brick-work, a valve is attached and the other end of the pipe from the valve enters the sewer or discharge tank. By opening the valve at intervals most of the sediment will be blown out before it is converted into hard scale. From the top of the box a pipe extends to the back end of the boiler where the water is discharged partly cleared of sediment and practically as hot as the water being used in the boiler. The pipes are held apart by clamps, or pipe B can be lowered to the same level as pipe A by using two 45 degree elbows and a short piece of pipe at the box.

If brass pipes can be used inside the boilers it will be an improvement over iron as scale or sediment is slower in attaching itself to brass than to iron. I am not the originator of this plan. It has been described to me.

JAMES E. NOBLE,
Portsmouth, Ont.

Shipping Documents Must Accompany Goods.—The Customs Department of Australia has notified the Department of Trades and Commerce in Canada that in future, starting from January 1 next, no goods will be delivered unless the shipping documents are on hand. This is because a great deal of trouble has been experienced through the failure of documents to arrive with the goods from Canada. There will be exemptions to this rule only in the most exceptional circumstances, and in these cases an extra duty of 50 per cent. will be demanded pending the arrival of the documents.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
⅛	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse	base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb.	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	10%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	15
Stove bolts	55
Wrought washers	25
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	58
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 50
Linseed oil, raw, single bbls.	2 90
Linseed oil, boiled, single bbls.	2 92
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20	Dark colored	09
Mixed colored	10		

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Gross Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

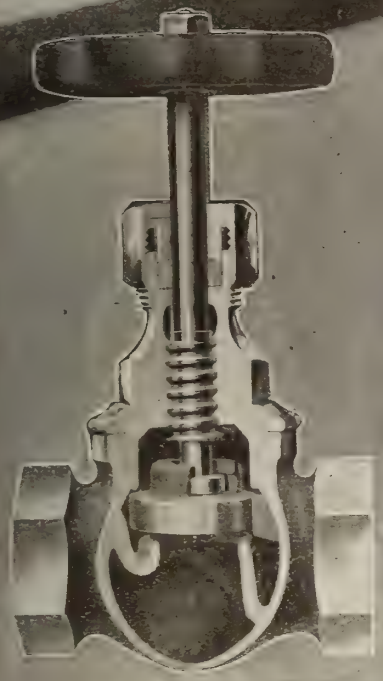
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

FAIRBANKS-MORSE



An Achievement in Mechanics

EACH individual department of The Canadian Fairbanks-Morse Company, Limited has given industrial Canada a new conception of achievement in mechanics. Each department has established a 100% quality and service standard. This is what enables Fairbanks valves to stand pre-eminent wherever valves are used.

When an engineer specifies Fairbanks valves, he knows that he has selected not only quality of material but workmanship that guarantees perfect operation.

He is satisfied with the reputation and service of the institution that stands behind them. He acknowledges an achievement in mechanics.

Wherever pipe lines are laid—in Canada's great industrial plants—in her immense water systems—in mines and mills—Fairbanks valves are giving a service that is marked by the 100% seal of quality, the standard of The Canadian Fairbanks-Morse Co. Limited.

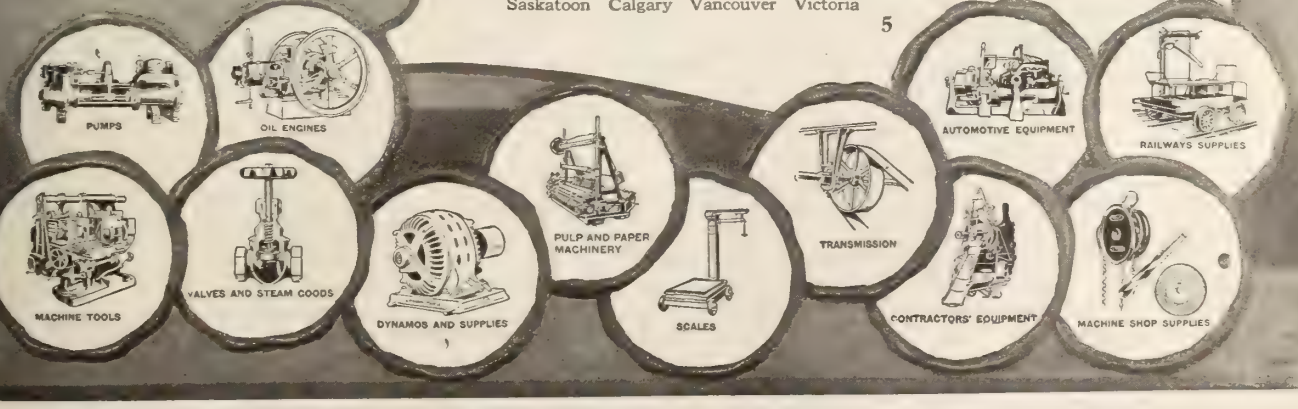
Our nearest branch will give you the benefit of this service, Our experts will help you in selecting valves and everything mechanical that you require. Make our catalogue your buying guide.

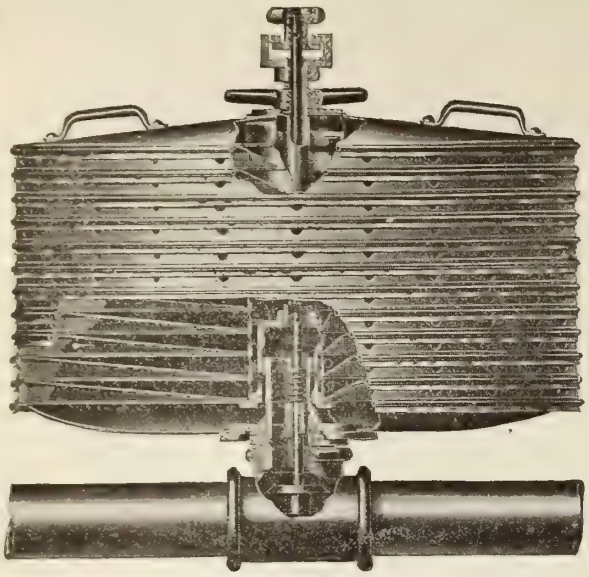
The Canadian Fairbanks-Morse Co.
Limited

Canada's Departmental House for Mechanical Goods

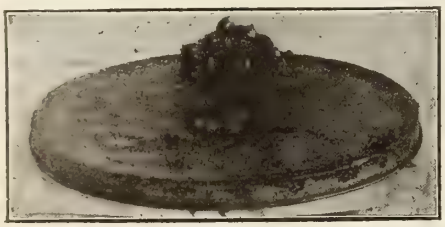
Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

5





No. 1—Sectional View of Bowser Filter Section Assembled.



No. 2—Filter Disc with dirt filtered from oil.

It Gets The Dirt
It's A BOWSER Oil Filter

The pictures shown illustrate the Bowser Filter Section as used in the Bowser Oil Filter.

No. 1 shows the Filter Section assembled, ready for use. No. 2 shows one of the Filter discs with dirt that the Filter has collected from used oil. This pile of dirt is about 6 in. in diameter and from 2 in. to 3 in. high.

There are twelve of these filter discs and cloths in a Bowser filter section, each as effective as the one you see pictured. As many complete Filter Sections as needed are furnished in the Bowser System.

Bowser Systems are applicable to any size and type of power producing and transmitting machinery.

We will be glad to send literature and explain to you how the Bowser principle of Oil Filtration can be applied to your power plant.

S. F. BOWSER COMPANY, Limited

66-68 FRASER AVE., TORONTO, CANADA

Offices in Principal Cities of the World

steam pressure which according to the gauge remained at zero. To complete the chain of unfortunate circumstances the safety pressure was permitted to build up and finally the boiler gave way in its weakest part.

The total number of persons killed was 62 and besides this there were 40 more or less severely injured. This unusually large number of casualties for a boiler explosion was, of course, due to the cramped conditions usually prevailing in a ship's power plant and the fact that on naval vessels men are likely to gather in great numbers at any given point, but no doubt the very high pressure at the time was a contributing factor to this large loss of life.—The Locomotive.

WHY WESTINGHOUSE DOES NOT USE THE METRIC SYSTEM

It is sometimes difficult to explain the obvious, all the more so when reasons for explanation appear unnecessary as well as approaching monotonous repetition.

This is doubly true of the case against the adoption of the metric system, whose use pro and con has been expounded in all sections of the United States since the early part of the nineteenth century. At first, suggestions were quietly put forth regarding its supposedly simple characteristics. During the past few years propaganda urging its general adoption has grown more aggressive until now the mails are filled with metric literature. Bills have even been introduced in Congress whose passage would have meant that the use of any system of weights and measures other than metric would have been illegal.

In spite of all this urging there appears to be no general demand for the adoption of the metric system in this country. The manufacturing plants which are using it are few in number and they are doing so under difficulties, while the great mass of people who are responsible alone for a system of weights and measures are scarcely aware of its existence. This cannot be attributed to ignorance for it is taught in all public schools. There is no "gag," for the statutes of the country legalized its use many years ago. If it has so many desired characteristics it would seem to the layman that the process of simplifying weights and measures was very slow.

One of the reasons most commonly urged for the adoption of metric units was that it would greatly aid foreign trade. That would appear to be inviting the mountain to go to Mahomet, for the greater number of manufacturing plants are located in English-speaking countries where naturally the people use only the British system of weights and measures. Factories located in the United States, for instance, sell all but a small per centage of their goods in this country. It would appear then, that to sell a few articles to metric countries, a certain class would make one hundred million people climb out of their accustomed channels to learn a puzzling unfamiliar language. Nor is this necessary, for Westinghouse Electric and Manufacturing Company does a great deal of business with countries using the metric system without difficulty or embarrassment.

From stories sent out it would seem that all foreign countries with the exception of Great Britain were metric. That this is not true is evident from the fact that even those which are out and out metric, like France, Belgium, Denmark, etc., are more familiar with the English system than we are with the metric. In Latin America some countries use a system of English extraction but with Spanish terms. Some use metric and Spanish. Others use metric alone, but they are all familiar with the English.

No one doubts for a moment the tremendous difficulties that would be involved in making this country over into a metric speaking and thinking people. These difficulties would multiply daily until nothing less than chaos would result. First, the greatest number of people in the country would have to learn the metric tables. Then they would have to translate metric terms into English before a ratio of values could be obtained. This in daily life where thousands of small transactions are carried on would be ludicrous. Imagine the mental calisthenics of a grocer should he suddenly be asked for .454 kilograms of butter, which is approximately one pound.

This is a period when production is

DURABLA

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Use The LONG STEAM *for* TRAP SATISFACTION

Automatically drains jacket kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.

The Hamilton Powder Works, Beloeil, P.Q., use them with great success. Read this letter:

Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.

(Signed) J. Murray Wilson,
Superintendent.

Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

J. T. LONG

48 ADAM ST.

MONTREAL - CANADA

If your dealer does not sell it, write direct.

4

needed throughout the country, there being a shortage of manufactured materials. Is there any reason for urging the adoption of the metric system at this time, when it is certain that were it suddenly introduced in the factory production undoubtedly would be held up and more than likely would be stopped entirely, until the workmen familiarized themselves with the new units? The very fact that English measurements can be halved and quartered without introducing complicating fractions makes it more advantageous in shop work than the metric measurements.

A case in which metric measurements complicate shop work has been recently acknowledged by an official of one of the largest tire companies in the world. His company recently adopted the metric system and it is now partially used in all except the most recent factory, which is all metric. His words regarding the advantages of the system are interesting, particularly in regard to its use in the storekeeping and shipping departments. In the former, raw materials received in English units must be transferred into metric units by production clerks before going to the workmen. Upon completion, the metric article must again be converted into the English units in order to mark shipping weights. There are some departments of the company which are still using the English system. More translation. This condition, the writer says, will last until the United States adopts the metric system. Judging from past experience there will be a long wait.

NON-CORROSIVE CYLINDER OIL

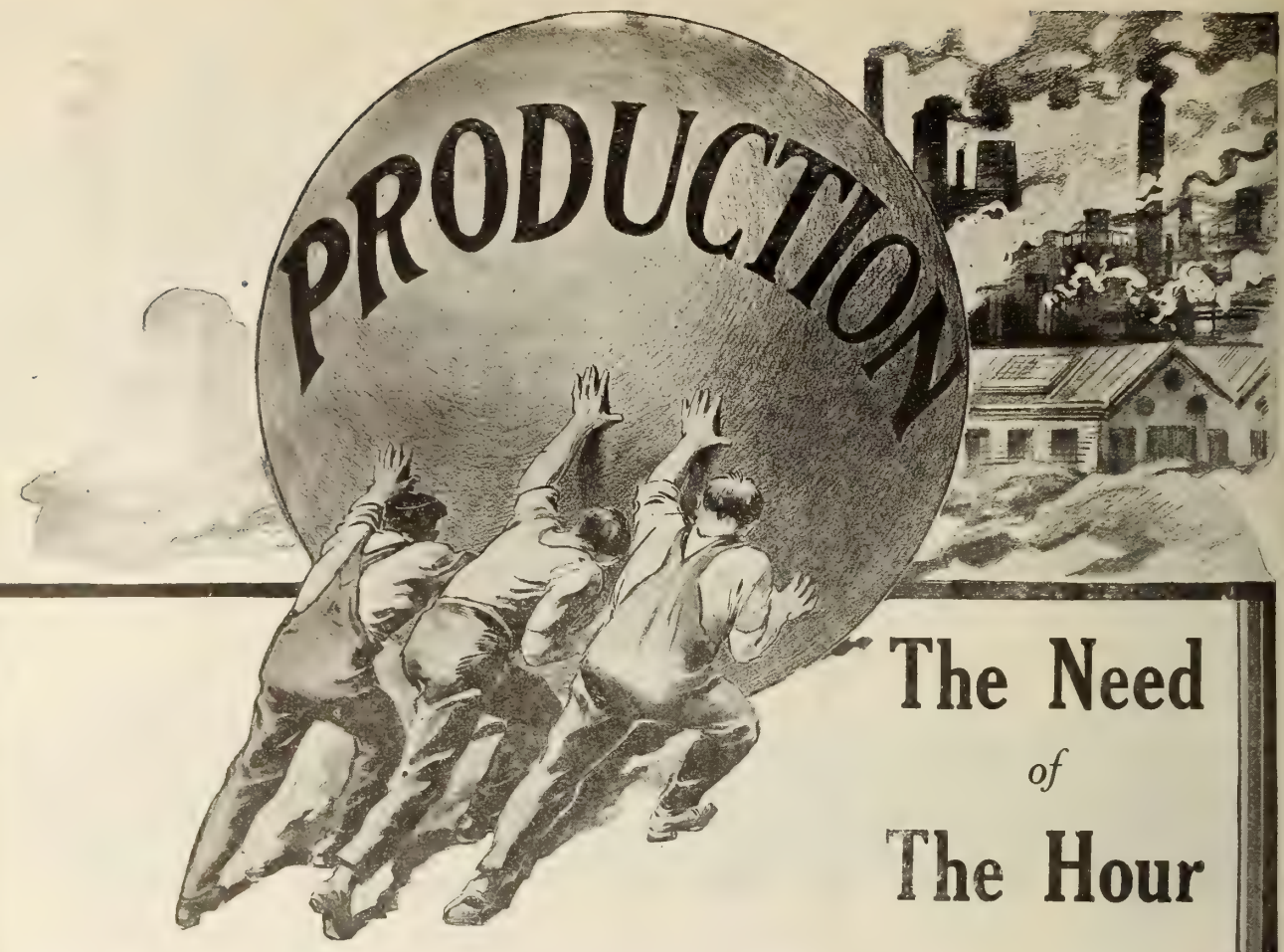
MANUFACTURED ONLY BY E. H. KELLOGG & CO. NOS. 242 TO 244 SOUTH ST. NEW YORK, U.S.A.

FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,

New York, U.S.A.



The Need *of* The Hour

PUSHING PRODUCTION to meet the demand necessitates the saving of all useless operations about the plant, among which is the constant repacking of piston rods and small valves, which may be avoided by using

"PALMETTO"

REG. TRADE MARK

the packing that has the quality that gives long, satisfactory service.

Such a packing may cost a little more than ordinary packing but is worth it because of the big saving in the labor of frequent application.

Let us send you working samples to test. No charge.

Greene, Tweed & Co.

Sole Manufacturers

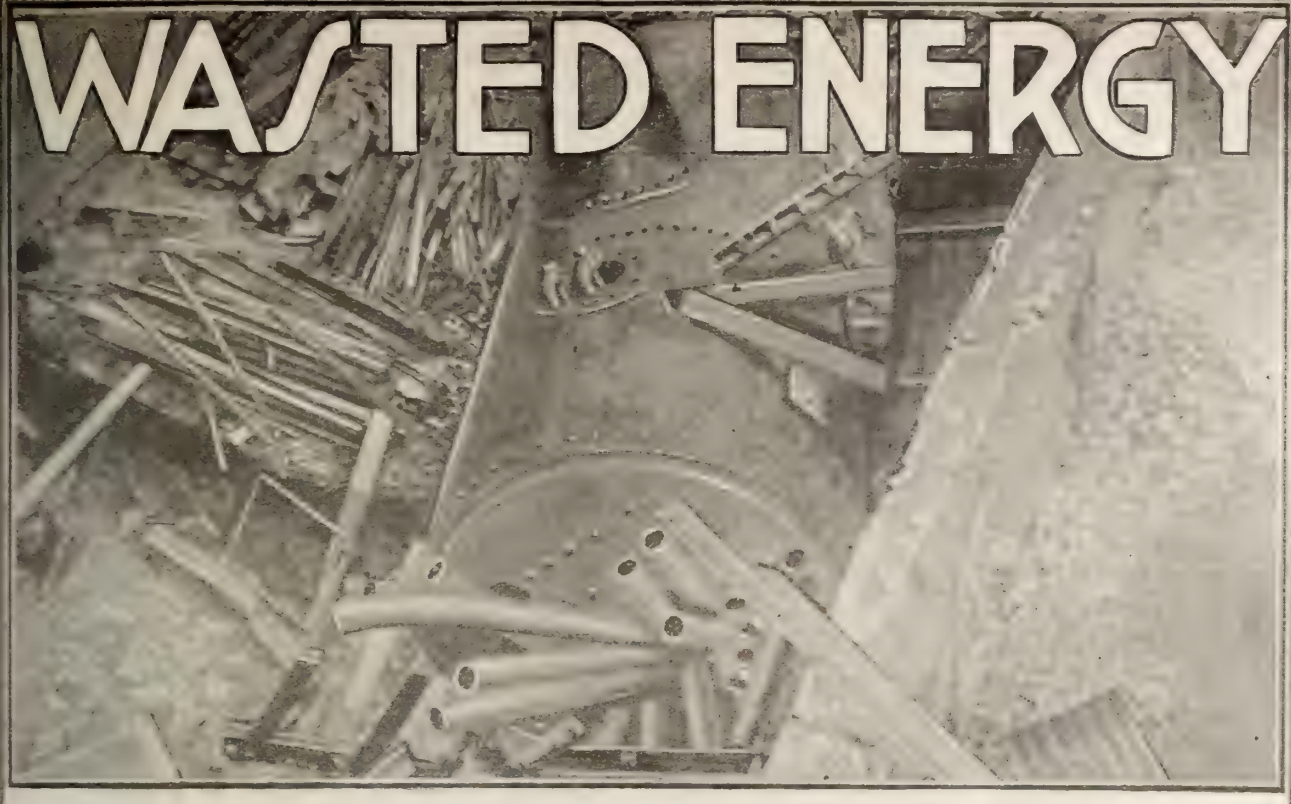
109 Duane St.
NEW YORK

Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver

WASTED ENERGY

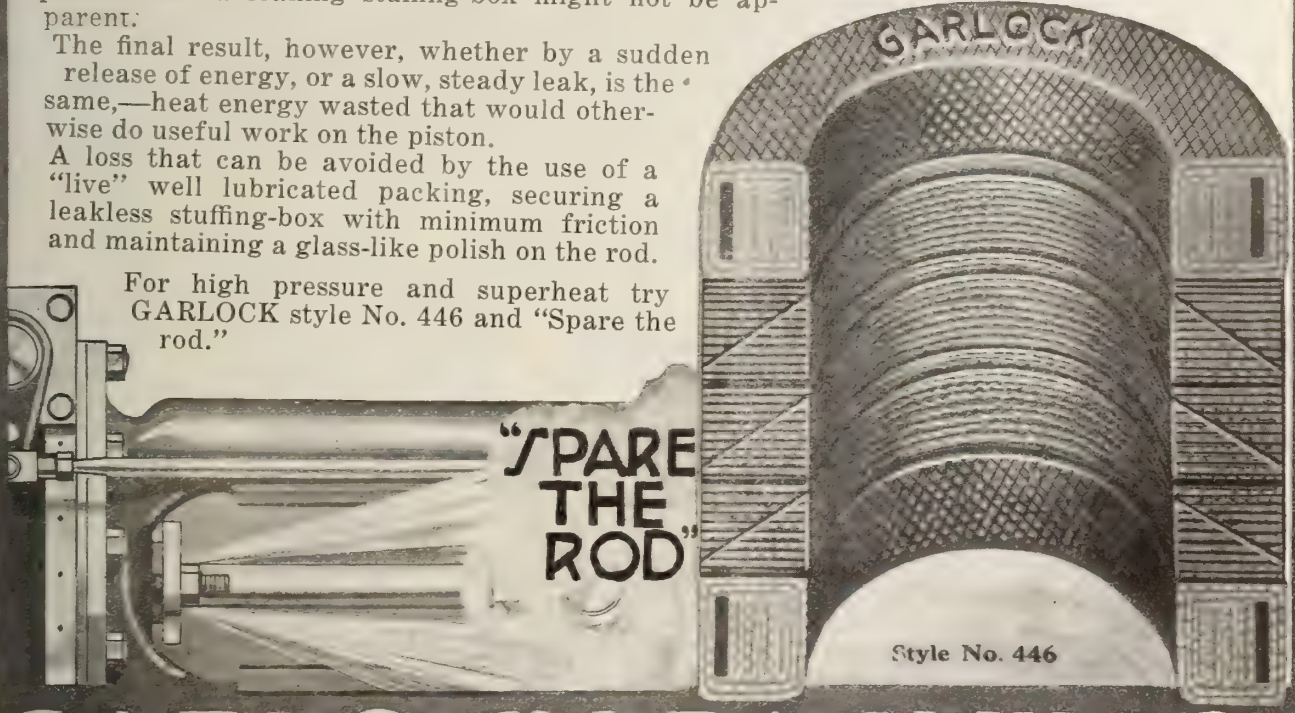


At first glance, the connection between a boiler explosion and a leaking stuffing-box might not be apparent.

The final result, however, whether by a sudden release of energy, or a slow, steady leak, is the same,—heat energy wasted that would otherwise do useful work on the piston.

A loss that can be avoided by the use of a "live" well lubricated packing, securing a leakless stuffing-box with minimum friction and maintaining a glass-like polish on the rod.

For high pressure and superheat try GARLOCK style No. 446 and "Spare the rod."



GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

Branches
MONTREAL, QUE. CALGARY, ALTA.
TORONTO, ONT. ST. JOHN, N.B.
WINNIPEG, MAN. VANCOUVER, B.C.

Which?

The Old Soft Rubber Valves For Your Plant OR

Rub-Steel Valves

If you are running your plant by obsolete methods; satisfied with makeshifts and second best equipment; content to lose out in the march of progress, the old soft rubber valve is good enough for you.

Voorhees Rub-Steel Valve is the new way, the best way of obtaining real valve service. It cannot soften, dish or blow through the ports. The rigid "backbone" of steel keeps it strong under all temperatures and pressures. The rubber seating surface gives it the necessary resiliency.

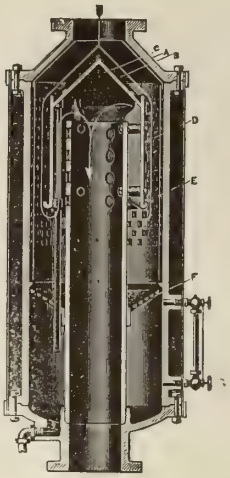
Ask for free trial valve.

The Canadian Fairbanks-Morse Co., Limited

Exclusive Canadian Agents for
Voorhees Rubber Mfg. Company
Jersey City, N.J.

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

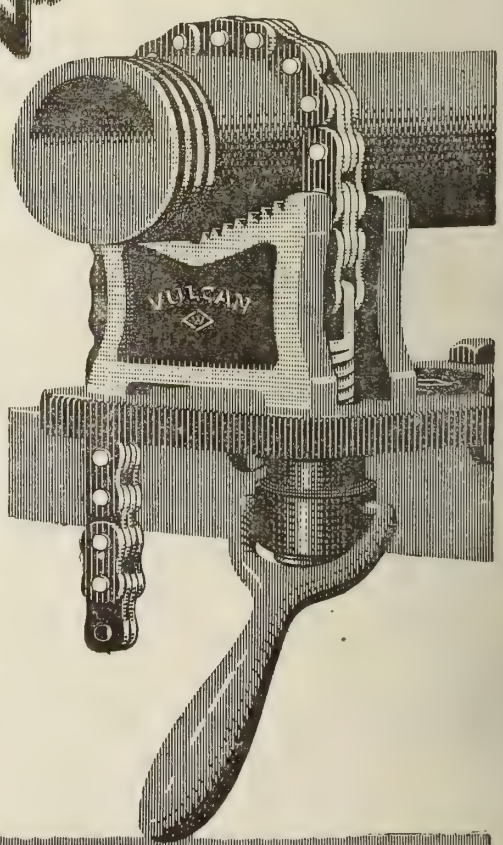
III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

WILLIAMS' "VULCAN" DROP-FORGED CHAIN PIPE VISE



A PIPE vise, like any tool intended for rough usage, should be so designed and constructed that the severe strains and stresses of hard, continuous service cannot cause breakage or failure in operation.

Williams' "Vulcan" Chain Pipe Vises have no weak parts to fail through faulty design. Though they are far lighter and cost less than the conventional cast pipe vise, they are unbreakable. These Vises are made entirely from wrought metal, tested in our Laboratories before used. Each Chain is hand made.

Nothing that engineering experience and technical skill can suggest to improve them is omitted in their manufacture. All are backed by our unconditional guarantee.

Three sizes for ⅛ to 8" pipe. Booklet on request.

J. H. WILLIAMS & CO.

"The Drop Forging People"

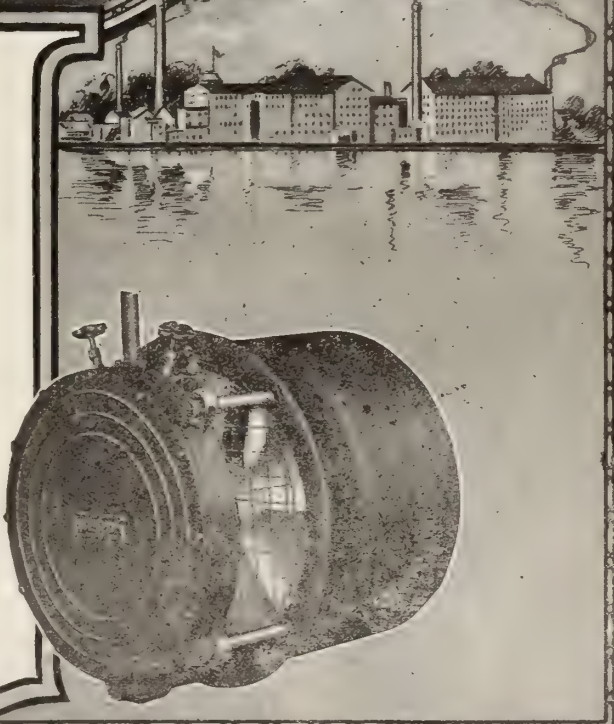
CHICAGO
1078 W. 120th Street

BUFFALO
78 Vulcan St.

BROOKLYN
78 Richards St.

Western Canadian Agent: W. Bruce Campbell, 78 Confederation Life Bldg., Winnipeg

REGISTERED COPPUS U.S.PAT.OFFICE *In Paper Mills*



STEADY steam pressure is a vital factor in making good paper. A sudden drop at the gauge might mean serious loss in the mill. Keeping up steam is a matter of prime importance.

That is why modern paper mills are equipping their power plants with COPPUS Turbo Blowers to maintain constant steam pressure under varying conditions of load, fuel, and weather.

For instance, the COPPUS Blowers shown above operating in the plant of the Hampshire Paper Company, makers of good paper, at South Hadley Falls, Mass., have kept steady steam pressure with very satisfactory results. Peak loads are quickly met, steam pressure is always constant, and cheap fuel is economically burned.

COPPUS Turbo Blowers are helping out engineers and speeding up boilers in power plants the country over. Their good work is not confined to the paper industry—it extends wherever power is used and coal is burned. If they are not already working for you it is likely that they could save time, money and labor in YOUR boiler room.

Write for Blower Catalog.

"COPPUS Equipment Can Save You Money"

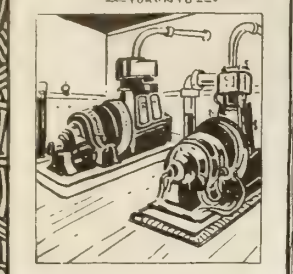
The COPPUS ENGINEERING & EQUIPMENT CO.

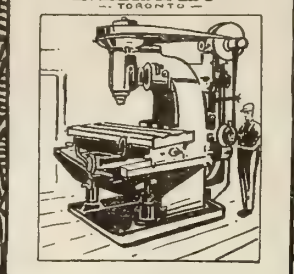
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

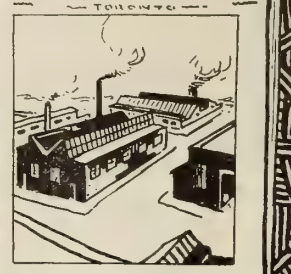
341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.

COPPUS TURBO BLOWER







For Self-Promotion and Sales Promotion Use These Publications

POWER HOUSE
Twice a month—$2.00 per year.
Serves the power plant engineer—Steam, Electric Refrigeration, Hydraulic.

CANADIAN MACHINERY
Weekly—$4.00 per year.
Covers the metal working field—serving shop executives, purchasing agents and owners. First-class mechanical paper and market paper combined.

CANADIAN FOUNDRYMAN
Monthly—$2.00 per year.
A paper for the foundry owner, superintendent and foreman. Claimed by its readers to be unexcelled.

MARINE ENGINEERING
Monthly—$2.00 per year.
Interprets marine engineering in its broad sense, serving the ship builders, navigation companies and their officers. (The editor holds an extra first-class B.O.T. certificate).

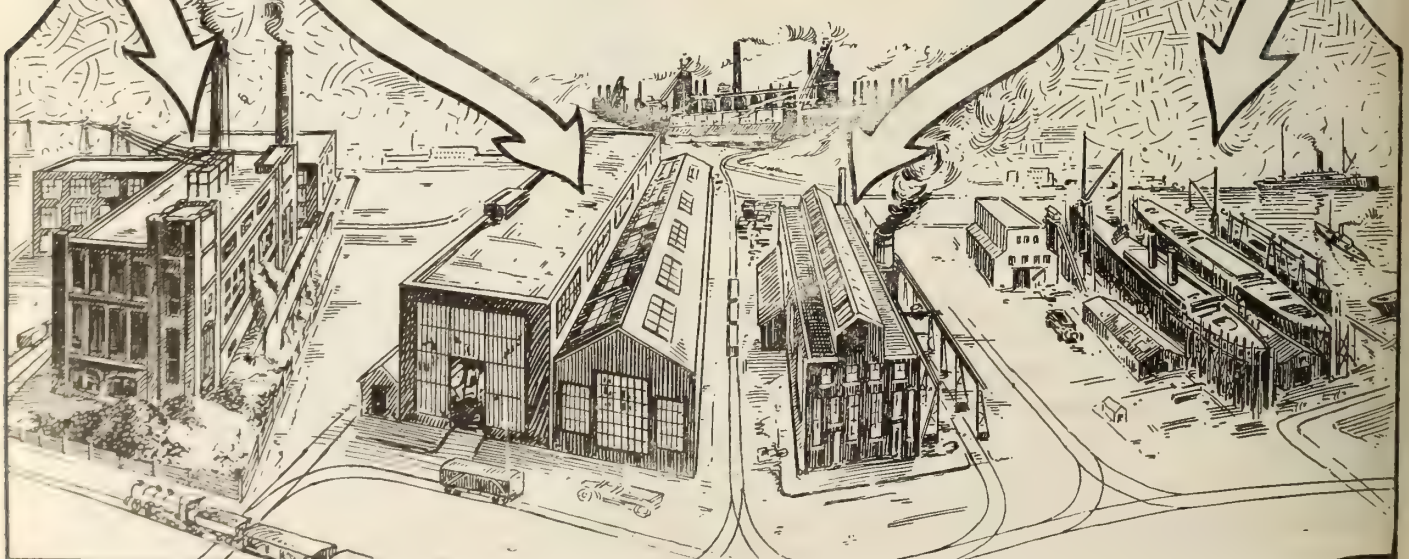
Published by

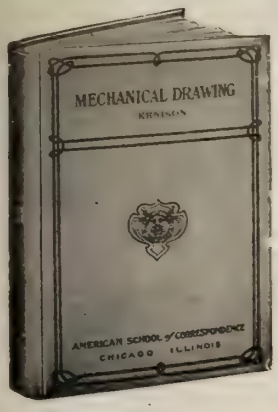
THE MACLEAN PUBLISHING COMPANY, LIMITED

143-153 UNIVERSITY AVE., TORONTO

A company whose idea of service has made it the largest concern of its kind in the British Empire.

Sample Copy and Advertising Rates sent upon request.





Clearance Sale of High Grade Technical Books

FOR several years we have maintained a Technical Book Department, handling high-class books published by various well known publishers. For various reasons we have now decided to discontinue our Book Dept. and in order to clear out what stock we have on hand we offer the following books at prices considerably lower than the regular selling price. Each item represents high quality at bargain prices. These books will not last long—first come first served. This is a fine opportunity to add to your technical library.

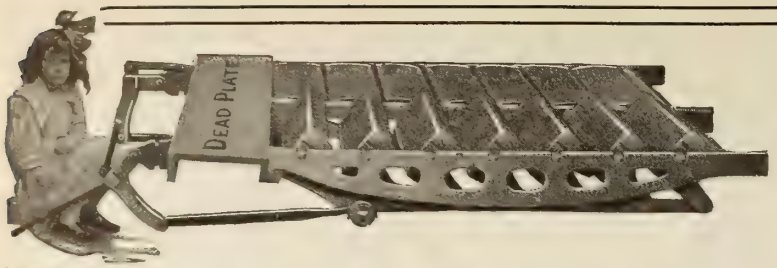
Title of Book	Name of Author.	Binding	No. of pages	Illustrated	Price
Electric Chemistry	G. W. Cravens	Cloth	132	Yes	$1.10
Hawkins Electric Dictionary (Best)	N. Hawkins	Leather	537	No	2.50
Electricity Simplified	T. O. Sloane	Cloth	172	Yes	.85
Electrical Motor	E. E. Burns	Cloth	197	Yes	1.25
Starting a Printing Office	R. C. Mallet and W. H. Jackson	Cloth	90	Yes	1.45
Half Tone Process	J. Verfasser	Cloth	378	Yes	2.50
Modern Printing Machinery	Wilson & Gray	Cloth	455	Yes	4.50
Manufacture of Paper	R. W. Sindall	Cloth	275	Yes	1.50
System for a Medium Size Printing Shop	C. V. Simmons	Paper	26	Yes	.50
Embossing	R. H. Dippy	Paper	12	No	.25
Patents, Inventors, Advisers	Marion & Marion	Cloth	170	Yes	.75
Machinists' Guide	Wm. Rogers .	Cloth	323	Yes	1.50
Mechanical Refrigeration	S. Sydney .	Cloth	70	Yes	1.25
*Stationary Engineers.	Is in sets of three volumes.				
Boiler Construction	F. B. Kleinhans	Cloth	422	Yes	2.50
Ford Car	V. W. Page	Cloth	288	Yes	2.00
New Catechism of the Steam Engine	N. Hawkins	Cloth	429	Yes	1.50
Mechanical Arts Simplified	D. B. Dixon	Cloth	497	Yes	1.25
Change Gear Devices	O. E. Perrigo	Paper	81	Yes	1.25
Factory Power Costs	J. G. Branch	Paper	43	No	.75
The Field Engineer	Unable to find book in stock				1.50
Power Stations and Transmission	G. C. Shand	Cloth	84	Yes	.85
Liquid Air	T. O. Sloane	Cloth	365	Yes	2.10
New Guide Book to the Local Marine Board	C. M. Swainson	Cloth	545	Yes	1.30
Modern Machine Shop Tools	W. H. Van Dervoort	Cloth	552	Yes	3.00
Locomotive Catechism	R. Grimshaw	Cloth	432	Yes	1.50
Locomotive Breakdowns	G. L. Powers	Cloth	244	Yes	1.25
Modern Ironmonger		Cloth	341	Yes	1.00
Gas Engine Troubles	J. B. Rathbun	Cloth	448	Yes	1.00
Combustion of Coal and Prevention of Smoke	Wm. M. Barr	Cloth	347	Yes	1.25
Engineers' Library	W. H. Wakeman	Paper	Different No. in each	Some are	.25
Elements of Machine Design	J. H. Barr	Cloth	446	Yes	2.00
Hawkins' Indicator	N. Hawkins	Cloth	73	Yes	.75
Gas Engine Construction	Parcell & Weed	Cloth	304	Yes	2.00
Mechanism of Mechanical Movements	Unable to find book in stock				2.00
Pattern Making	Ritchey & Monroe	Leather	222	Yes	1.25
Machine Design	E. L. Wallace	Cloth	157	Yes	1.25
Foundry Work	B. L. Gray	Cloth	196	Yes	1.25
Forging	J. Jernberg	Cloth	131	Yes	1.25
Tool Making	E. R. Markham	Leather	288	Yes	2.00

***These books are in sets of 3 volumes to a set. There are eight sets in stock. The price of which are $4.50 per copy or $12.50 per set.**

Above prices includes postage. Cash must accompany order as at the reduced prices quoted accounts cannot be opened. Remit by express or P.O. money order or by registered letter.

The MACLEAN PUBLISHING COMPANY, Limited

153 UNIVERSITY AVENUE, TORONTO, ONT.



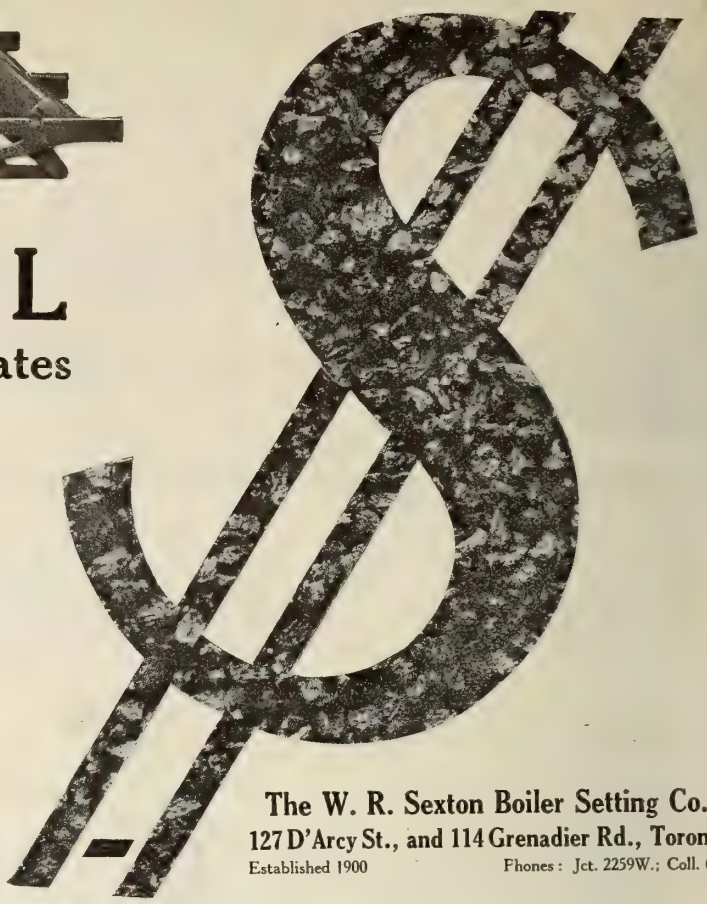
NONPAREIL

Shaking and Dumping Grates

Save Many Dollars' Worth of Fuel

This is not theory—it is an absolute fact. Records prove that Nonpareil Shaking and Dumping Grates always save at least ten per cent. in fuel bills—sometimes up to twenty per cent.! They get maximum heat with cheap fuel; they prevent waste. You can prove this at our risk—secure our trial offer; it's genuine!

Grate bars of all kinds promptly repaired, and don't forget "Safety First" Sexton for all kinds of Firebrick Work; this is our specialty.



The W. R. Sexton Boiler Setting Co.
127 D'Arcy St., and 114 Grenadier Rd., Toronto
Established 1900 Phones: Jct. 2259W.; Coll. 682

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

Motor Generator Sets

25 Cycle

1—600 K.W. Set, consisting of two 300 K.W. National Brake & Electric Generators, 6 pole, 500 volts, 500 R.P.M., on common base and direct connected one on each end of 550 K.W. National Brake & Electric Synchronous Motor, 3 phase, 6600 volt Motor, complete with switchboard.

1—400 K.W. Set, consisting of two K.W. Allis-Chalmers Generators, 8 pole, 150/165 volts, 500 R.P.M., on common base and direct connected one on each end of 580 H.P. Synchronous Motor, 2 phase, 2200 volts, complete with switchboard.

1—400 K.W. Set, consisting of one 500 K.W. Westinghouse Generator, 165 volts, 365 R.P.M., connected to one 580 H.P., 2 phase, 2200 volt Motor.

1—300 K.W. Set, consisting of one 300 K.W. General Electric Generator, 550/600 volts, 750 R.P.M. on common base and direct connected to one 325 K.V.A. Synchronous Motor, single phase, 2300 volts, complete with switchboard.

1—300 K.W. Set, consisting of one 300 K.W. General Electric Generator, 275/300 volts, 750 R.P.M. Connected to one 425 H.P. Synchronous Motor, 3 phase, 2300 volts. Complete with switchboard.

1—200 K.W. Set, consisting of one 200 K.W. Generator, 6 pole, 250 volts, 500 R.P.M. Direct connected to and mounted on cast iron sub-base with one 300 H.P. Synchronous Motor, 3 phase, 2200 volt. Complete with switchboard.

1—125 K.W. Set consisting of one 125 K.W. Westinghouse Generator, 600 volt, 720 R.P.M. Direct connected on same bedplate to one 185 H.P. Westinghouse Motor, 3 phase, 440 volt.

1—125 K.W. Set, consisting of one 125 K.W. Westinghouse Generator, 4 pole, 125 volt, 720 R.P.M. Direct connected to one 200 H.P. Westinghouse Motor, 2 phase, 220 volt.

1—75 K.W. Set, consisting of one 75 K.W. Generator, 250 volt, 750 R.P.M. Direct coupled to one 100 K.V.A. Synchronous Motor, 3 phase, 220 volt.

1—50 K.W. Set, consisting of one 50 K.W. General Electric Generator, 250 volt, 750 R.P.M. Direct connected to and on common base with one 75 H.P. General Electric Motor, 3 phase, 440 volt. Complete with switchboard.

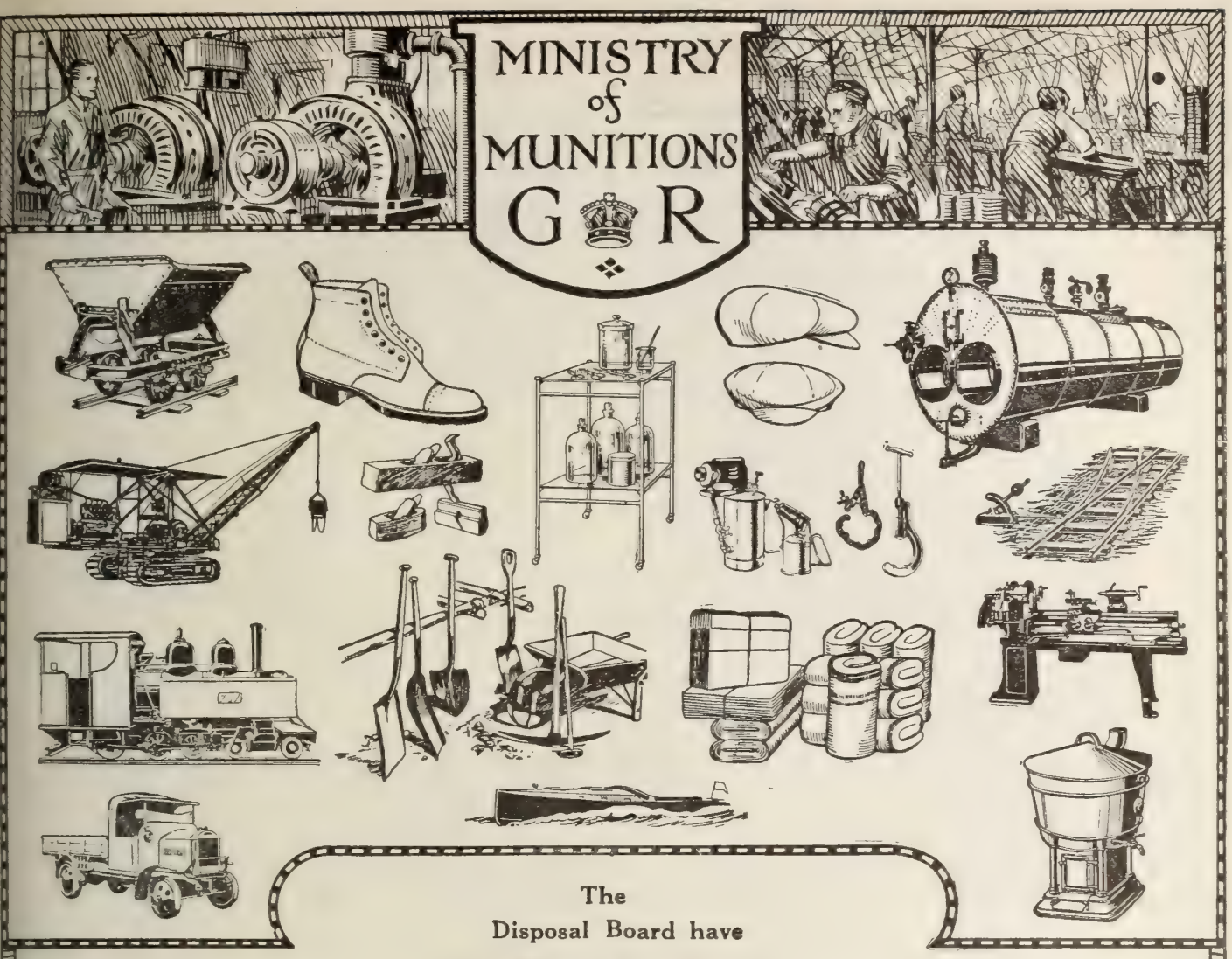
MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburg, Seattle Plants: Lincoln, N.J., and Linden, N.J.

Buyers and Sellers of New and Used Machinery

A Continent-Wide Service



The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

LINCOLN ARC WELDER

Accepted—

THE Lincoln Electric Welding Process is accepted by every class of industry—as being of major importance in maintaining efficient production.

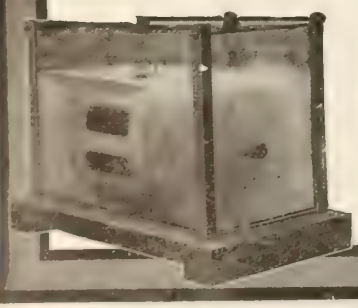
This is because Lincoln Electric Welding saves. It saves hours and days and dollars and cents when a boiler happens to become leaky—or when a batch of castings turns out slightly defective — when a piece of machinery gets broken or worn .

It quickly welds together broken parts — builds up new metal where necessary—and fills molten steel into boiler or other defects.

We will be pleased to discuss Lincoln Electric Welding with you. 'Phone Adelaide 7200 or write us to send a Lincoln Welding Engineer to see you. It costs you nothing for this service.

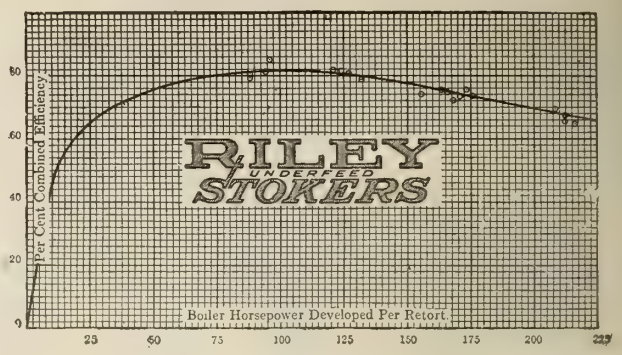
"Link Up With Lincoln"

The Lincoln Electric Co. of Canada Limited
136 John St. TORONTO Phone Adel. 7200



Montreal Branch: Coristine Building

High Efficiency



The continuous high efficiency of the Riley Stoker is due to the moving grates. These moving units not only keep the fuel bed open, porous and free from clinkers, but automatically discharge the ash and refuse.

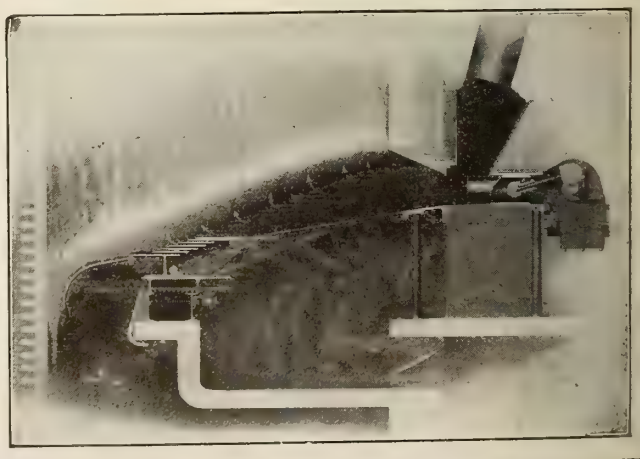
Because of the moving grates, Riley Stokers have that faculty of operating continuously at high efficiency and capacity. Fuel-saving is a mechanical certainty. There can be no waste.

The efficiency curve shown above is typical of Riley Stoker performance. This curve is plotted from a series of tests conducted on a 16-retort Riley Stoker installed at the Essex Station of the Public Service Electric Company, Newark, N.J. Why not duplicate these results in your plant? You can do it with Riley Stokers.

Riley Stoker catalog HR-8 sent on request.

For information on the Murphy Automatic Furnace for smaller boilers, see last month's advertisement, or send for Murphy catalog HM-8.

Sanford Riley Stoker Co.
Worcester, Mass.



The Belt that Saves Power

P.M.S. BELTS

This is the Brand—"P.M.S." It is a truly scientific production and has proved itself the ideal belt for hard places. The "non-slip" feature, the "minimum-stretch" feature, and the exceptional adaptability and durability of P.M.S. Belting, are points that make it the choice of the most experienced Belt Buyers in Canada.

If you have power transmission problems, let our expert give you the benefit of his opinion.

Gutta Percha & Rubber, Limited

Head Office and Factory: TORONTO

BRANCHES IN ALL THE LEADING CITIES OF THE DOMINION

"MEAD-MORRISON"

CANADIAN MM

CANADIAN MM

Coal Handling Machinery

Coal and Ore Handling Machinery

Manufacturers of

Coal Bridges up to 1,000,000 tons storage

GRAB BUCKETS

STEAM HOISTS

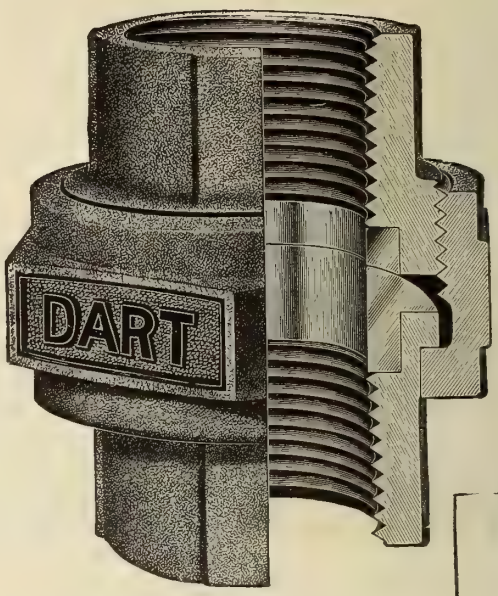
ELECTRIC HOISTS

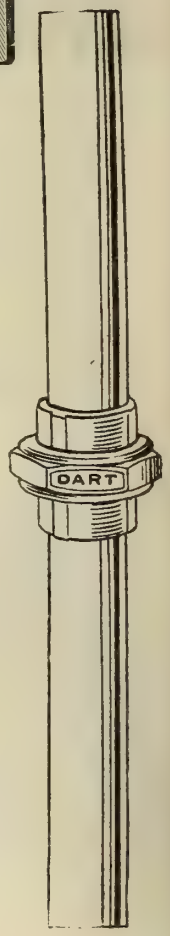
AGENTS:
HARVARD TURNBULL, TORONTO
KELLY POWELL, WINNIPEG
ROBERT HAMILTON, VANCOUVER

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Dart Unions

NEVER LEAK





WHEN THE BRONZE FACES of Dart Unions are drawn together you have a joint that is practically everlasting in its efficiency.

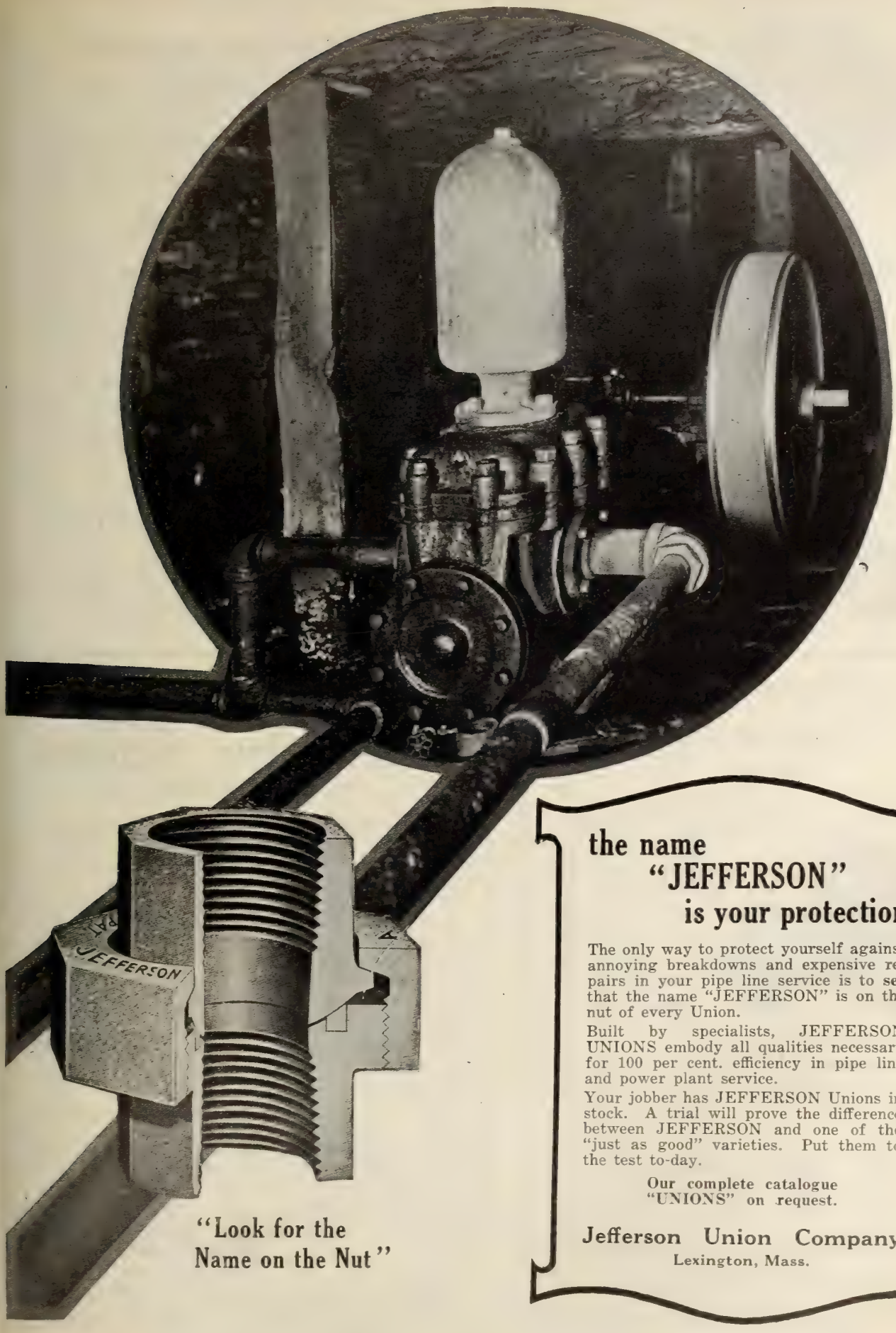
The Bronze **non-deteriorating** faces are supported by Heavy Malleable Iron Pipe ends and nuts. Dart Unions positively will not loosen up and leak in service.

The use of Dart Unions means no upkeep cost—no replacement cost—no loss from leaks.

Your Jobber Sells Them

Dart Union Co., Limited

Toronto, Canada



"Look for the Name on the Nut"

the name "JEFFERSON" is your protection

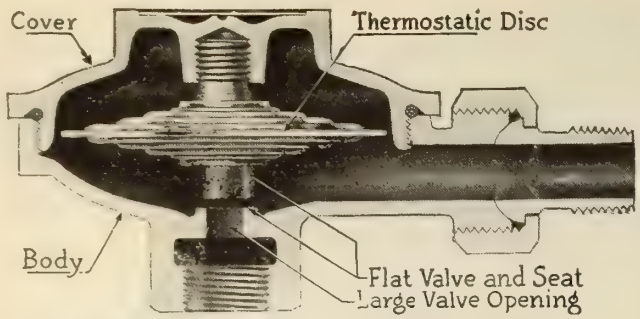
The only way to protect yourself against annoying breakdowns and expensive repairs in your pipe line service is to see that the name "JEFFERSON" is on the nut of every Union.

Built by specialists, JEFFERSON UNIONS embody all qualities necessary for 100 per cent. efficiency in pipe line and power plant service.

Your jobber has JEFFERSON Unions in stock. A trial will prove the difference between JEFFERSON and one of the "just as good" varieties. Put them to the test to-day.

Our complete catalogue "UNIONS" on request.

Jefferson Union Company
Lexington, Mass.



MADE IN CANADA

Dunham Specialties

Packless Radiator Valves
Radiator Traps
Drip Traps
Blast Traps
Air Line Valves
Vacuum Pump Governors
Reducing Pressure Valves
Oil Separators
Suction Strainers
Air Vents
Return Traps
Check Dampers
Damper Regulators

The DUNHAM HEATING SERVICE

Where better heat is needed there use Dunham Specialties

Almost without exception, there is a place for some one or other of the Dunham Specialties on every job where steam is used for heating purposes.

In placing before you so often the merits of the Dunham Radiator Trap, we perhaps risk your overlooking its companions in efficiency. Yet we most earnestly desire you to associate with all of them, that merit which has marked the Dunham Radiator Trap since its entrance on the market in 1903.

We stand ready to serve you without limit in the application of Dunham Specialties.

"The Dunham Hand Book" is full of facts. Send for your copy.

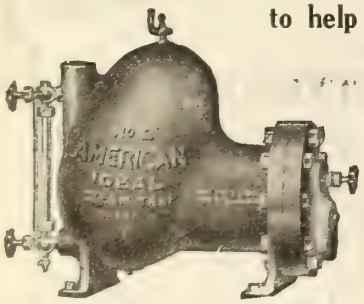
C. A. DUNHAM COMPANY, LIMITED
Toronto, Ontario

HALIFAX OTTAWA VANCOUVER MONTREAL WINNIPEG CALGARY

London: 64 Regent House, Regent Street, W. 1.

Get an American Ideal Steam Trap

to help you SAVE COAL



One trial will convince you of its ability to save for you as it is saving in hundreds of other plants.

Its TIGHT WATER SEALED VALVE
Its POWERFUL LEVERAGE
Its HEAVY FLOAT

Insure EFFICIENCY and ECONOMY

Write for "Specification" Booklet

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

American Steam Gauge & Valve Mfg. Company

New York, Chicago, BOSTON, Atlanta, Pittsburgh

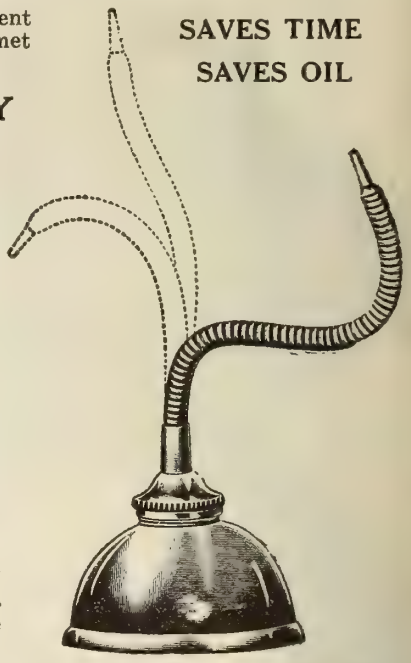
"SAFETY FIRST"

Bend the Spout
to suit position

Every requirement satisfactorily met with

ALL-WAY OILERS

SAVES TIME
SAVES OIL

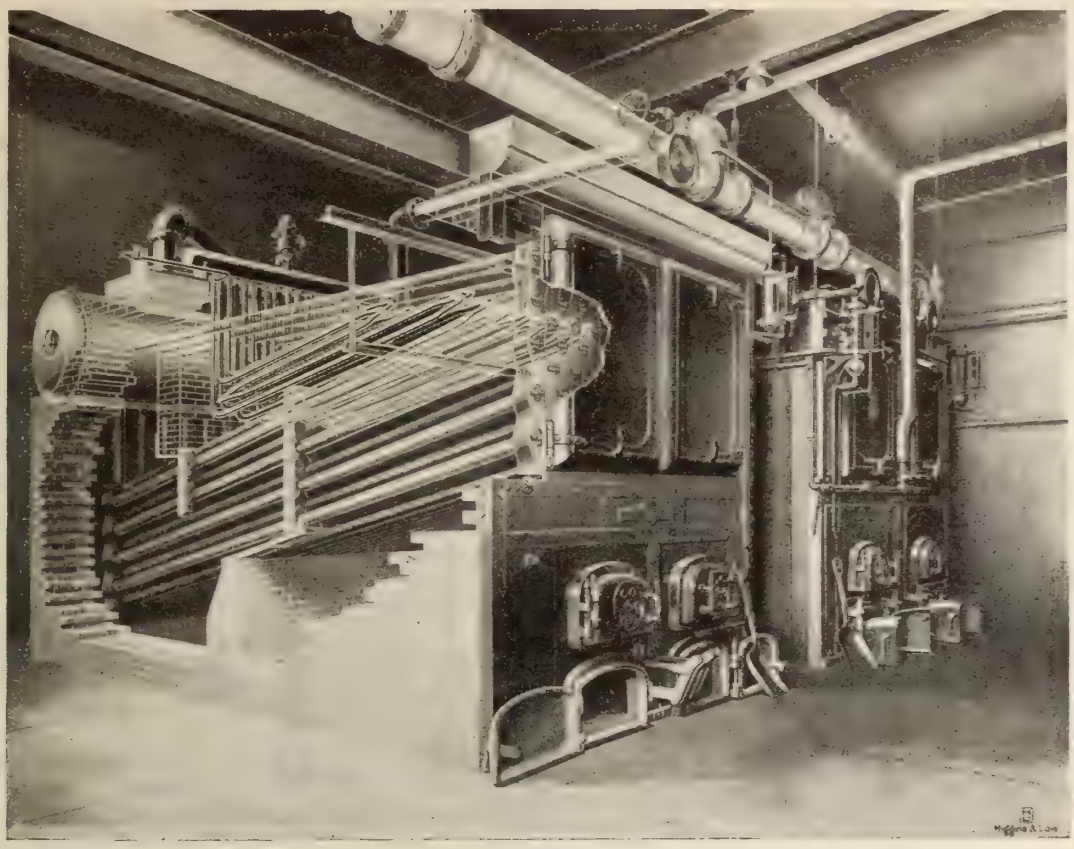


Note the flexible spout. It enables you to oil all places — many places that previously could only be reached with force pump cans with specially bent spouts.

Indispensable to those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET, WEST - TORONTO, ONTARIO



Lubrication With Superheated Steam in Reciprocating Engines

The advantages of superheated steam are evidenced by a decrease in fuel consumption, due to increased boiler efficiencies and reductions in steam line losses. These are worth-while advantages. But the vital and important economy of superheat is obtained when the superheated steam is carried *into the engine cylinder.*

The highest returns from superheated steam result from the saving it effects in fuel by the reduction in steam consumption of the engine itself, due to the elimination of cylinder condensation. Only highly superheated steam can accomplish these results. A reciprocating engine will not operate satisfactorily on dry or superheated steam unless lubrication is provided. If it is not necessary to lubricate, it is evidence of moisture in the steam and a lack of superheat.

The ease with which lubrication is correctly applied and the availability of suitable oils are facts which should guide you toward the correct and profitable use of superheated steam.

When you specify Elesco Superheaters, you are assured of the maximum returns from the application of superheated steam. They are designed to suit your conditions.

THE SUPERHEATER COMPANY, LIMITED

Transportation Building, MONTREAL ***Works at*** **Sherbrooke, Que.**

Designing Engineers and Manufacturers of Superheaters and Pipe Coils for all classes of service

MADE IN CANADA

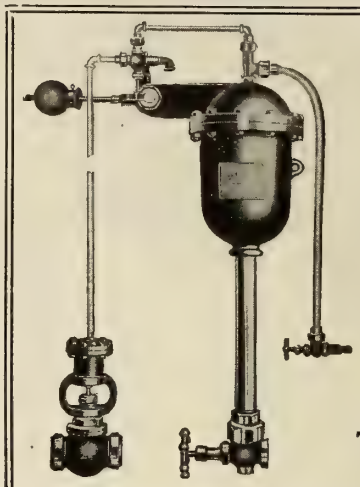
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



They Never "Forget"

VIGILANT FEED WATER REGULATORS

are always on the job every minute of the day, constantly making sure that the exact amount of water is being fed into the boiler to keep the gauge at middle point.
And this saves coal—don't forget that very important point. Let us explain how.

Write for full information to-day

The Chaplin-Fulton Mfg. Co
28-34 Penn Avenue, Pittsburgh, Pa.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED

London Liverpool Cardiff, Etc.

Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
Stocks Carried in All Sizes TEL. No. MAIN 2387

POWER HOUSE SOLVES THE PROBLEM

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E. S. MANNY Co

27 COTE St. MONTREAL, QUE

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

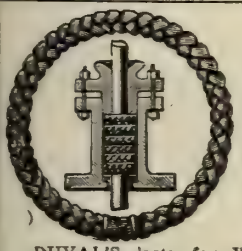
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

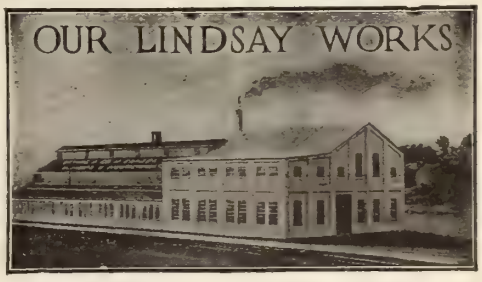
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

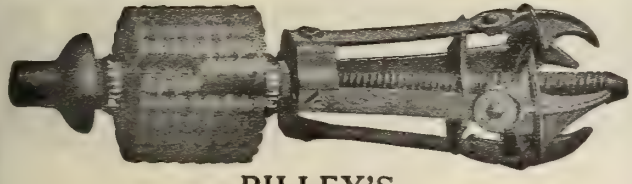
Board of Trade Building, Montreal

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario

The Simplest and Best Cleaner on the market is



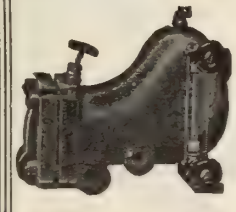
PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.



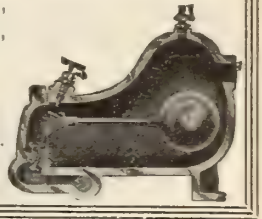
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa

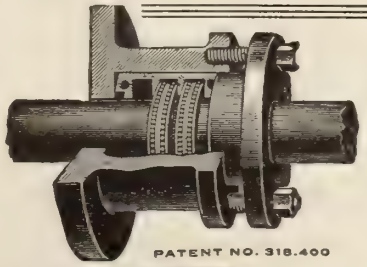
MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.

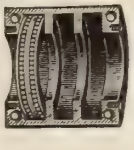
JOHN MONCRIEFF, Ltd., Perth, Scotland

Canadian Representative:
W. J. WALL, 134-136 Bleury St., Montreal



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,118
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775,193	" "	905,109
" "	775,194	" "	934,629
" "	791,300	" "	979,208
" "	805,669	" "	1000,76



Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing
Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
Incorporated 1897

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

CRANE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices: Halifax, Quebec, Ottawa, Calgary.

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

To Buyers' Directory
Page 70

HOMESTEAD
Quarter-Turn Valves

A Safe and
Economical Combination

The "HOVALCO" Renewable Blow-off Valve and the "HOMESTEAD" Quarter-turn Valve —a money-saving combination designed to give a clear passage and be absolutely tight when closed, consequently leak-proof!

Homestead Valves are made in Straightway, Threeway and Fourway patterns

The special alloy seats and discs of the Hovalco can be reversed, reground or renewed without shutting down the boilers.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

WE WELD
EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL
MACHINERY GUARANTEED

The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

Showing ease with which Plibrico is laid in place.

PLIBRICO is Jointless

For a gas-tight, one-piece furnace lining or baffle for boilers use

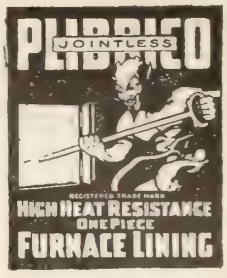
PLIBRICO

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

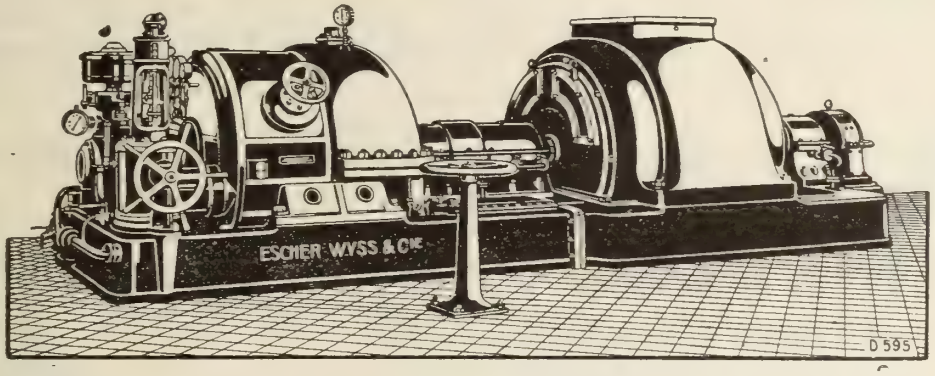


Trade Mark
Reg. U.S. Pat. Office.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

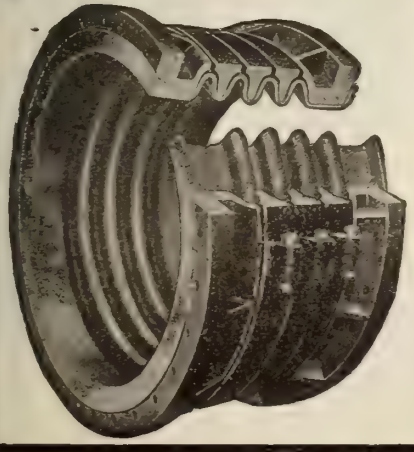
Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20



Most pipe line troubles are due to leaky joints—You cut out the leaks and the expense as well by installing

BADGER

SELF-EQUALIZING EXPANSION JOINTS

Write for Our New Book To-day

E. B. Badger & Sons Co.

101 Park Ave. NEW YORK

81 Pitts St., Boston

616 S. Michigan Ave. CHICAGO

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

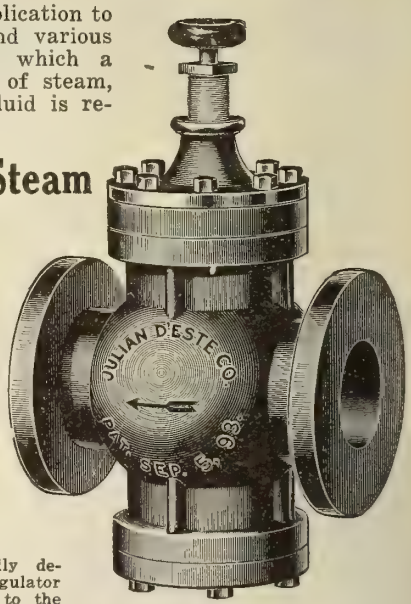
The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston,) Mass., U.S.A.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the



Improved Steam Pressure Regulator

has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.

Make Our Engineers Responsible for Your Belting Equipment

Put it up to them to place your transmission equipment on a 100 per cent. efficiency basis; make recommendations that will create savings, which in turn will practically offset any expenditure they may suggest.

So certain are we that our belting experts can practically eliminate your transmission troubles, we are quite willing to analyze your plant at no cost to you.

Practically every plant has one or more drives that are hard on belts. Just such drives as these are now equipped with

Dominion Friction Surface Belting

which for fifty years has justified every claim by satisfactory performance.

When you have belt trouble, phone, wire or write our nearest service branch.

DOMINION RUBBER SYSTEM

Our Dominion Hose, Packing and Industrial Rubber Goods are all the Same High Standard as Dominion Friction Surface Belting

Dominion Rubber System Service Branches

Halifax	Toronto	Fort William	Edmonton
St. John	Hamilton	Winnipeg	Calgary
Quebec	London	Brandon	Lethbridge
Montreal	Kitchener	Regina	Vancouver
Ottawa	North Bay	Saskatoon	Victoria

BELTING

Transmission: "Dominion," "Kēewatin," "Para."

Conveyor: "Rockproof," "Canadian," "Hiheat."

Elevator: "Dominion," "Rockproof."

Agricultural: "Lumber King," "Star."

Grain Elevator: "Metcalf Standard," "Grain King."

HOSE

Air: "Kushion Kover," "4810 Airtite."

Steam: "Indestructible," "Rockproof," "Para."

Water: "Indestructible," "Kushion Kover," "Para."

Suction: "Para," "Star," "Trade."

Garden: "Canadian," "Dominion," "Star."

PACKINGS

Sheet: "Join-Tite," "Star," "Importers"

Rod: "Cabestos," "Valve-Bestos," "Canadian."

Valves: "Montreal," "Commercial," "Canadian."

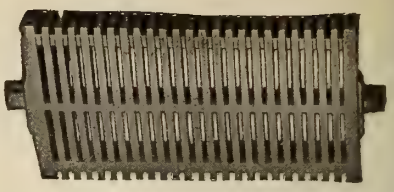
MISCELLANEOUS

Mats, Matting and Flooring, Plumbers' Specialties, Rubber-covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rubbers, Moulded Goods.

Cyclone Grates

We are prepared to instal Cyclone Grates on a 30-day free trial basis. Details upon request.

Instal Them Now!



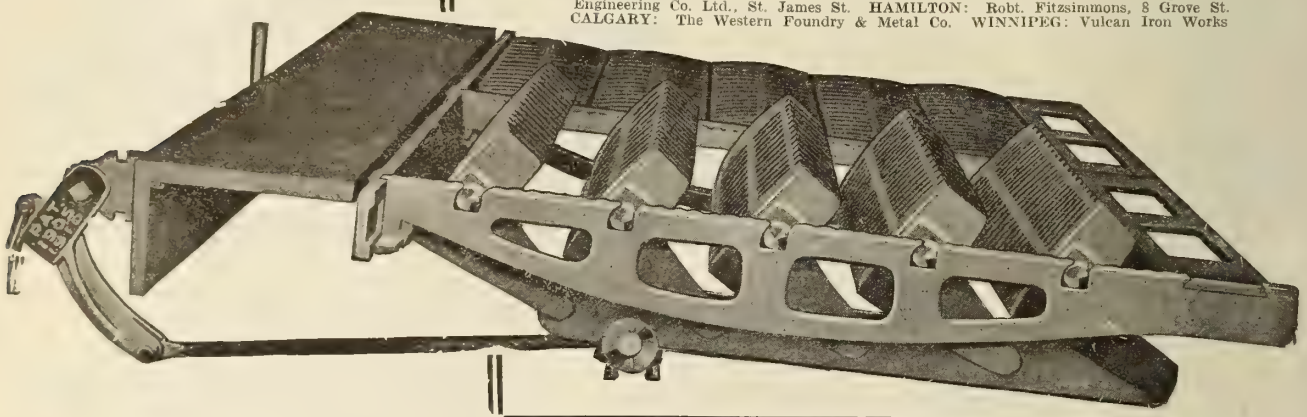
Think of the increasing price you are paying for coal! Isn't a saving of at least 10% of your fuel a saving well worth investigation?

Cyclone Grates **WILL** save you at least 10%. Because they provide for 60% air space and 90% underdraft, you are able to extract every bit of energy from the coal you use.
Get the benefit of that 10% by installing Cyclone Grates **now!**

The Canadian Steam Boiler Equipment Company, Ltd.

20 McGee Street 'Phone G. 3660 Toronto, Ont.

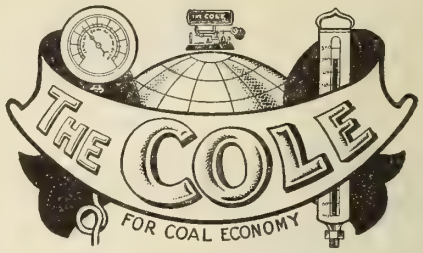
AGENTS :
ST. JOHN, N.B.: F. W. Blizard, 239 Charlotte St. MONTREAL: Mason Regulator and Engineering Co. Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St.
CALGARY: The Western Foundry & Metal Co. WINNIPEG: Vulcan Iron Works



ECONOMY AND EFFICENCY

At the
Toronto Exhibition

Our equipment may be seen in operation in the south-east corner of Machinery Hall. Be sure to look it up!



System of Heat Transmission and Condensation Drainage

"Cole" Equipment is saving thousands of dollars every year for its users. We will be pleased to show you how it will save money for you.

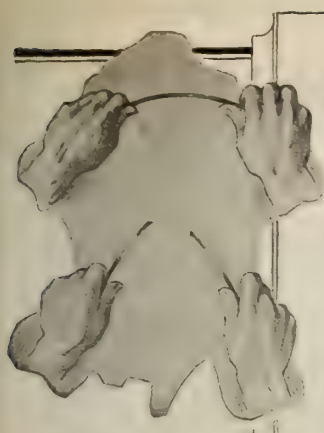
GEO. W. COLE LIMITED

Engineers and Manufacturers

2002-4 Dundas St. W., Toronto

Winnipeg, Man. Vancouver, B.C. New Glasgow, N.S. Montreal, Que.

IN THE STEAM PLANT.



broken blades are not always poor blades.

Often it's a case of a good saw used in the wrong way. A hack saw may be brittle as glass or flexible as a watch spring, according to the temper of steel, but the temper is only one of the things that go to make good blades.

Starrett Hack Saws are tempered, milled and selected according to the work they are designed to do. That's why they "cut quicker and last longer."

According to the Starrett system of blade selection, there's a saw for every metal. Many saws will cut more than one metal, but no single blade will cut all metals, or even all shapes of the same metal economically.

Starrett Hack Saws plus the Starret Hack Saw Chart make it easier to cut metal economically. Ask for a copy of Chart CD—and "Hack Saws and Their Use"—both are free.

THE
L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Mfrs of Hack Saws Unexcelled
ATHOL, MASS.

42-64

Starrett Hack Saws

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

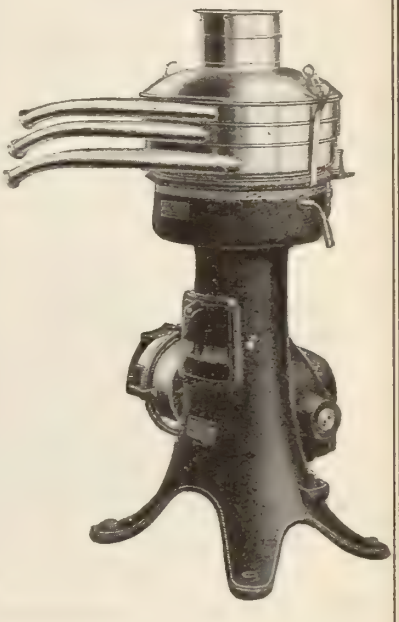
Permanent CO_2 Record in Engineer's Office
Fireman's CO_2 Guide on Boiler Front
Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet
"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.
Combustion Engineers
2008 EMPIRE BLDG., NEW YORK

De Laval Oil Purifiers Save Oil and Add Years to Life of Machinery



The De Laval method of purifying used lubricating oil is quicker, more efficient, and more economical than any method of purification previously used.

It reduces the loss of power due to friction, eliminates the danger of clogged oiling systems and lengthens the life of machinery by maintaining clean oil in the oiling system indefinitely. In a number of cases it has been found that the temperature of the oil is reduced by the De Laval method of purification.

By the De Laval method the used oil may be purified continuously or in batches. By either system the purification is complete and is accomplished instantaneously. All foreign matter such as water, grit and particles of metal are removed in the bowl of the purifier and the oil is returned to the lubricating system as good as new.

The De Laval Oil Purifier occupies less than two square feet of floor space, requires less than two h.p. to drive, and needs very little attention. The bowl is the only part that requires cleaning, and this is done without muss or waste of oil—quickly and easily.

De Laval engineers will be glad to investigate conditions in your plant and to recommend the type of installation best suited to meet them.

Write to nearest De Laval office for Oil Purification Bulletin No. 100; also Crank Case Oil Bulletin No. 102.

The De Laval Separator Company

New York **Chicago**

TURBINE EQUIPMENT COMPANY
Toronto, Ontario

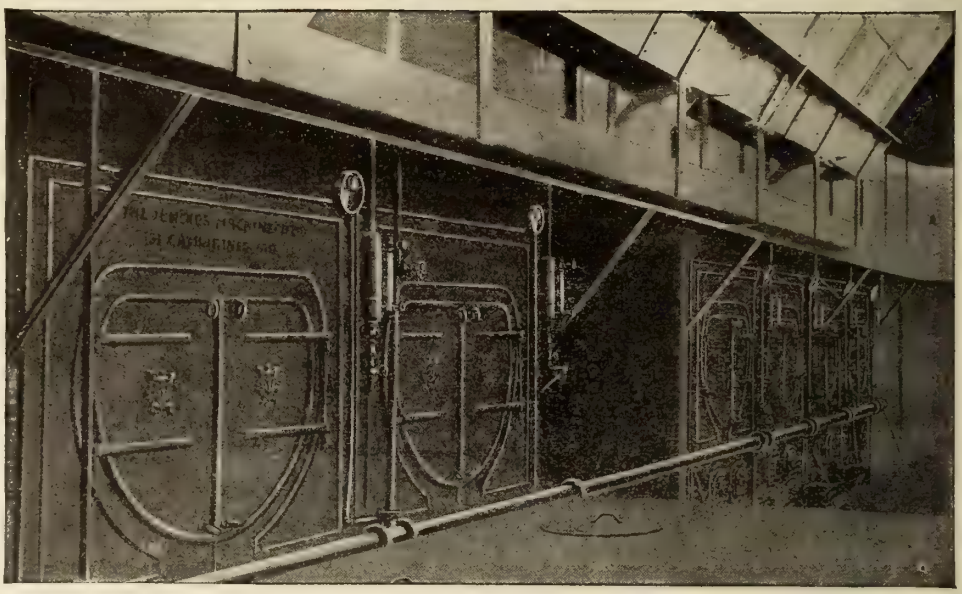
THE DE LAVAL CO., LTD.,
Peterboro, Ont.

BOILERS READY---NOW!

Not often you get this opportunity. Quality considered, you'll never do better. Subject to prior sale we offer following boiler sizes, 125 and 150 lbs. pressure:—

72 in. x 18 ft.
72 in. x 16 ft.
66 in. x 16 ft.
66 in. x 14 ft.

Write or wire for quotations.



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

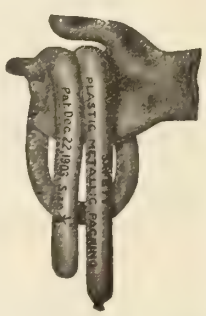
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

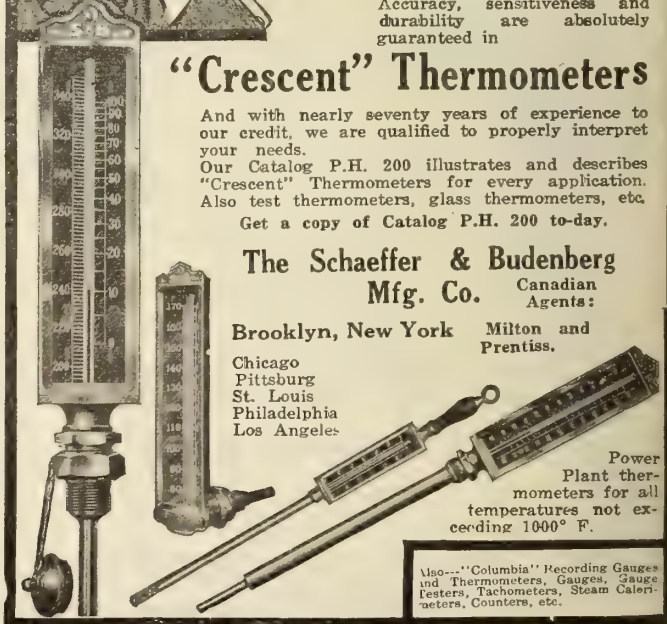
Get a copy of Catalog P.H. 200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Canadian Agents:
Milton and Prentiss.



Power Plant thermometers for all temperatures not exceeding 1000° F.

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

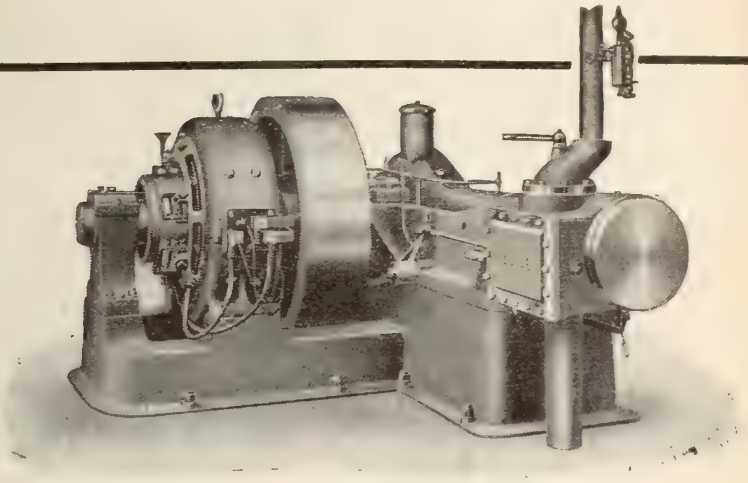
ROBB

For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

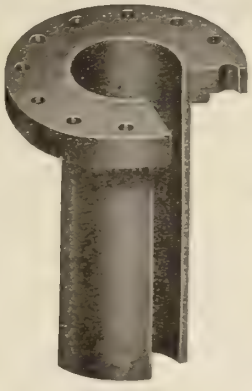
Robb Engineering Works Co., Ltd.

Amherst, N.S.

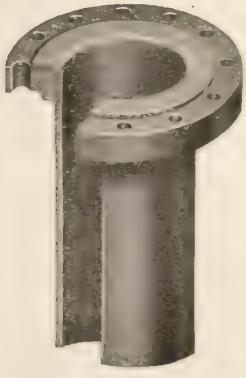
Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

P⊗H FLANGED PIPE JOINTS



SCREWED



P.H. LAP

P⊗H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

Made in Canada by

PAGE-HERSEY IRON, TUBE & LEAD Co. LIMITED

Head Office: 100 CHURCH STREET, TORONTO, ONT.

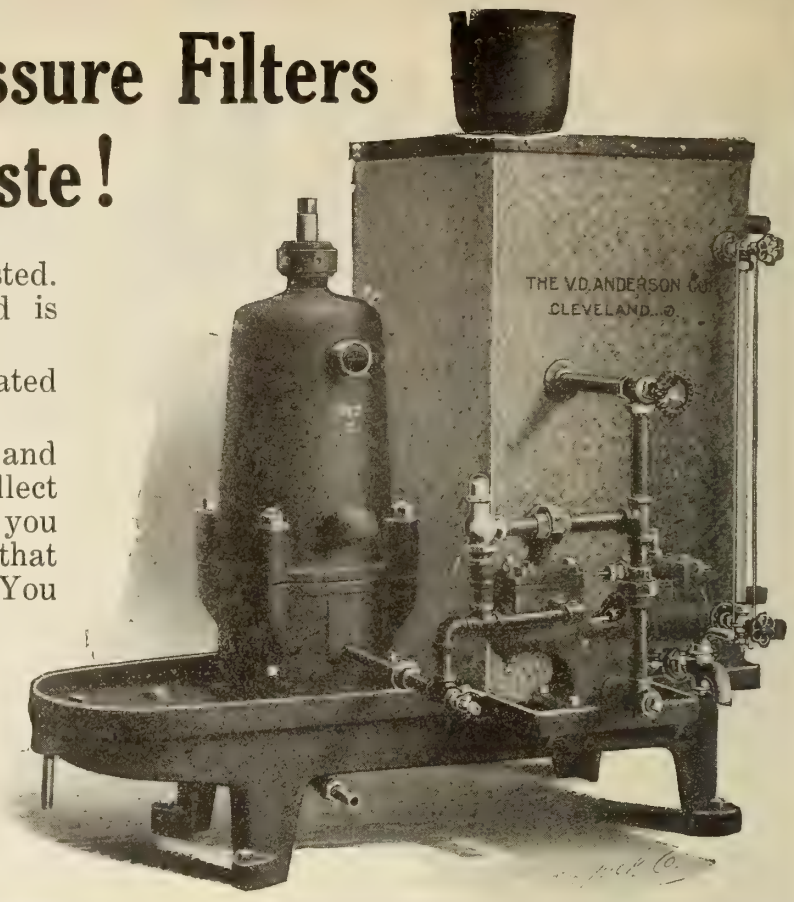
Anderson's Pressure Filters Prevent Oil Waste!

Oil is too high in price to be wasted. Yet more than half the oil used is wasted—lost on wipers.

The Anderson Filter here illustrated will **prevent** this dead loss.

Place drip pans beneath engines and machinery. Pass the oil you collect through the Anderson Filter and you will have oil as pure and clean as that which is fresh from the refiners. You can use the oil over and over again; always the Anderson makes it as clean as before!

We shall be glad to furnish full particulars.



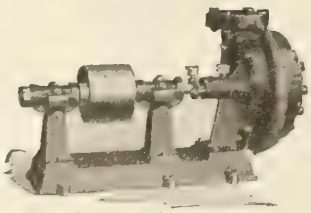
The V. D. Anderson Co.
West 96th Street, Cleveland, Ohio

AMERICAN-MARSH PUMPS

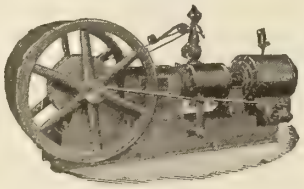
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



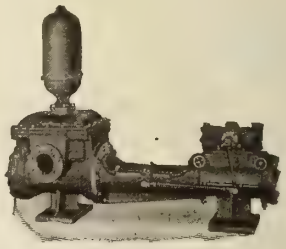
American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors

Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

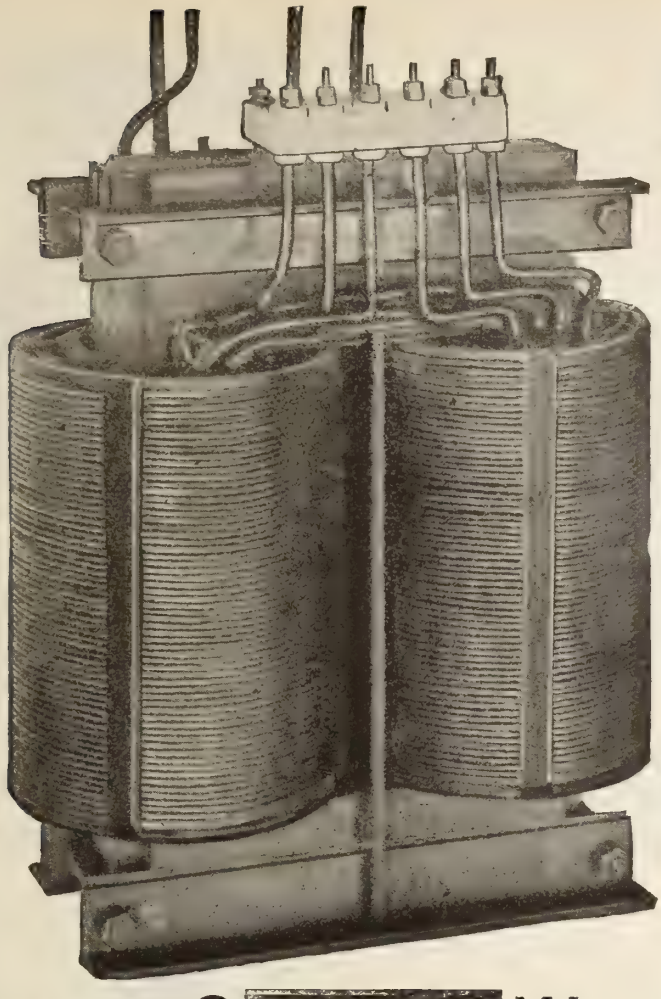


Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanic's Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.



CANADIAN CROCKER-WHEELER
New Service Transformers

Embodying —

True core type construction with cruciform section.

Terminal Boards specially designed with large creepage surfaces.

Circular coils — the strongest known construction.

Coils with large oil ducts, liberal clearance and entirely surrounded by oil.

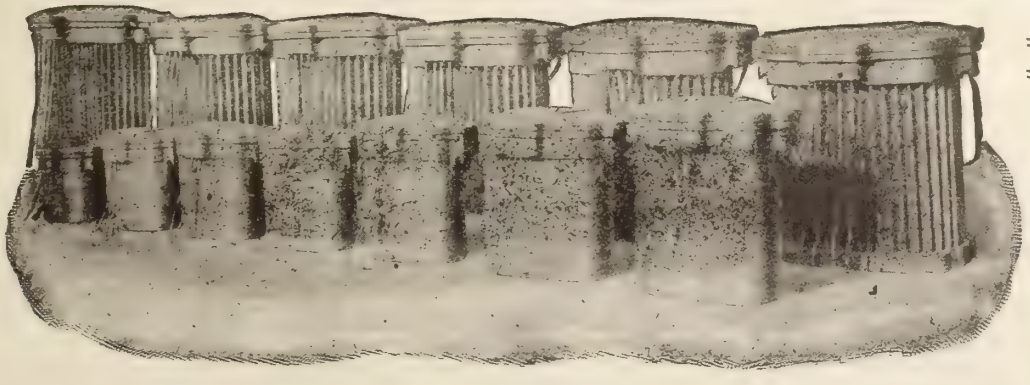
Low magnetising current.

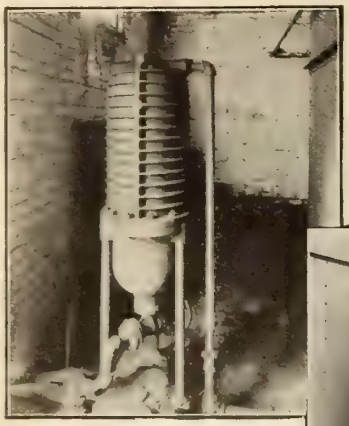
Light welded steel tanks.

Obtainable Through Our Houses

Northern Electric Company
LIMITED

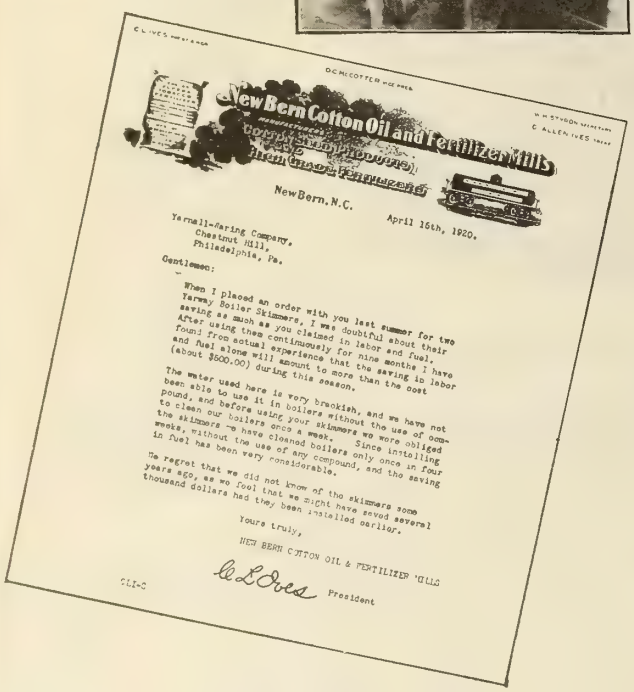
MONTREAL HALIFAX TORONTO LONDON WINNIPEG CALGARY VANCOUVER
QUEBEC OTTAWA HAMILTON WINDSOR REGINA EDMONTON





Yarway Skimmer installed on Boiler No. 1, New Bern Cotton Oil & Fertilizer Mills, New Bern, N. C.

Yarway Skimmer installed on Boiler No. 2, New Bern Cotton Oil & Fertilizer Mills New Bern, N. C.



New Bern Cotton Oil and Fertilizer Mills

New Bern, N.C. April 16th, 1920.

Yarnall-Waring Company,
Chestnut Hill,
Philadelphia, Pa.

Gentlemen:

When I placed an order with you last summer for two Yarway Boiler Skimmers, I was doubtful about their saving as much as you claimed in labor and fuel. After using them continuously for nine months I have found from actual experience that the saving in labor and fuel alone will amount to more than the cost (about $600.00) during this season.

The water used here is very brackish, and we have not been able to use it in boilers without the use of compound, and before using your skimmers we were obliged to clean our boilers once a week. Since installing the skimmers we have cleaned boilers only once in four weeks, without the use of any compound, and the saving in fuel has been very considerable.

We regret that we did not know of the skimmers some years ago, as we feel that we might have saved several thousand dollars had they been installed earlier.

Yours truly,
NEW BERN COTTON OIL & FERTILIZER MILLS
W L Ives President

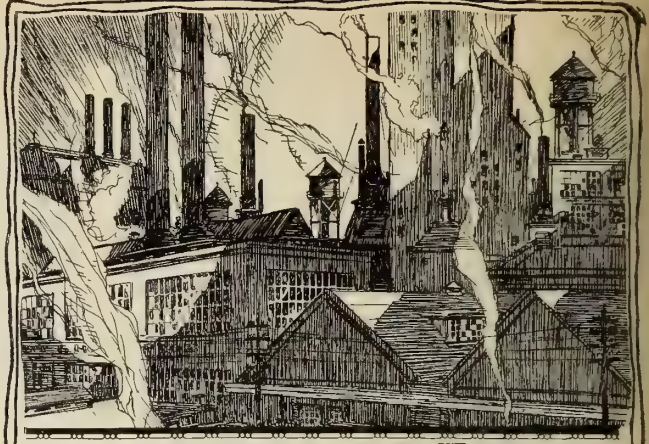
YARWAY

Boiler Skimmer

A Continuous Circulating Surface Blow

Yarway Boiler Skimmers are shipped on 60 days' trial, without obligation. Send for Bulletin S-1201-A, giving full details.

YARNALL-WARING CO.
7004-20 Queen St.
Chestnut Hill Philadelphia
REPRESENTATIVES IN ALL PRINCIPAL CITIES.



ECONOMY *renewable* FUSES

Double Protection for Electrically Driven Machinery

Knife-blade type

The "Und. Lab. Inspected" label on Economy Fuses and the symbol on Economy "Drop Out" Renewal Links mean double protection for all industries using electrical energy.

Factory inspection is backed by constant rigid tests in the Underwriters' Laboratories.

Economy Fuses are accurately rated. They give maximum safety and efficiency at minimum cost—cut annual fuse maintenance costs 80% as compared with the use of "one-time" fuses.

Fibre cartridge, sturdy end-caps and the vinged washers which securely lock the fuses are virtually indestructible.

Ferrule type

All that is discarded in a blown Economy Fuse is the inexpensive strip of fused metal, which is replaced in a few moments by a new Economy "Drop Out" Renewal Link.

For sale by all leading electrical jobbers and dealers.

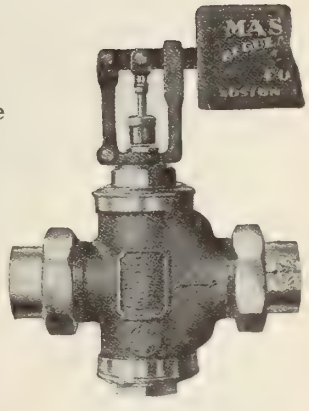
Economy Fuse & Mfg. Co. of Canada, Ltd.
UNITY BLDG. MONTREAL, CANADA

Economy Fuses were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be APPROVED IN ALL CAPACITIES by the Underwriters' Laboratories.

Standard Reducing Valve
Iron Body

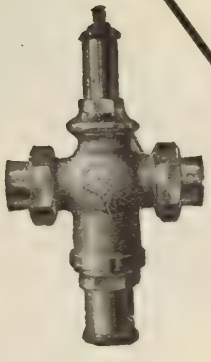
LOOK FOR IT—
IT'S YOUR GUARANTEE

Genuine Mason Regulating Appliances have this TRADE-MARK cast on the body



Balanced Valve

Pump Pressure
Regulator



Standard Reducing Valve
Bronze Body

Made in Canada by

THE MASON REGULATOR & ENGINEERING Company Limited

Montreal
135-153 Dagenais St.

Toronto
145 Wellington St. W.

Dirty Boiler Tubes Spell W-a-s-t-e

Soot and ash deposits on the tubes of a boiler inevitably mean wasteful operation—lost coal, low boiler efficiency.
They probably also indicate the presence of other boiler and engine room losses—for failure to remove soot deposits is generally symptomatic—the power plant operator who ignores dirty boiler tubes will ignore other causes of waste.
If you want to keep up steam when soot piles up in your boiler, you will have to pile in more coal.
Diamond Soot Blowers are the one logical solution to the soot problem. Last year 2,200,000 H.P. of boilers were equipped with Diamonds. For the first six months of 1920 the record is 1,500,000 H.P.
As compared to the best possible results with the hand lance, Diamonds will effect the following economies:

1. FUEL: a saving of 5 to 8%.
2. BOILER EFFICIENCY: an increase of 4%.
3. LABOR: a saving of many hours per day.
4. LONGEVITY: an increase in the length of service of boiler tubes through the prevention of corrosion.
5. STEAM: a saving of 25 to 75% of steam used for cleaning.

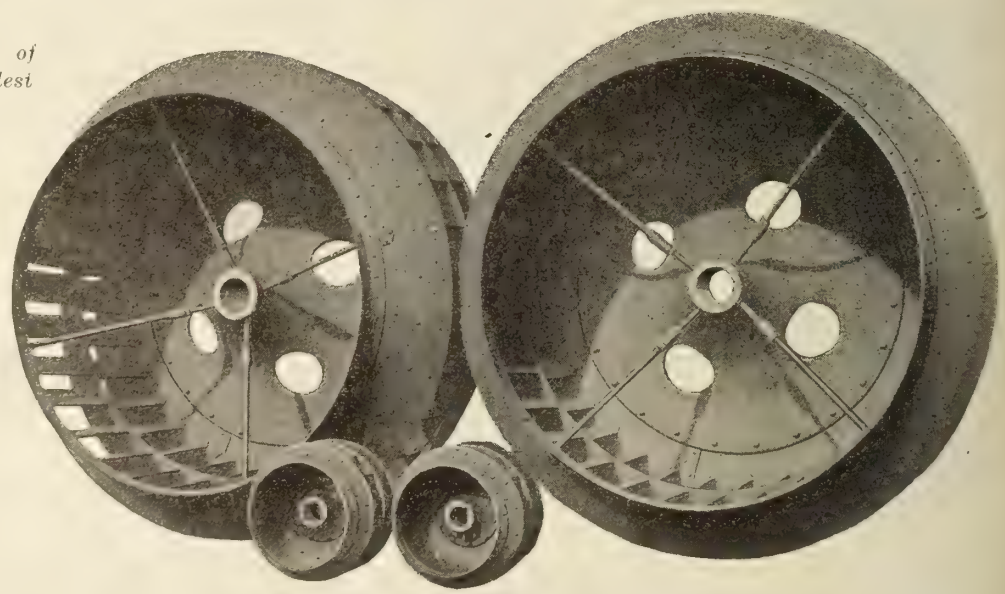
If your boilers are not yet equipped with this money-saving apparatus, ask for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ont.

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

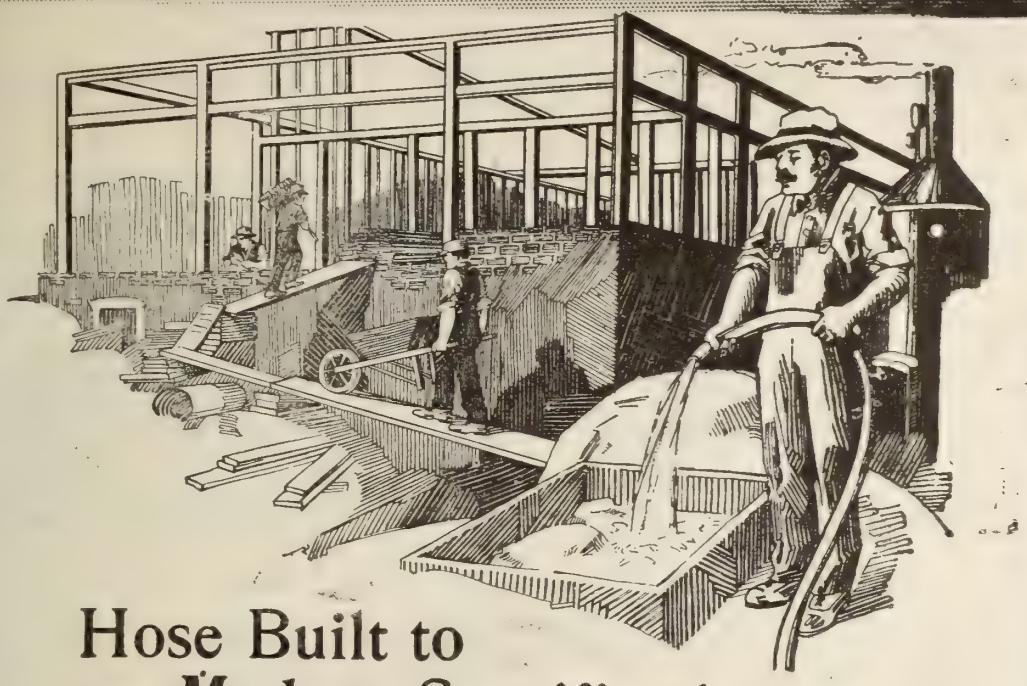
Comparison in Size of the Largest and Smallest Fans Manufactured



More Draft for Less Power

GREEN'S RADIAL FLOW FANS are built for capacities of 1,600 to 275,000 cubic feet per minute and pressures up to 7 in. of water.
These fans, besides having low horsepower requirements, operate at the most economical speeds for direct connection to turbines and motors, making possible small high speed efficient units.
Fans are built in two types—"RB" and "RR"—for forced and induced draft, respectively.
Our Engineers will be glad to submit data covering the requirements of your individual draft problem. Let us send full details.

GREEN'S ECONOMISER, LIMITED.
TORONTO



Hose Built to *Modern* Specifications

MOST equipment of fifty years ago has little place in modern industrial plants. Improved methods are constantly needed to keep pace with modern standards of production and efficiency.

Yet until Goodyear entered the hose field, rubber hose was built in much the same old-fashioned manner as it had always been.

But Goodyear went into the foundry, the mine, the paper mill, the railway, the steel plant—studied the *actual* conditions industrial hose must meet in use.

Then new standards were set. A *better* hose was developed to meet the demands of modern industry.

The cover on ordinary water hose was found inadequate to protect it against the sharp objects over which it is constantly dragged. In a great many cases this cover was cut through and the hose destroyed long before it had given the service it should.

To prevent this, Goodyear Water Hose is fitted with a thicker-than-usual cover of exceptionally tough rubber. A cover that prevents wear and gives longer life to the hose.

Added to the good inner tube and strong fabric, it explains why Goodyear Water Hose has set a new standard for economy and freedom from hose troubles.

The efficient construction and unusual economy of Goodyear Water Hose is characteristic of all Goodyear Industrial Hose.

A man trained by Goodyear in hose problems will call upon you without obligation. Phone, wire, or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

BRANCHES—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.

GOODYEAR
MADE IN CANADA
INDUSTRIAL HOSE

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd. St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co. Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont
Robb Engineering Works, Ltd. Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S. Toronto.

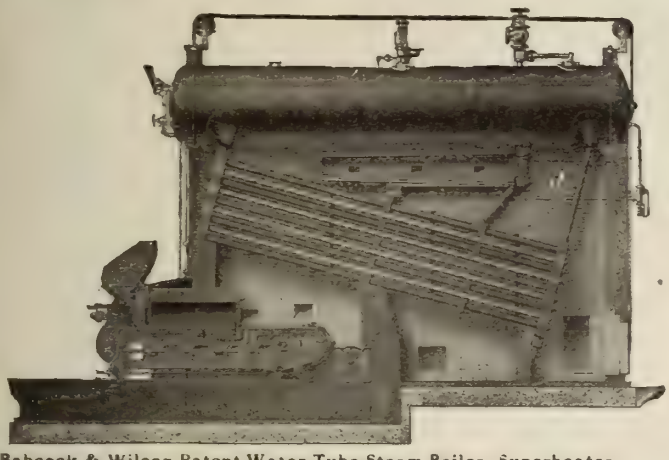
CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

Which!--One-Piece or Thousands?

Joints cause the failure of fire brick linings. The front wall and door arches are usually the weakest points in a laid-up fire brick lining. A lasting arch cannot be built of separate fire brick with its many joints filled with fire clay. The joints soon open enough to allow the bricks to separate or drop out, thus weakening the arch and paving the way for a total collapse.

The one-piece lining is the logical fire brick lining, because there are no separate bricks and clay joints.

Betson's Plastic Fire Brick

because af its make-up and the experience behind it, has made the one-piece lining a practical possibility and success. With this material the door arches and firebox walls are formed in one solid block, from the grate lining to the boiler shell and up around the sides of the smoke box on fire tube boilers, or up to the tube headers on water tube boilers. The entire construction is self-supporting and requires no iron door or other reinforcements. The front walls fit the boiler shell perfectly.

Betson Plastic Fire Brick costs less to install and will outlast the ordinary fire brick lining several times over.

Write for informing pamphlet on boiler furnace linings.

BETSON PLASTIC FIRE BRICK CO., INC.
P.O. Box 386-6 Rome, N.Y.

Canadian Distributor : INTERNATIONAL CHEMICAL CO., 44-6 Lombard St., Toronto, Ont., Canada

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empure Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Is, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

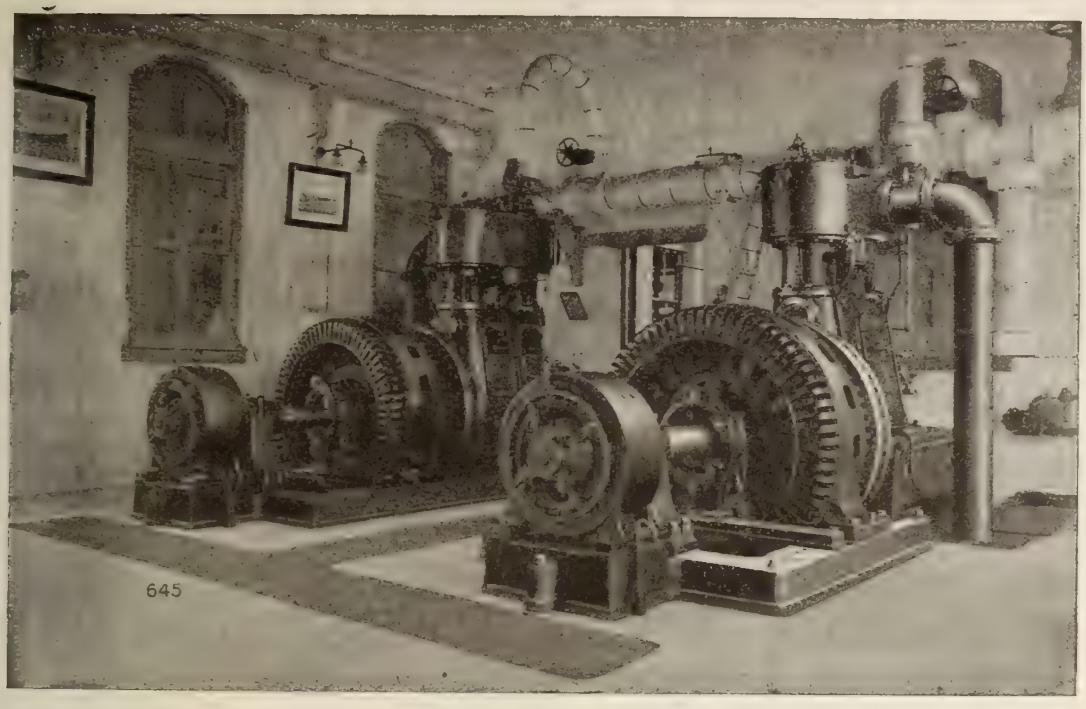
FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk, Con.



Belliss & Morcom Engines at Verdun, P.Q., Waterworks

Belliss & Morcom Engines Were Chosen By The City Engineers At Verdun, P.Q.

When an engineer selects an Engine or Air Compressor you can rest assured that it is the best in its class for the particular job for which it has been chosen. No detail escapes his attention; design, operation, manufacture and maintenance are thoroughly investigated and tested. That's why you'll find Belliss & Morcom Engines and Air Compressors in many of Canada's most modern engine rooms. Their scientific principles and design and their long service records stamp them as the best in their class and they are the invariable choice of engineers and men who know. When you're in the market, do not fail to investigate the Belliss & Morcom line.

We carry a complete line of Power House Equipment and Supplies. Prompt shipments from stock assured. Complete Power Plants designed, erected and equipped. **Enquiries cheerfully answered.**

LITERATURE UPON REQUEST

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG., MONTREAL

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Boving Co., Hagerstown, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

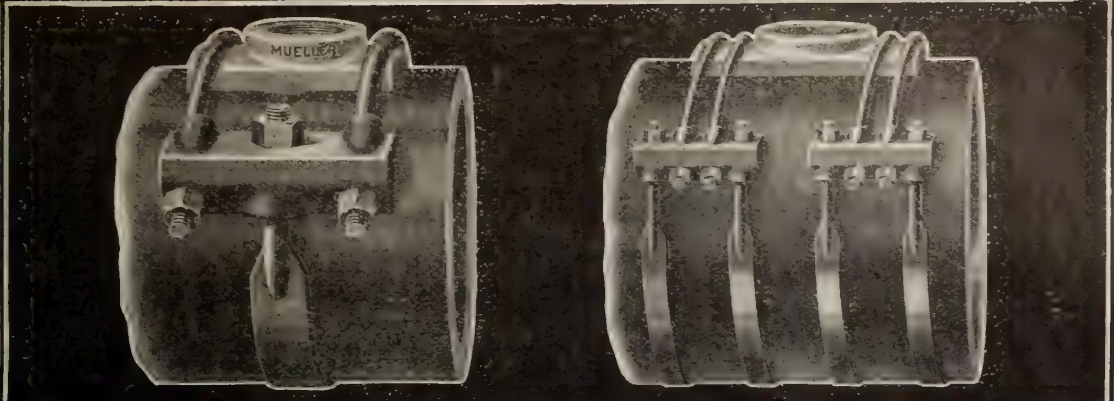
LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont



Dependable Service Means Real Economy

For carrying service from wrought-iron or light-weight mains—thru threaded connections that insure dependable service—there is nothing equal to

MUELLER Service Clamps

The straps are all hand-forged, soft steel—with threads and nuts accurately cut. The malleable clamps are galvanized by the hot process, which fills all pores and prevents leaks.

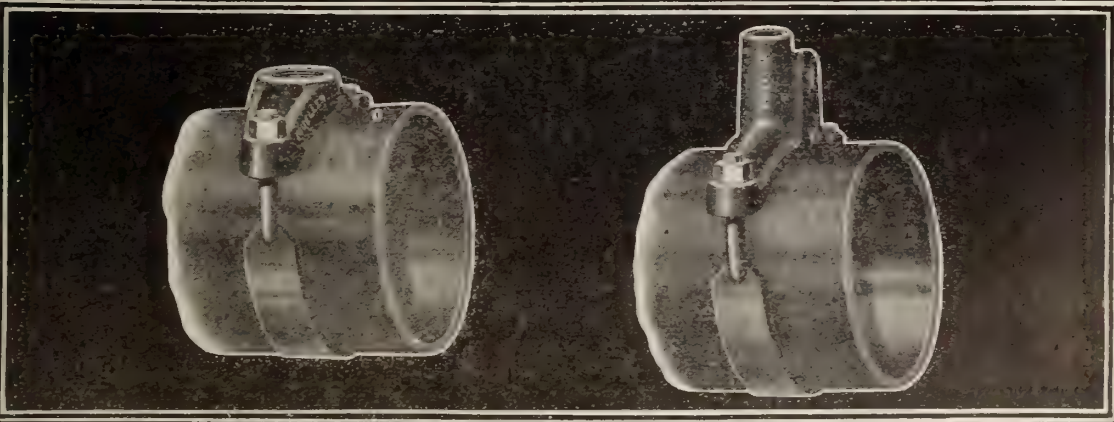
Write for catalog and prices. Mail orders given immediate attention.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools

American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.



LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lunkenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Sutherland Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

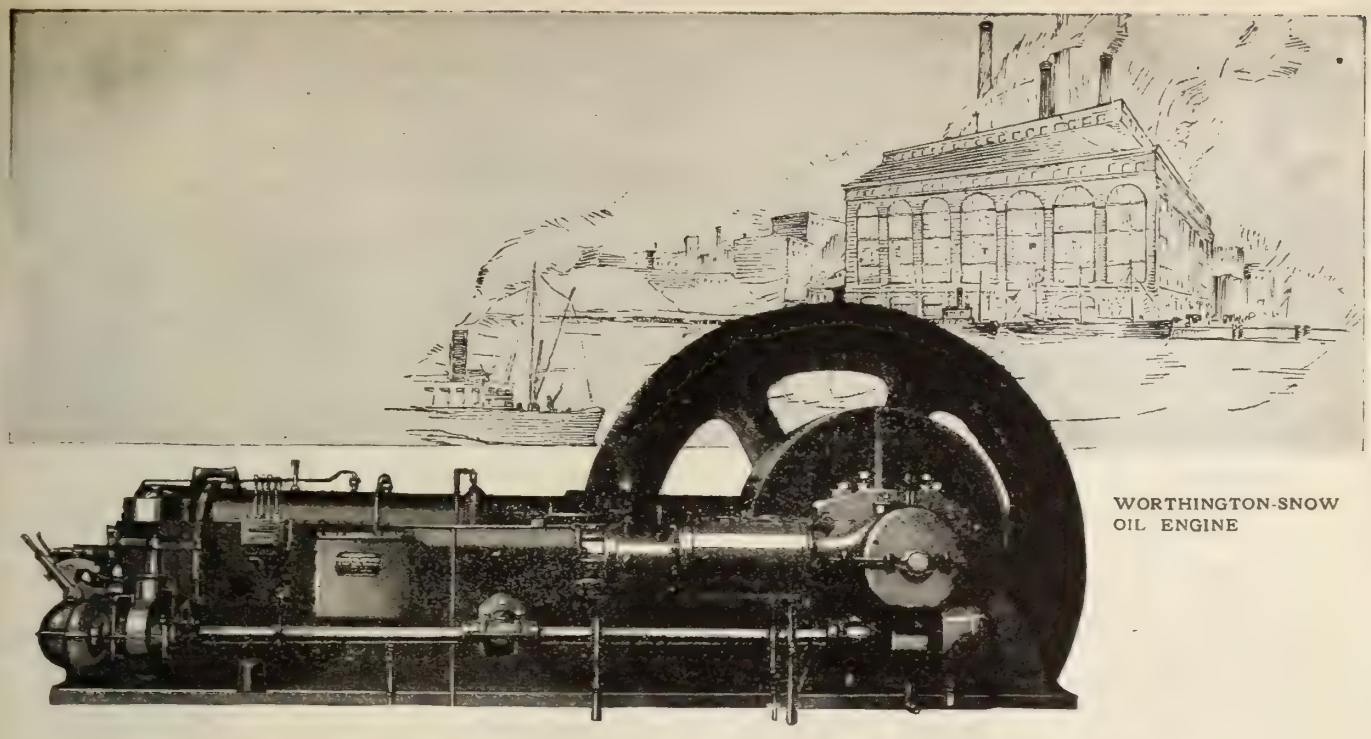
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



WORTHINGTON-SNOW
OIL ENGINE

See our exhibit at the

SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

Grand Central Palace, New York

Week of September 20th

Other Worthington Products:

Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

Horse Power Hours at $34

CAN you do it with coal at $15 the ton? Not so. Not even with old man Economy himself stoking the fires.

But you can buy your horse power hours at about $34 using Worthington-Snow Oil Engine prime mover service. For the Worthington-Snow Oil Engine is a horizontal, full diesel engine. And the diesel engine is the most economical prime mover yet designed. The main feature of the Worthington-Snow Engine is its economy—the percentage of potential power actually obtained for useful work.

Even when boilers are oil fired Worthington-Snow Oil Engines will deliver cheaper horse power hours. Computing costs on the basis of prevailing fuel prices, coal costs about $50 the horse power hour, fuel oil $43. Either way you figure it, Worthington-Snow Oil Engine is a well-paying investment.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

W-303.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*

Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co. Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co. Inc. New York N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Dunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd Sarnia.
Valve Engineering Company.

DUMP THE MATERIAL WHERE YOU WANT IT WITH A—*Jeffrey Travelling Tripper.*

—and you will be surprised how easily and accurately you can control the handling of loose materials in your power plant.
The Jeffrey Travelling Tripper, has assured a method of emptying the buckets, has its cams made of thick wearing surface, deep chilled, and hard as flint—may be lowered and quickly shifted when carrier is idle or a stationary tripper is in service—is so easily balanced that it can be readily moved when Carrier is in motion—and its release ends are adjustable for easy release of the buckets.

Simple, safe, accurate, and mobile it possesses all the characteristics that go to make up other Jeffrey equipment.

Our engineers will gladly point out to you all the advantages of the JEFFREY Carrier. Write to-day for our new Catalog No. 210.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms: MONTREAL

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall. Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall. Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

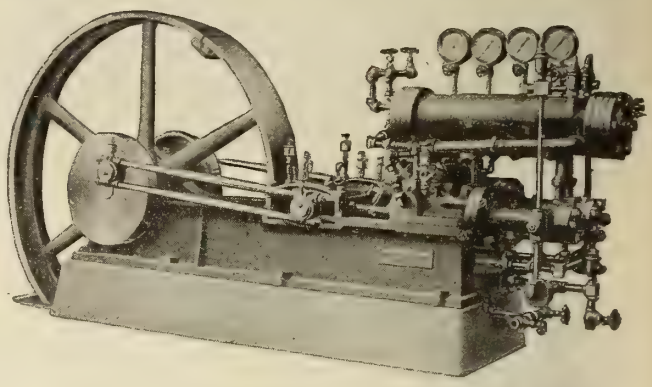
WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

NORWALK
AIR & GAS · COMPRESSORS

The Norwalk Record

of unvarying success in foundry compressing service has been maintained under severe and widely differing operating conditions. Whatever the individual problem of the user may be, it is part of the Norwalk job to solve it.



NORWALK FOUR-STAGE, BELT-DRIVEN AIR COMPRESSOR

For air-line efficiency, start right by using Norwalk Compressors.
"Norwalks always do the work."
New Bulletins on Request

THE NORWALK IRON WORKS COMPANY

Pioneer Builders of Compressors, South Norwalk, Conn. **A. S. Leitch Company, Toronto, Canadian Sales Representative**

ANY·CAPACITY ANY·PRESSURE

INDEX TO ADVERTISERS

A

All-Way Oiler Co. 52
American Steam Gauge & Calve Mfg. Co. 52
American Steam Pump 46
Anderson Co., V. D. 64
Armstrong Cork & Insulation Co. 11

B

Babbitt Steam Specialty Co..... 5
Babcock & Wilson 71
Badger & Sons, E. B. 57
Betson Plastic Fire Brick Co... 71
Brown, Wm. J. 54
Boving ydraulic Eng. Co. 55
Busch-Sulzer Bros. — Diesel Engine Co. 56

C

Can. Consolidated Rubber So. . 59
Can. Fairbanks-Morse Co.... 37, 42
Can. Johns-Manville Co. 7
Can. Mead-Morrison, Ltd..... 50
Can. Steam Boiler Equipment.. 60
Cole Ltd., Geo. W. 60
Crane-Fulton Mfg. Co..... 54
Coppus Engr. & Equip. Co. 43
Crane Ltd. 56

D

Darling Bros. 56
Dart Union o. 50
D'Este Co., Julian 58
De Laval Separator Co. 61
Department of Labor 55
Diamond Specialty Co. 68
Direct Separator Co. 42
Dominion Coal Co. 54
Dunham & Co., C. A. 52
Durabla Mfg. o. 39

E

Economy Fuse Co. of Can., Ltd. 66
Electric Welding Co..... 56
Empire Mfg. Co. 3
Engr. & Mach. Works of Can. 62
Escher, Wyss & Co. 57

F

Frick Co. 11

G

Garlock Packing Co. 41
Garth Co., The 55
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co. ..8, 9, 69
Greene, Tweed & Co. 40
Green's Economizer, Ltd. 68
Gutta Percha 49

H

Holden Co., Ltd., The..... 6
Holmes Metallic Packing Co.... 55
Homestead Valve Mfg. Co..... 66
Hoyt Metal Co. 54

I

Inglis Co., John..Inside back cover

J

Jamison Cold Storage Door Co.. 12
Jefferson Union Co. 51
Jeffrey Mfg. Co. 79
Jenkins Bros. ....Inside front cover
Jointless Fire Brick Co..... 57

K

Kellogg & Co., E. H..... 39
Kerr Engine Co. 58

L

La Clede Christy Clay Products Co. 14, 15
Laurie & Lamb 55, 73
Leitch, The Arthur S. 2
Lincoln Electric 88
Linde Can. Refrig. Co. 10
Long, J. T. 39
Lunkenheimer Co. 4

M

MacGovern & Co. 46
Magnolia Metal Co. 5
Manny Co., E. S 54, 56
Mason Regulator & Eng. Co... 67
Ministry of Munitions 47
Morrison Brass Mfg. Co., Jas. Outside back cover
Mueller Mfg. Co., H. 75
Murphy Iron Works 48

N

Northern Electric Co. 65
Norwalk Iron Works Co. 80

P

Page-Hersey Iron & Lead Co., Ltd. 63
Peacock Bros. Ltd. 44, 45
Penberthy Injector Co...Front cover
Pilley Packing & Flue Brush Mfg. Co. 55
Pratt & Cady Co., Inc..... 5

R

Robb Engineering Co. 63

S

Sanford Riley Stoker Co..... 48
Sexton Boiler Setting Co. 64
Scaife & Sons Co., Wm. B. ... 80
Schaeffer & Budenberg Mfg. Co. 62
Starrett Co., The L. S. 61
Steel Mill Packing Co..... 62
Superheater Co., Ltd., The.... 53

T

Trimont Instrument Mfg. Co., The 58

U

Uehling Instrument Co..... 61
Under-Feed Stoker Co. of Canada, Ltd., The..... 13

V

Victoria Foundry Co. 56
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd. 42

W

Wall, W. J. 55
Waterous Engine Works Co..... 1
Watson & McDaniel Co..... 55
Williams & Co., J. 42
Worthington Pump & Machine Co. 77

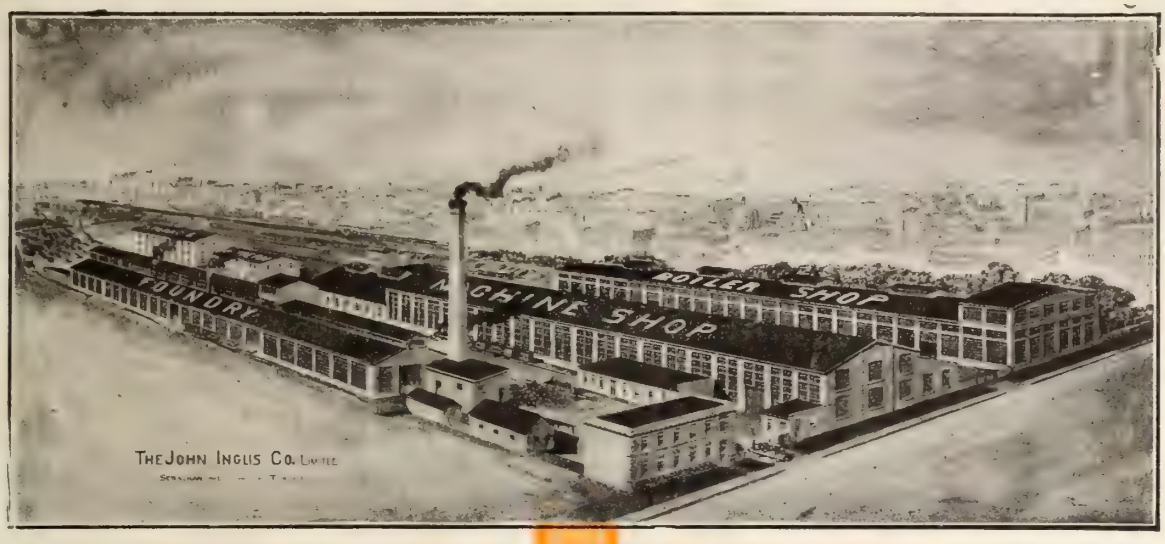
Y

Yarnall-Waring Co. 66
York Mfg. Co. 12

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



BOILERS

TANKS AND ENGINES

Of All Kinds for Any Service

Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.

14 Strachan Ave., TORONTO

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada:
JAMES W. PYLE & CO., LIMITED
232 St. James St., MONTREAL

MORRISON'S

Steam Specialties

"A single fact is worth a shipload of argument."

The fact that Morrison's products have been considered thoroughly dependable for half a century is proof of their quality. Every installation is a demonstration of their merit.

Morrison Injector

Some of the Morrison Lines

Vacuum Gauges,	Pipe Fittings,
Ammonia Gauges,	Steam Whistles,
Lubricators,	Engine Indicators.
Stop Valves,	Injectors,
Check Valves,	Ejectors,
Gate Valves,	Inspirators,
Safety Valves,	Jet Pumps,
Relief Valves,	Steam Gauges,
Reducing Valves,	Pipe,
Steam Traps,	Tools, Etc.,

A full description of these and other Morrison lines will be found in the Morrison catalogue. Write for a copy.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West, TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

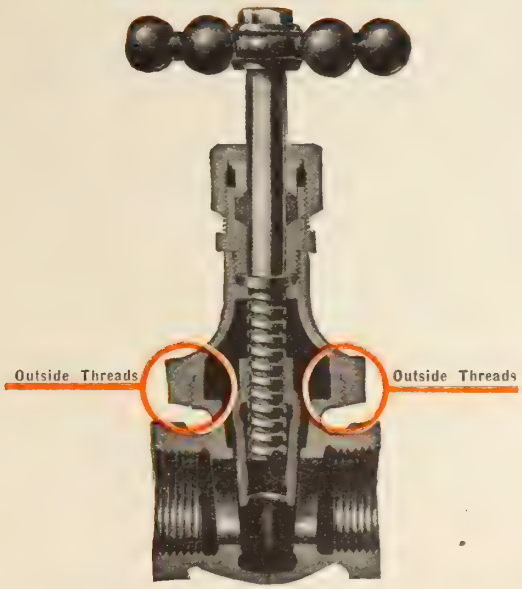
MONTREAL: Southam Building | LONDON, ENG.: 88 Fleet Street, E.C. | WINNIPEG: 1103 Union Trust Building

Vol. XIII. No. 18. Publication Office, Toronto, Sept. 20, 1920 | Published Semi-Monthly Canada, $2; U.S. $2.50 a year

TRADE PENBERTHY MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY

"The Valve of all Valves"



BRASS GATE VALVES

There are special features in the construction of Penberthy Gate Valves that appeal to every good engineer—viz.—

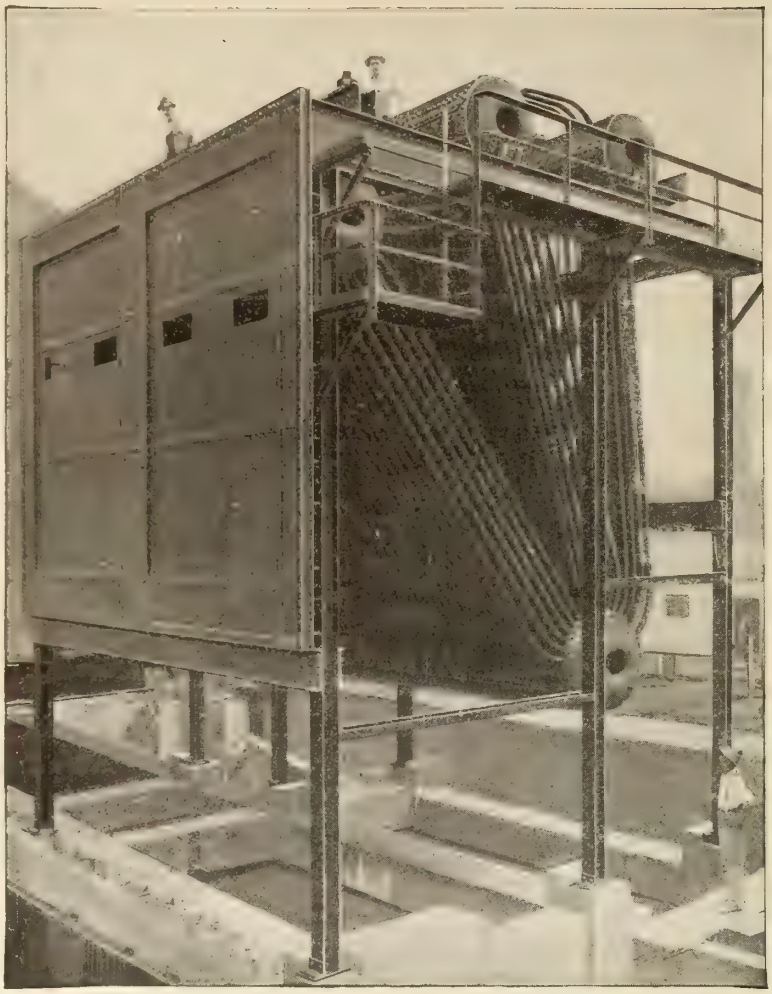
The Outside Bonnet Construction
The Solid Wedge Disc
Stuffing Box With Packing Gland and Follower
Best Quality Steam Metal
Careful Workmanship and Finish
Reg. and Approved (Ont. Pub. Wks. Dept.) for 150 Lbs. Steam Pressure

Used by the Best Engineers

Manufactured by

Penberthy Injector Co., Limited, Windsor, Ontario

86th Year



86th Year

Connelly (Patented U. S. & Canada) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of circulation and deliver steam superheated to from 5 to 10 degrees Fahrenheit.

Simple in design, no flat surfaces, no staybolts, no crown bars, no braces, no hand-holes, free from joints.

All parts easily accessible for cleaning, both internally and externally.

Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. LEONARD & SONS LIMITED

Head Office and Works: LONDON, Canada

Branches:

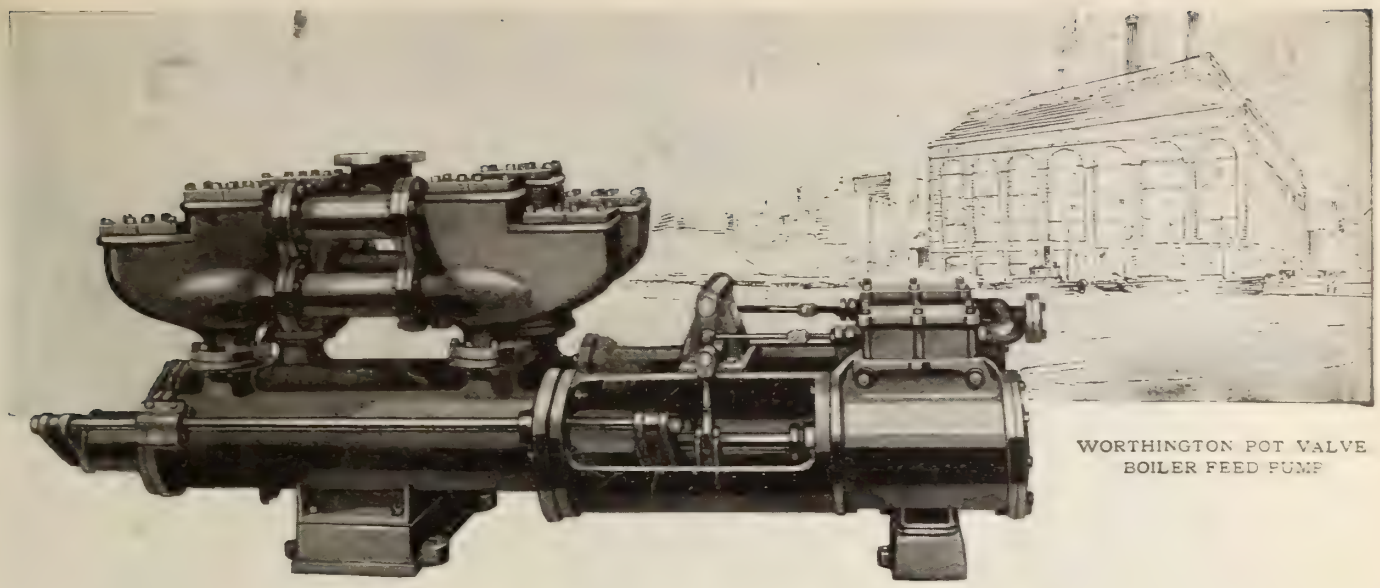
1790 St. James St., Montreal, Que.

62 Water Street, St. John, N.B.

Agents:

E. J. Philip & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning Street, Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave Street, St. John's, Nfld.

LEONARD



WORTHINGTON POT VALVE
BOILER FEED PUMP

The throbbing heart of industry

DOWN in the depths of boiler rooms the world over, Worthington boiler feed pumps are successfully satisfying most exacting service demands. Functioning perfectly and without falter, they are the throbbing heart of industry.

Since 1840, Worthington power plant apparatus has satisfied over 200,000,000 boiler horse power. Of this line of apparatus, Worthington Pot Valve Boiler Feed Pump is a worthy representative. It is regularly built for pressure up to 300 pounds. Where space is limited the pump can be furnished with center-packed pot valve water end.

In addition to boiler feeders, Worthington manufacture a most complete line of pumps and pumping machinery which has earned for the Worthington line the title of "world's standard."

Other Worthington Products:

Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

W-297.5

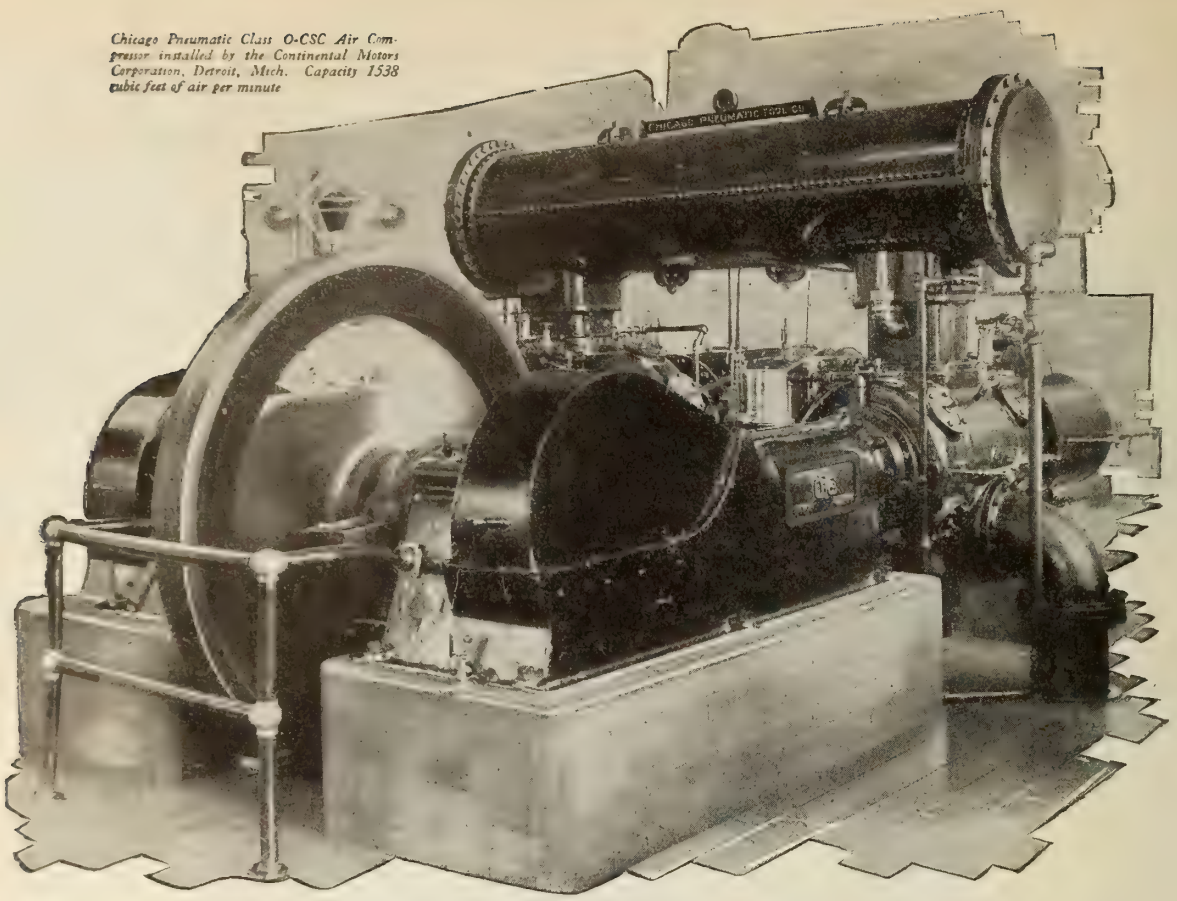
PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Crane Works, *Holyoke, Mass.*
[illegible] Works
[illegible], *Mass.*
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*

Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*



Chicago Pneumatic Class O-CSC Air Compressor installed by the Continental Motors Corporation, Detroit, Mich. Capacity 1538 cubic feet of air per minute

Try inhaling through your fist

VACUUM resistance means wasted power! Breathing through your fist requires effort —wasted effort.

In an air compressor, pulling against a vacuum due to a choked intake is *wasted power.*

With Chicago Pneumatic Air Compressors it's different—

Their unloading system automatically holds the inlet valves open after unloading. This permits free passage of air at no load.

If your compressor is working against a vacuum, a Chicago Pneumatic will save power at every stroke.

This is *one* Chicago Pneumatic feature. It will pay you to know *all* of them. Bulletins upon request.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street C-71-H

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

Proper Lubrication Pays

TROUBLE with plant machinery usually simmers right down to a problem of correct lubrication. Hasn't that been your experience time and again?

The *right* lubricating oil for every working part is your best insurance of smooth running, effective mechanical units—which, in turn, means full-capacity plant operation.

Engineers who have standardized on Imperial Lubricants find the quality uniform with a grade especially suited for every type of machine. And *immediate* supplies are always available in any quantity.

Imperial Lubrication Engineers co-operate with plant engineers and superintendents to get more work out of power-producing and power-using equipment at lower lubrication costs. An experienced Imperial Oil man will gladly make recommendations for the particular needs of your plant.

Write to 56 Church St., Toronto, Ont., or our nearest branch.

IMPERIAL

Lubricants

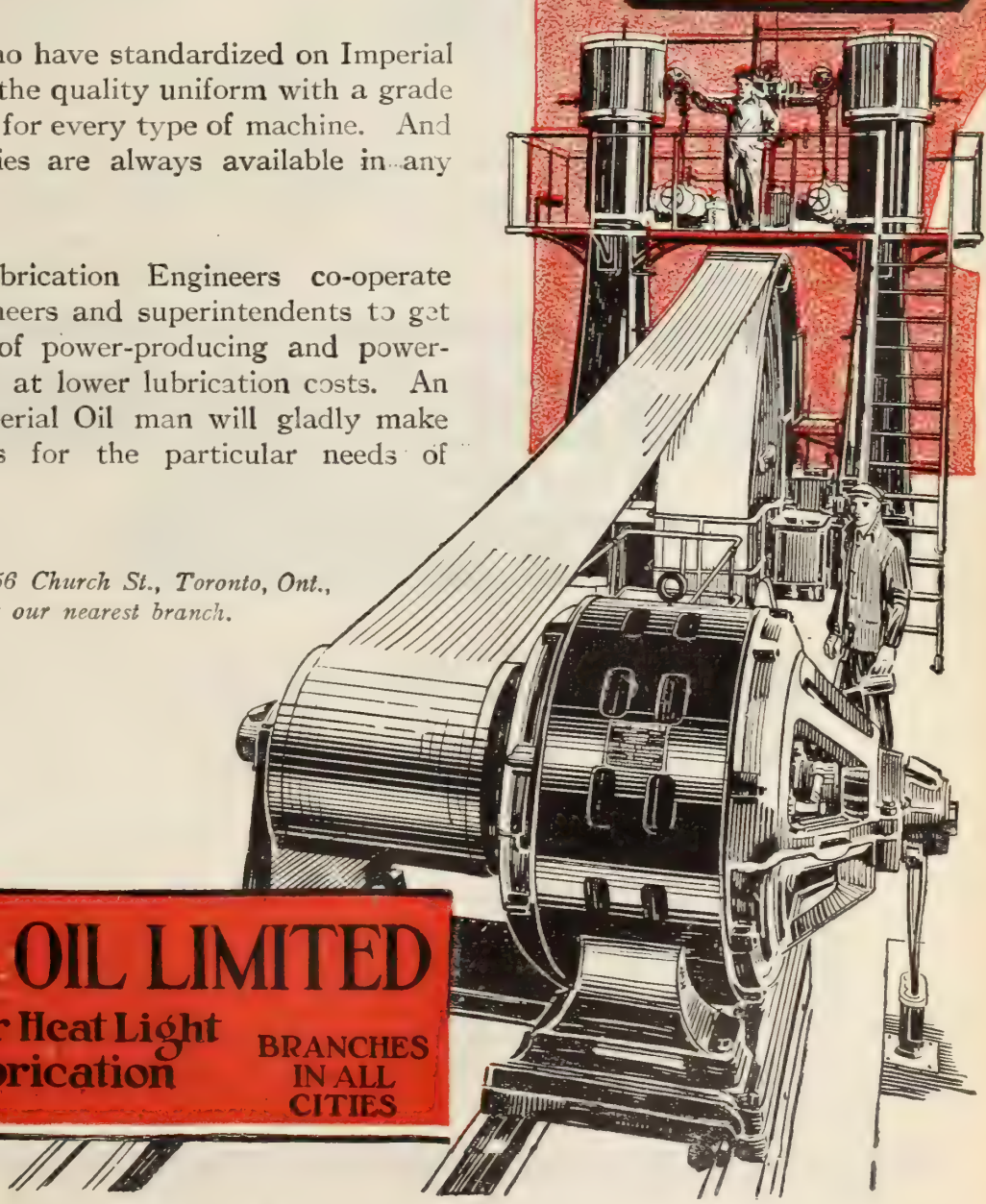
For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Gas Engine Oil
Imperial Arlo Compressor Oil



IMPERIAL OIL LIMITED

FIVE CANADIAN REFINERIES

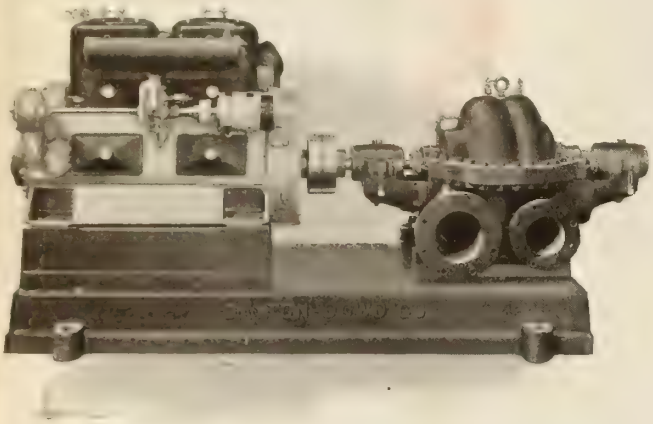
Power Heat Light Lubrication

BRANCHES IN ALL CITIES

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Adequate Standby Equipment

Consists of a self-contained and economical prime mover, not dependent upon the main unit nor upon outside sources for propulsion. A Sterling high-duty gasoline engine, operating dependably at centrifugal pump or electric generator speed, costs little to install and little to maintain. It is virtually power insurance.



Model FC, 4-cylinder, 90-100 H.P. Sterling direct connected to Dayton-Dowd 500 G.P.M. centrifugal pump for the town of Lockport, Ill.

STERLING ENGINE CO., Dept. C-4, Buffalo, N.Y.

12 to 300 H.P. at speeds of 400 to 1600 r.p.m. for fire protection and emergency service.

Gates Refractories
Limited

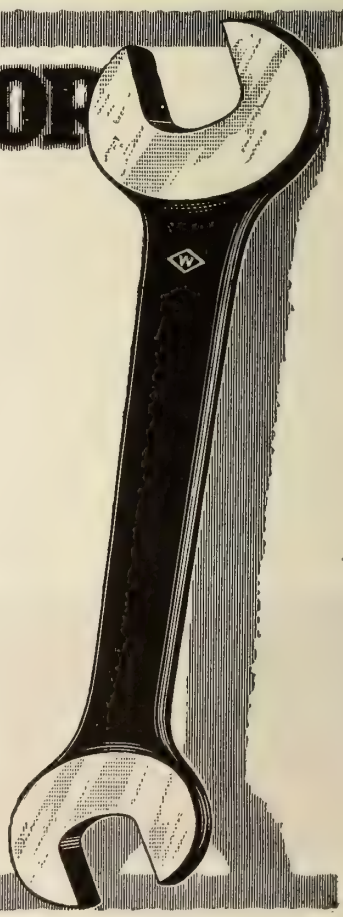
Contractors
for

Boiler Setting
Furnace Building
Oven Work
Repair Jobs

Estimates on all Work

382 St. James St. Montreal

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES



Better tools make better workmen—

And you can't buy a better wrench than a Williams

J. H. WILLIAMS & CO.
"The Wrench People"

BROOKLYN	BUFFALO	CHICAGO
78 Richards St.	78 Vulcan St.	1078 W. 120th St.

THESE COMPANIES ARE REPRESENTATIVE OF MORE THAN 1800 USERS OF

Jones & Laughlin

Escanaba Paper Co.

Firestone Tire & Rubber Co.

Fulton Bag & Cotton Mills

Republic Iron & Steel Co.

Edison Illuminating Company

Youghiogheny & Ohio Coal Co.

Solvay Process Co.

International Harvester Co.

National Cash Register Co.

General Electric Co.

Laurentide Paper Co.

Eastern Steel Co.

Rochester Ry. & Lgt. Co.

Oliver Plow Works

Lancaster Glass Co.

Lima Locomotive Works

Cincinnati Traction Company

Reo Motor Car Co.

United States Playing Card Co

Sullivan Machinery Company

Harvard Medical College

Erie Lighting Co.

Republic Stamping & Enameling Co.

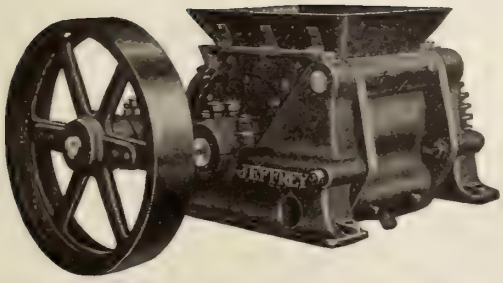
Solar Refining Co.

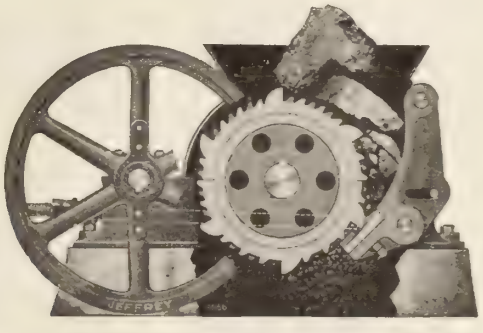
Insure a supply of properly sized coal in your boiler plant by installing a Jeffrey Single Roll Crusher

THE JEFFREY MFG. CO.

Canadian Branch and Warerooms:

MONTREAL





Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

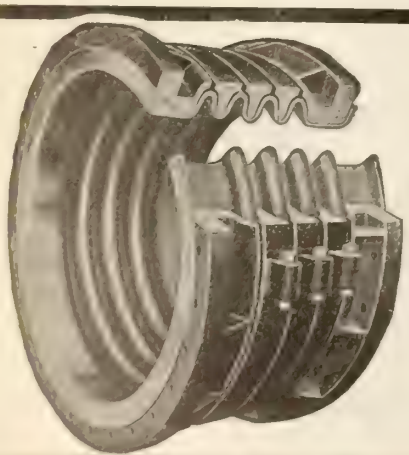
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.



Cut Out Your Pipe Leaks and Save Your Pipe Expense With

BADGER SELF EQUALIZING EXPANSION JOINTS

Write for our new book to-day

E. B. BADGER & SONS COMPANY

101 Park Ave., New York 81 Pitts St., Boston 616 S. Michigan Ave, Chicago

ROBB

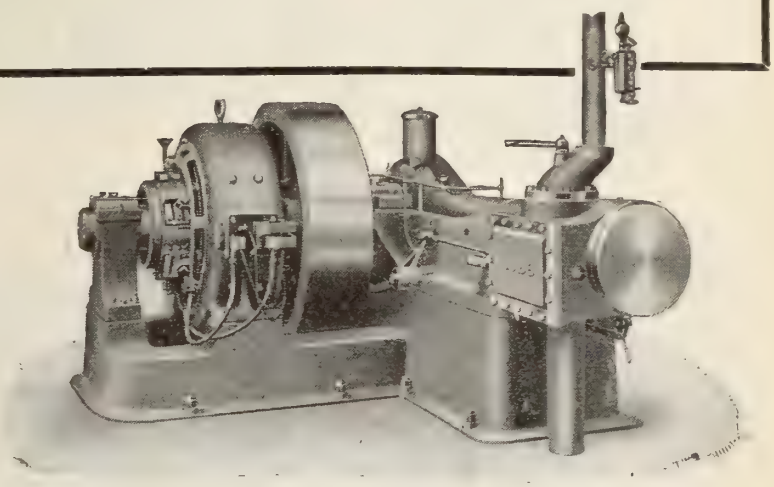
For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



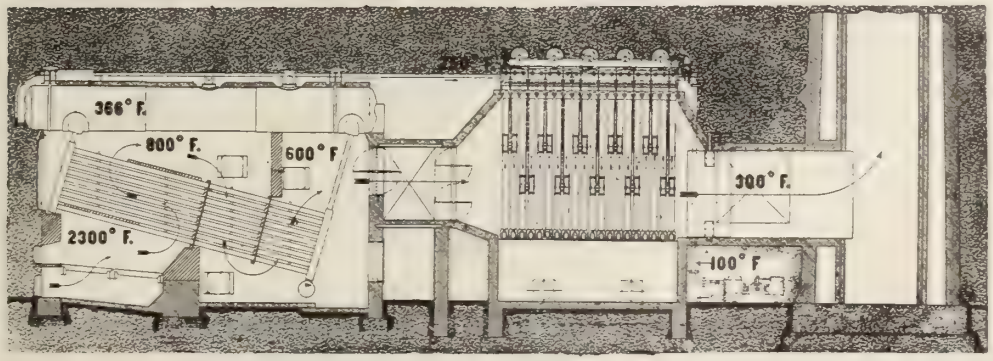
Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

GREEN'S ECONOMISERS



A Saving of 13.6%

Green's Economiser "installation temperature diagram," showing a rise of 150° in feed water temperature above that of the feed water heated. This is not an unusual case, and under these conditions would show a saving of 13.6% based on 1% saving for each 11° increase in feed water temperature.

Modern economic operation of boiler plants demands that your boilers be operated above normal rating. This means higher exit temperatures of the flue gases.

Green's Fuel Economisers utilize this heat in the flue gases to heat the feed water under boiler pressure, which accounts for the fuel saving and also allows you greater boiler capacity.

Ask our engineers for data on economisers for your plant.

GREEN'S ECONOMISER, LTD.
TORONTO

Another New Link-Belt Data Book

Enables you to select Roller Chain Drives for Industrial Drives,—Tractor and Truck Drives

FOR years the power transmission engineer had his Link-Belt Silent Chain Data Book, which enabled him to select the correct silent chain drive for his purpose and figure its cost. This is the recognized authority on silent chain drive practice.

And now comes this new hand-book of roller chain practice. It shows how to figure drives, determine prices, gives information on care and upkeep, and a wealth of other information on this whole subject which will prove invaluable to the engineer and others interested in roller chain.

The subject of wheels is also gone into very thoroughly. (The chain is the standard and the wheels must be made to fit it, to assure their working together properly.)

In short it is a complete handbook of roller chain application and design. It is not merely a catalog.

Send for it today. Use the coupon.

CANADIAN LINK-BELT CO., LIMITED
Wellington and Peter Streets, TORONTO

World's Largest manufacturers of Elevating Conveying and Power Transmission Chains

Canadian Link-Belt Company, Limited, Wellington and Peter Sts., Toronto

Please send me a copy of your New Roller Chain Data Book No. 257.

*Name*_____ *Firm*_____

*Address*_____ *Town and Province*_____

The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

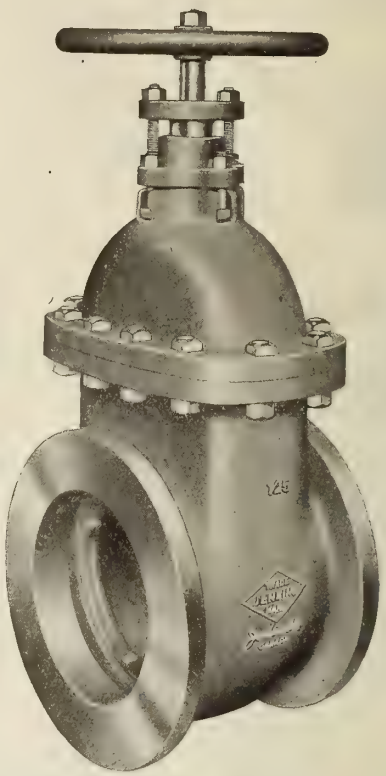
Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

A DEPENDABLE VALVE FOR EVERY PURPOSE

The Valve Test That Safeguards A 56 Years' Reputation

We might well depend solely upon the care used in their designing and the high-grade materials from which they are made to maintain the high standard of value established by Jenkins Valves some 56 years ago.



—but that our enviable reputation may be preserved unimpaired we see to it that every valve bearing our well-known Diamond Trade-Mark is **thoroughly tested before leaving the plant.**

So that the valve purchaser who specifies Jenkins Valves is insured against the losses inherent with the cheap imitations of the genuine Jenkins, a host of which is now on the market.

Therefore—look for the Diamond Trade-Mark on the body of the valves you buy. It is your guarantee of long and satisfactory service, even where conditions of usage are more than ordinarily severe.

Stocks at all good dealers.
Write for Catalog No. 8.

TRADE JENKINS MARK

Jenkins Bros.

LIMITED

TRADE JENKINS MARK

Head Office and Works: 103 St. Remi St. Montreal, can.

Jenkins Bros EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY. LONDON W.C.2. ENG. Jenkins Bros

Agencies in all the Principal Countries of the World

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

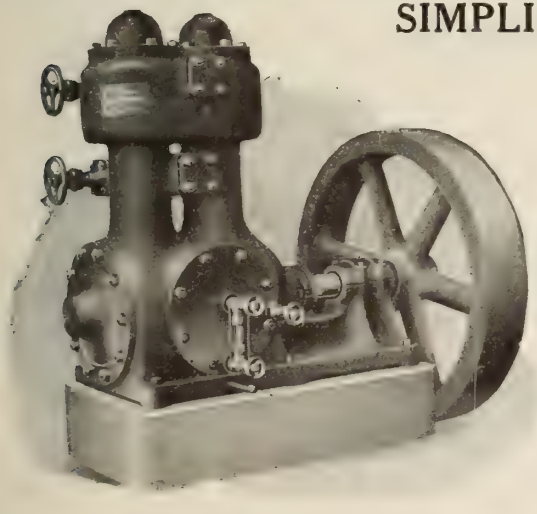
DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permit them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

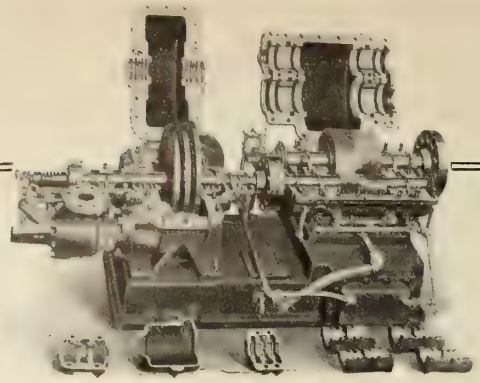
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



The Design of Moore Steam Turbines Prevents Steam Leaks

Ample surfaces at the joints have been provided to prevent leakage of steam—also the number of vertical joints have been reduced to a minimum. In a turbine having numerous vertical joints it is almost impossible to prevent leakage and consequent loss of efficiency in operation.

The careful designing to prevent all steam leakage is but one feature of Moore Steam Turbines. Send for our booklet. It explains fully the others.

Moore Steam Turbine Corporation

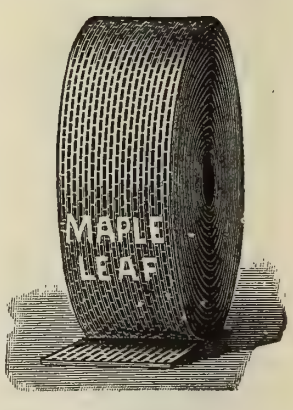
Wellsville New York U.S.A.

Dominion Belting Company, Limited Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

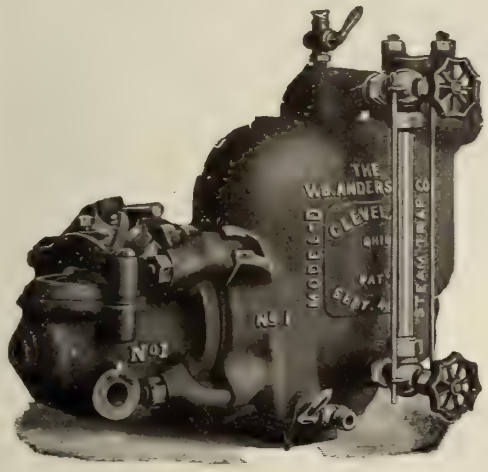
Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

THE ANDERSON Model "D" STEAM TRAP



Tight from the day you put it in!!

Think of the care-free trap service you will have once the Anderson is in your steam room! Tight from the moment it is installed!

The Anderson Model "D" Steam Trap is operated by a counter-balanced Lake Superior Copper Float. Its large area valve is always under deep water seal, and it will never wire draw.

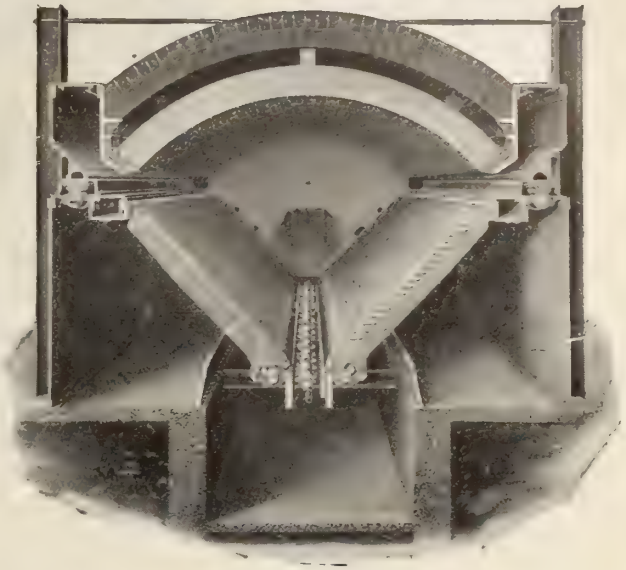
Every part is machined to solid gauges. The self-contained strainer and self-contained by-pass are Anderson features. The simple design gives complete accessibility to every part.

Write for full particulars.

The V. D. ANDERSON CO.

1935 W. 96th St., CLEVELAND, Ohio.

MURPHY AUTOMATIC FURNACES



For Any Boiler

50 h.p. and Up

Any boiler from 50 h.p. and up can be equipped with the MURPHY FURNACE. The *smaller plant* can therefore enjoy all the economical advantages of fuel and labor savings *without resorting* to forced draft.

To-day over 6,000 *boilers* are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry—from hospital to industrial and central station service. MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

Our Catalogue "CM-9" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

For information on RILEY UNDERFEED STOKERS for large boilers, see last month's advertisement or send for RILEY STOKER Catalogue "CR-9"

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

D.K.McLaren's

GENUINE BRITISH-OAK TANNED

LEATHER BELTING

TRADE MARK

The Oak Leaf is the Sign to Go By

Bear in mind the Oak Leaf—the sign of dependability—the next time you buy belting; it will serve you as a guide to better belting service in your plant.

Three features loom large in the manufacture of D. K. McLaren's Leather Belting. They are: **The Hide, The Tanning and The Workmanship.**

THE HIDES are cut from the **backs** of the choicest steers.

THE TANNING. Genuine British Oak Tanning imparts that desirable toughness to the leather for which D. K. McLaren's Belting is famous.

THE WORKMANSHIP is of the highest grade possible.

Altogether, if you make sure that the Oak Leaf is on your next belting, you'll secure exceptional service.

GENUINE OAK

D·K·McLAREN LIMITED

GENUINE OAK

HEAD OFFICE AND FACTORY
351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

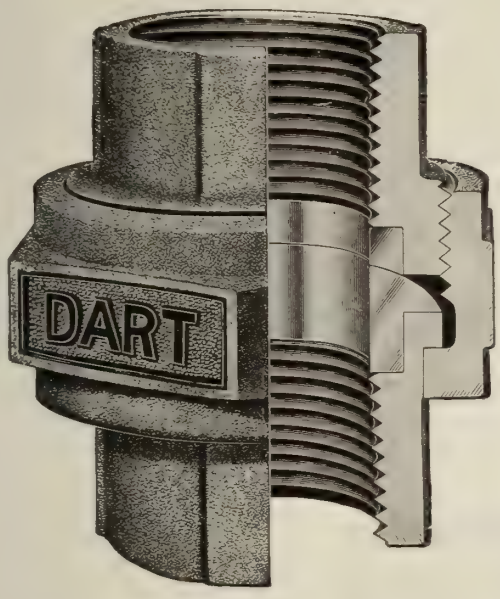
TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 Germain St.

VANCOUVER, B.C.

Specify the

DART



The Union Pipe Coupling that will keep you free from Trouble and Upkeep Expense

Face and Seat are Bronze. There is no deterioration of any kind at the point where the joint is made.

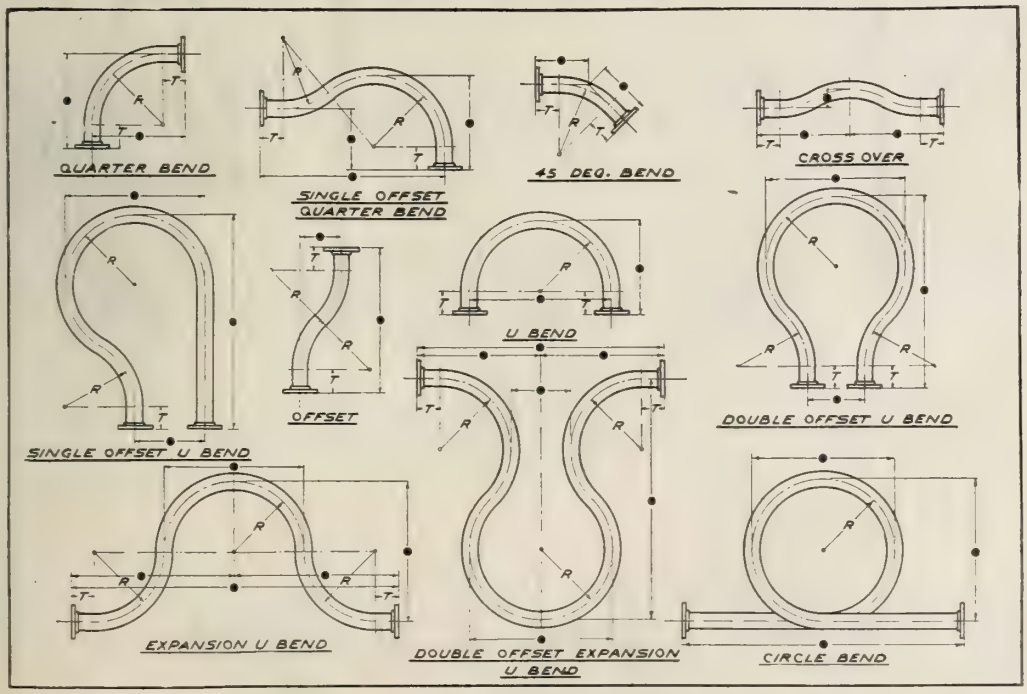
Iron Parts are Heavy. They positively prevent splitting or pulling apart under strain or heavy pressure.

There's a variety of styles to fill all requirements.

Your Jobber Has It

Dart Union Co., Limited, Toronto, Ont.

P&H WROUGHT PIPE BENDS



ALL KINDS AND SIZES UP TO 10" DIAMETER

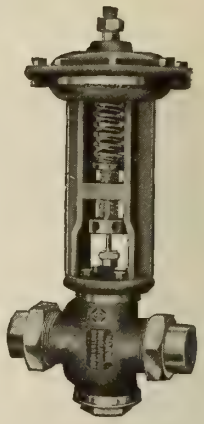
MADE IN CANADA BY

PAGE-HERSEY IRON, TUBE & LEAD Co. LIMITED

100 CHURCH STREET, TORONTO, ONT.

Bundy Return Trap

Mason
Standard All-Bronze
Reducing Valve



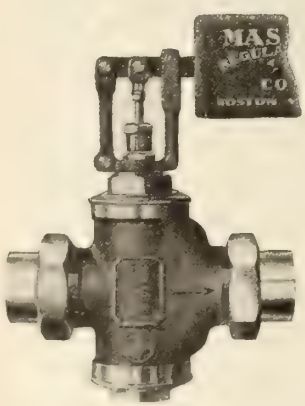
Mason No. 55
Pump Pressure
Regulator

The splendid reputation of Mason Power Plant Devices is not the result of an accident, but the expected outcome of thirty years of persistent effort backed by large capital and superior manufacturing facilities.

They hold the first place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend upon these devices working in many critical locations and find them satisfactory.

Mason Equipment is designed by expert engineers of long and varied experience and having a full and complete knowledge of the requirements of a power plant, and they are built under the supervision of experts.



Mason
Balanced Valve.

Mason
Standard Reducing Valve.
Iron Body

THE MASON REGULATOR & ENGINEERING COMPANY, LIMITED

MONTREAL
135-153 Dagenais Street

TORONTO
145 Wellington St. W.

Two Types of Jones Under-Feed Stokers

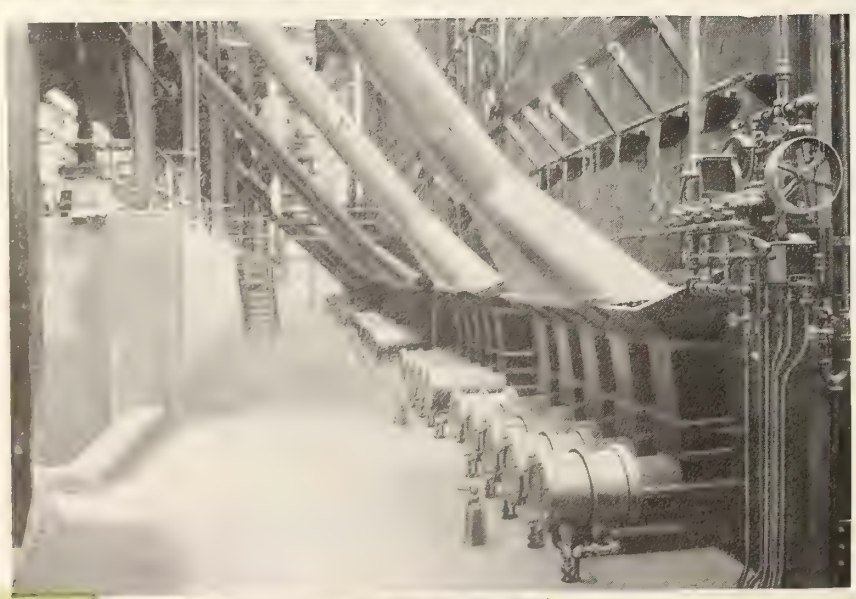
"A-C" and "STANDARD"

Jones "A-C"

Jones "A-C" Stokers

are automatically cleaned, high-duty stokers. From coal-hopper to ash discharge the cleaning is entirely automatic. No hand labor is needed. No trouble is experienced from big clinkers in the fire—and no clinkers are formed either on the bridge wall or side walls.

As the steam-driven rams push the charges of green coal into the retorts, the entire fuel bed is slowly pushed toward a balanced dump plate at the rear. This is ***not*** a gravity movement. The incline of the retorts is not sufficient to to cause avalanching. By the time the fuel bed reaches the rear of the furnace, the fire is burned out and nothing is deposited on the dump plate but dead ash and refuse. This dump plate is so balanced that it is easily and quickly operated by hand. No power driven dumping mechanism to cause trouble.



Jones "STANDARD"

Jones "Standard" Stokers

are very simple. There are no moving parts in the fire—and very few moving parts of any kind. Simplicity and easy accessibility insure low maintenance costs.

Fuel and air supplies for both types of Jones Stokers are controlled automatically, and proportioned for complete combustion and high efficiency with any grade of coal. Smoke is waste—with Jones Stokers there is no waste. The automatic controls can be adjusted to maintain any desired steam pressure within very close limits—regardless of sudden changes in load.

Jones "Standard" Stokers can be installed under limited space conditions. No ash pits or other excavations are necessary. Old boilers can be equipped without changing settings. Wherever installed, they increase fuel efficiency and reduce operating and maintenance costs.

Jones Service

The engineering department of this company will be glad to give assistance in the handling of any power plant plans involving the possible use of stoker equipment. As the oldest manufacturers of the under-feed type of stokers, our experience enables us to solve unusual combustion problems, either in the power plant field or for special purposes.

We have prepared a catalog illustrating and describing the Jones "A-C" Stoker and another one showing the Jones "Standard" Stoker in detail. We shall be glad to mail a copy of either or both of these books to any interested engineer.

The Under-Feed Stoker Co. of Canada, Ltd.

81 Victoria Street

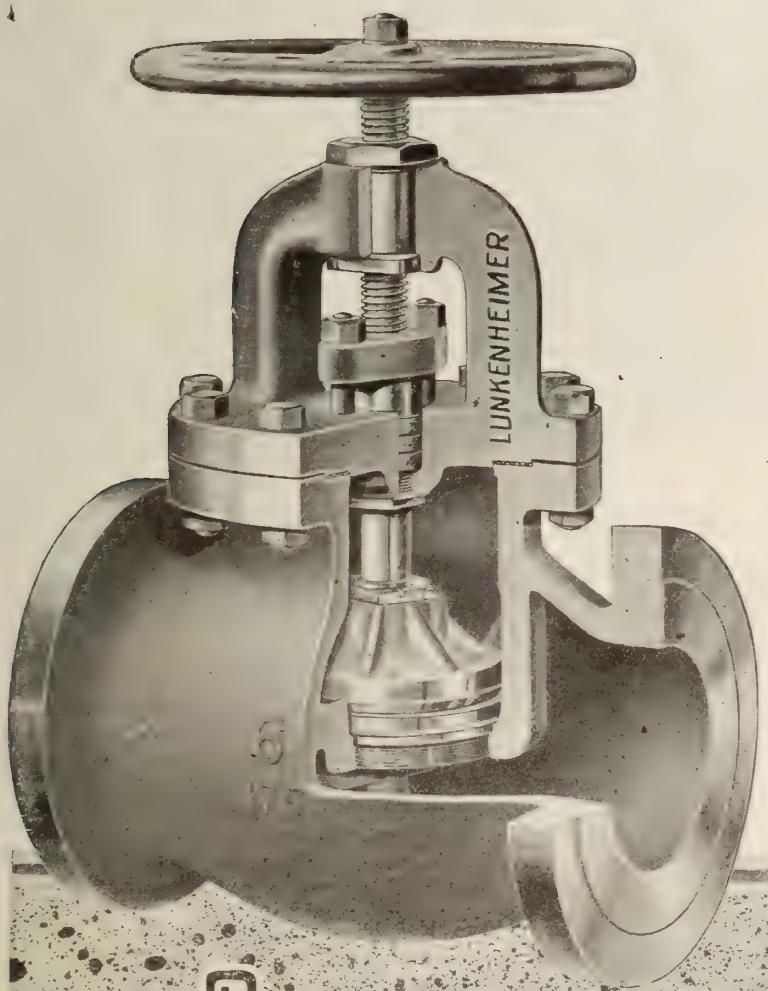
TORONTO

-lasting satisfaction

LUNKENHEIMER

IRON BODY BRONZE MOUNTED

GLOBE, ANGLE, CROSS & CHECK VALVES



give lasting satisfaction in service. Their design, extreme strength and durability due to the high quality materials used, and the Lunkenheimer system of test and inspection which they undergo, insure safety and maximum valve service.

Lunkenheimer "Valve-iron" is close grained and has a tensile strength far in excess of the iron used in the average valve. The trimmings are made of Lunkenheimer "Valve-bronze," a material possessing extreme wear resisting qualities.

The compensating seat in Lunkenheimer Valves will adapt itself to any slight distortion which may be caused by temperature change or pipe strains. The seating surfaces are re-grindable and all the parts renewable.

For high temperature service these valves can be supplied with trimmings made of Lunkenheimer "Valve-nickel"

All standard sizes, in three weights, for working steam pressures up to 125, 175 and 250 pounds.

Specify LUNKENHEIMER Iron Body Valves and insist on their installation.

Distributors of Lunkenheimer Products situated in every commercial centre.

THE LUNKENHEIMER CO.
"QUALITY"

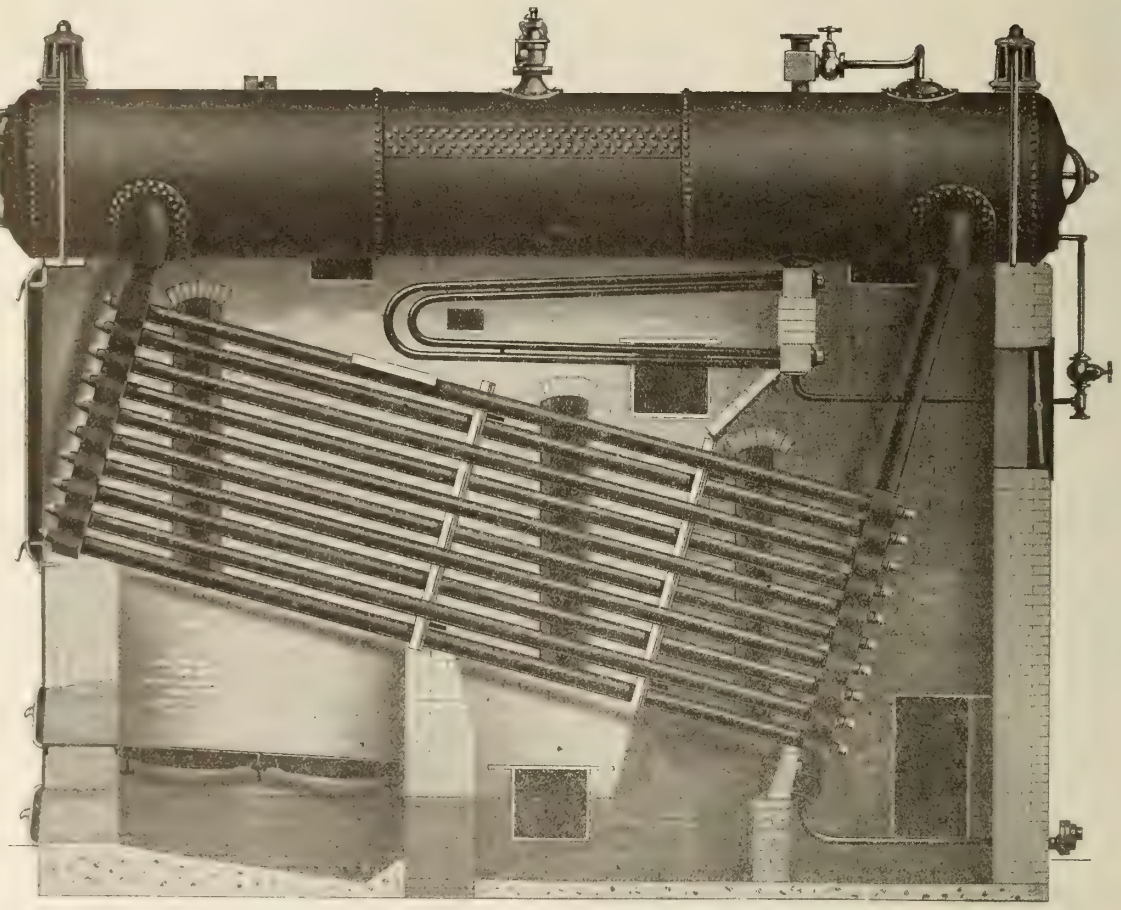
Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

New York Chicago Boston London

AMERICA'S BEST
LUNKENHEIMER
—QUALITY—
SINCE 1862

DEPENDABLE POWER EQUIPMENT



Type B with Superheater

G. & McC. Co.

SECTIONAL WATER TUBE BOILERS

Superior in Design and Construction

Greater combustion area and increased steaming capacity are two important features of Goldie & McCulloch Water Tube Boilers that distinguish them from ordinary boilers—they can be forced without danger.

They are equipped with large steam and water drums and connecting nipples of increased sizes, and every part subjected to steam pressure is made of FORGED STEEL. Send for full description.

The Goldie & McCulloch Co., Limited

Head Office and Works, GALT, Ontario, Canada

Toronto Office: Suite 1101-2, Bank of Hamilton Bldg.

Quebec Agents: Ross & Greig, 400 St. James St., Montreal, Que.

Western Branch: 248 McDermott Ave., Winnipeg, Man.

British Columbia Agents: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Some Recent Utilization of Water Power

Some Facts From a Paper Read Before the Institute of Mechanical Engineers, Great Britain, Which Illustrate Development in this Apparatus.

By ERIC M. BERGSTROM

IN THE years 1890-1898 a power station was erected at Chevres, near Geneva. It consisted of 15 Jonval turbines of the multiple-runner type, each having an output of 1,200 h.p. under a maximum head of 26.5 ft, and at a speed of first 80 r.p.m. and then 120 r.p.m. In its day, which was not so long ago, this plant was representative of the highest stage of hydraulic engineering as it existed. If this plant were built today and equipped with high-capacity Francis turbines, a single-runner turbine at 120 r.p.m. would give an output per unit of 2500 h.p., or, conversely, with an output of 1200 b.h.p. the maximum speed would be approximately 175 r.p.m., which would mean a very material saving in the cost of the electrical-generator equipment. With each unit consisting of a double Francis turbine, a maximum output of 5000 b.h.p. would be secured at a speed of 120 r.p.m., or with the original output of 1,000 b.h.p. a speed of 290 r.p.m. would be obtained.

To present the recent advances and the present state of water-turbine development was the purpose of the paper recently presented before the Institute of Mechanical Engineers (Great Britain), by Eric M. Bergstrom, from which the above facts are taken.

Under the heading of Francis turbines Mr. Bergstrom calls attention to the early development of standard turbines which could be sold at an exceedingly low cost. This was followed by an increase in size of units specially designed for the conditions of installation which gave considerably greater economies than could be realized from standard machines. Following this development came the recognition of the value of "specific speed," which many leading manufacturers now use as the basis for the manufacture of standard runners, a series of runners corresponding to a certain specific speed being selected as standards to meet the conditions most frequently met with.

The important factor in connection with modern turbine practice is that exhaustive tests have been made giving a complete knowledge of the efficiency and other characteristics of each standard wheel made, so that knowledge of its behavior under varying conditions will enable a runner to be selected which will meet most efficiently a given set of requirements. The standardization of the modern turbine has been developed from these improved methods of systematic tests which provide definite knowledge of the chief characteristics of the turbine. The early American standardization practice was empirical in nature and did not encourage further developments.

It is a general practice for European turbine manufacturers to install testing plants within their own works. This enables them to accurately analyze not only standard runners, but any new special designs. The importance of tests of research work has best been shown by the evolution of the Francis runner, the development of which has been possible by exhaustive trials and intelligent applications of the results obtained.

The development of the high-capacity runner has enabled designers to use a higher value of specific speed during the last ten years. Where the limit of specific speed was approximately 75 (330 metric system) in 1909, today turbines have been installed with a specific speed of approximately 95 with good efficiencies resulting. It is now possible to obtain runners of specific speed of 100, together with even a higher maximum efficiency than secured previously with a specific speed of lower value and with only small sacrifice in efficiency at part gate.

A design of runner recently constructed by the Escher Wyss and Co. gave good results at speeds corresponding to a specific speed of from 85 to 112. The main feature of this new turbine, shown in Fig. 1, is the large space be-

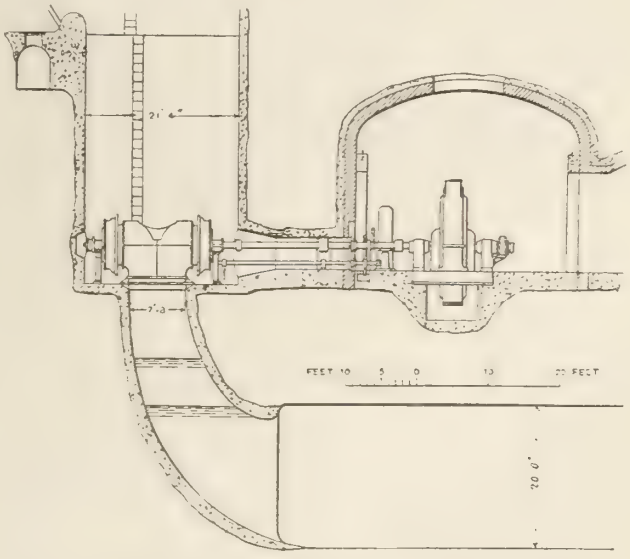


FIG. 2—HYDRO-ELECTRIC POWER STATION AT FORSHULTEN, SWEDEN.

tween the guide vanes and the entrance edge of the runner.

Two examples of notably high efficiencies are given; the American installation at the Appalachian Power Co. with a 6,000-h.p. single open vertical unit operating under a 49-ft. head at 116 r.p.m., specific speed 69.5, with an overall efficiency of 93.7 per cent.; the Forsse Hydroelectric Plant, Sweden, with a 3,750-h.p. double enclosed horizontal unit, operating under a 57-ft. head at 250 r.p.m., specific speed 80, giving a maximum overall efficiency of 94 per cent. Other efficiencies ranging from 87 per cent. up are given of plants installed in Norway, Switzerland, Canada and the United States.

It follows logically that these most notable achievements in maximum efficiencies are the results of the more careful and correct runner design referred to before. Improvements in the design of casing, guide apparatus, suction casings and suction tubes are based on a better understanding of the conditions of flow in various parts of the turbine, thus eliminating as far as possible impact losses and eddy losses in the water during its passage through the turbine.

Another significant fact is the long range of gate openings for which an efficiency of over 80 per cent. is obtained. In 1911 results of experiments were published showing the average efficiency of tests then on record to be 85 per cent. This value has been greatly exceeded, and a general increase of 10 per cent. above efficiencies obtained twelve years ago can now be recorded.

The low-pressure Francis turbines used for heads up to 75 ft. are in Europe generally located in open flumes to which the water is conducted through an intake channel, the plant being arranged with vertical or horizontal shaft. The American arrangement for this class of turbine is generally a single vertical turbine, and the most notable developments in hydro-electric plants have been with this type of runner.

The power plant at Forshulten, Sweden (Fig. 2) is an example of a typical horizontal low-pressure turbine plant. The units, of which there are six in operation, each with an output of 3,000 h.p., are arranged with double runners on a horizontal shaft. They operate at 187 r.p.m. under a net fall of 42.6 ft., the wheels being placed in open concrete pits protected by sluice and strainer racks, the two runners discharging into a common cast-iron suction casing. The shaft is supported at each runner on two outside ring-lubricated bearings, in addition to a babbit-lined automatically grease-lubricated bearing inside the suction casing. The practice of providing the turbines with lignum-vitae underwater bearings has now been discontinued in favor of outside ring oil-lubricated bearings, the bearing on the inlet side being made accessible through an inspection tunnel as in the present case or through a vertical steel funnel protruding above high-water mark.

More than usual interest is presented by the arrangement adopted at Mockfjaerden Hydroelectric Power Station, Sweden, on account of the power house being situated underground and using open turbines under the relatively high fall of 72 ft. The arrangement of the plant is seen from Fig. 3, and comprises four units each having an output of 5,000 b.h.p. at 225 r.p.m. with double runners on horizontal shafts. Each turbine is placed at the bottom of a concrete-lined shaft and discharges into the common tailrace tunnel. The power house is blasted out of solid rock, the floor level being approximately 70 ft. below the surface, whereas the switchboard and transformer are housed in a separate building on ground level and communicate with the power house below through an inclined shaft. The alternators are directly connected to the turbine shaft and, due to the underground situation, special arrangements had to be made to insure sufficient cooling. For this purpose the alternators are totally enclosed and cool air is forced down a separate shaft and distributed through underground ducts to each alternator, the hot air escaping from the top of the housing and being expelled through the vertical shaft communicating with the surface.

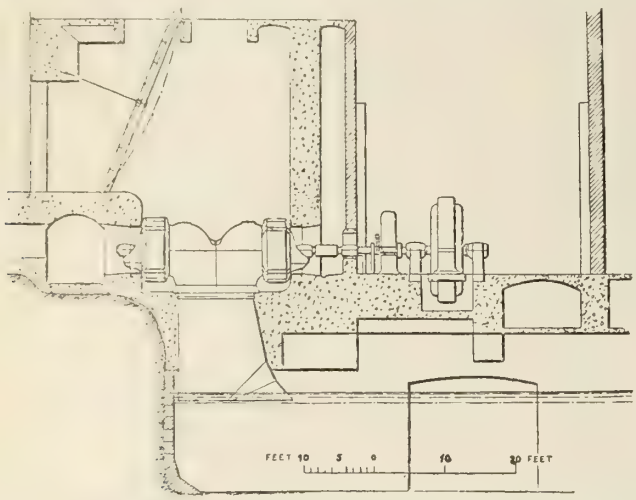


FIG. 3—MOCKFJAERDEN HYDRO-ELECTRIC POWER STATION, SWEDEN.

Medium-pressure Francis turbines are classified by the author as those operating between the heads of 75 to 150 ft. A unique installation of this type of turbine is the Porjus Power Station, Sweden. As in the case of the Mockfjaerden Power Station, this plant is also situated underground, but the turbines are enclosed in steel casings and placed at the bottom of the intake shafts about 160 feet below ground level. The vertical shafts are cut through solid rock and provided with liners of steel pipes with an internal diameter of 11 ft. 6 in.; and with flanged connection to the turbine casing. There are five units with an average capacity of 12,500 hp. each under a net fall of 163 ft. running at 225 r.p.m. The turbines are of the double type with two runners, discharging into the common suction casing. The power house is also blasted out of solid rock, and is 36 ft. wide and 310 ft. long, communicating with the turbine chambers through the short tunnels which accommodate the shaft extension connecting turbines and alternators.

The roof is supported on a strong concrete arch, and by the provision of false walls and roofs leaving a space between the rock and the walls through which warm exhaust air from the generator is allowed to pass, all damp is prevented from penetrating into the power house. The generators have a normal output of 11,000 kva. and 10,000 to 11,000 volts 3-phase current. The necessary switchgear and transformers are also in this case placed in a separate building on ground level, a shaft providing communication between this building and the power house below, through which the heavy parts of the machinery can be lowered; in addition to which there is lift accommodation both for passengers and goods. The line voltage is 80,000, the power being utilized for railway traction and for mining purposes.

As an instructive example of the arrangement of the medium-pressure turbine with horizontal shaft and spiral casing, Fig. 4 shows a section through a unit of the Massaboden Hydroelectric plant used in connection with the Simplon Tunnel in Switzerland. Each unit is capable of developing 3,500 b.h.p. under a net head of 142 ft. at 500 r.p.m. The turbine is equipped with two runners cast back to back in one piece, the outside bearing being arranged with thrust collars to take up any unbalanced thrust in an axial direction.

The noteworthy fact with medium-pressure plants as in the case of low-pressure turbines is that recent developments seem to favor single-runner units on account of higher mechanical overall efficiency and less foundation work, coupled with lower initial cost. The decision in each case must be made on its own merits and with a careful

consideration of local conditions.

The outstanding feature in the development of the high-pressure Francis turbine is its adoption for use with increasing heads. Today Francis turbines utilizing a head of from 500 to 600 ft. are not uncommon, the highest fall for which a Francis turbine has been designed being approximately 745 ft.

The most important improvement in the Pelton wheel is in the system of regulation which was necessary for new conditions of electrical transmission, and the demand for accurate and reliable automatic governing. The inherent defect of the method of by-pass regulation being liability to stick and excessive wear, together with difficulty of insuring synchronizing action, resulted in the introduction of the deflecting nozzle. In recent years the combined spear and deflecting nozzle has come to the front and has now been adopted in most modern plants. A number of different designs of this method of operation can be traced to one of the three systems shown diagrammatically in Fig. 5. In each case the operating cylinder of the oil-pressure governor operates the deflector and spear simultaneously when opening, but by sudden closing of the governor the

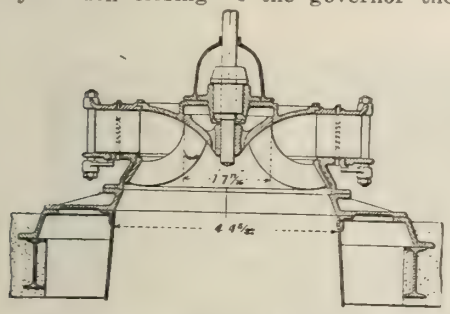
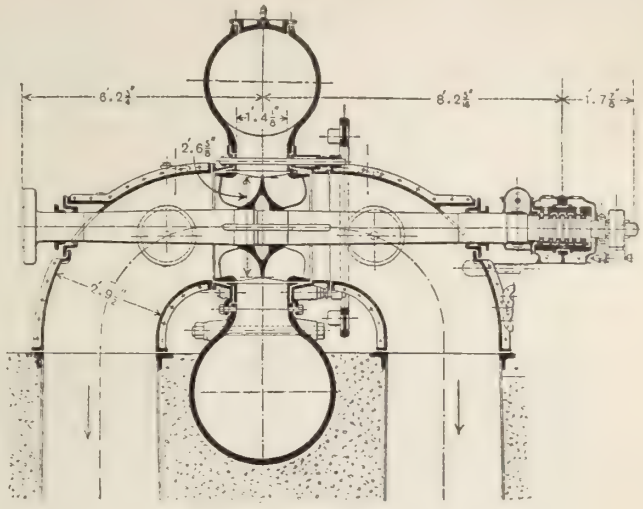


FIG. 1—NEW TYPE OF TURBINE BUILT BY ESCHER, WYSS & CO.

deflector will in the first instance cut into the jet and divert the water from the wheel until the spear, by slowly overcoming the dashpot resistance, regulates the water supply corresponding to the load, when the deflector will be brought back into a position just tangential to the reduced jet. The free movement of the deflector, independent of the spear in the closing direction, is in each case permitted by the "lost motion" existing in the mechanical connection between the deflector and spear.

The principal development in the design of pipe lines has been the use of concrete for low-pressure lines where its low initial cost and durability give it a decided field of usefulness. In some places concrete pipes have been used as a pressure line when a special form of reinforcement and treatment to exclude leakage has been adopted. Wood-stave pipe line is of value because of its durability, low cost, and low coefficient of friction, and is therefore of practical advantage for the construction of the upper portion of pipe lines where suitable wood can be procured.

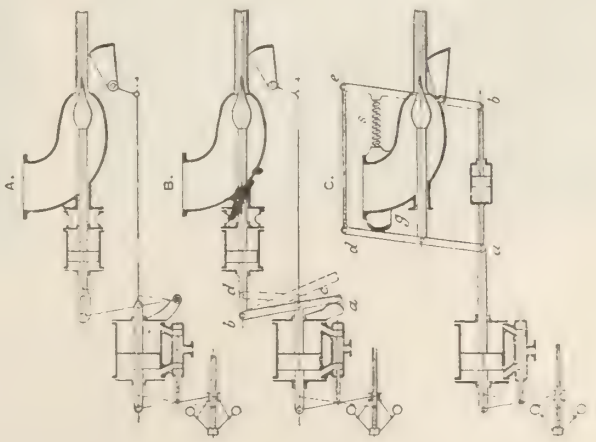
The welded-steel pipe lines signify the most important developments in recent years because of the progressive utilization of high heads requiring close study of pipe-line construction. Welded pipe lines are exclusively used for high-pressure installations on account of their



superior strength and absence of rivets which obstruct the flow of water. Welded pipes are heated by means of water gas and welded under high-speed, mechanically-driven hammers, which produce a weld of approximately 95 to 97 per cent. of the strength of the full plate. After welding the pipes are annealed to remove all internal stresses. The foregoing process is only suitable for material up to about 1¼ in. thick, as above this thickness the heat would not penetrate sufficiently to produce a uniform welding heat. For larger plate thickness, the "wedge-welding" method is resorted to, the edges being brought together and a separate bar inserted, forming the weld. With this method pipes up to a thickness of 1¾ in. can be satisfactorily welded. The material used in welded pipe lines is best open-hearth steel, with a tensile strength of 56,000 lb. per sq. in. and an elongation of 20 to 25 per cent. in 8 in. On account of pressure surges plate thicknesses are calculated with a factor of safety of from 4 to 5, based on the strength of the weld equal to 100 per cent. Pipes are made in lengths of an average of 18 to 20 ft., using riveted joints for medium pressures and flange or expansion joints for high pressures. In the riveted, or so-called "bump" joint, the pipe ends are swelled so that the rivet heads do not obstruct the free area of the pipe.

A further improvement in the art of welding is reinforced welded pipe, consisting of a number of solid forged rings shrunk on to the outside of the pipe and adding further strength to the pipe with a reduction of plate thickness. This innovation in pipe design permits, for high heads, the use of a larger-diameter pipe without exceeding the maximum limit of plate thickness to obtain a reliable weld. thus reducing the number of pipe lines for large installations and the initial cost of installation. Although the present method of manufacture permits only short lengths of reinforced pipe to be made, these may be welded together with a circumferential weld into lengths of about 18 ft. In high heads this method of pipe-line construction makes an appreciable reduction in the initial cost of the development.

In his conclusion, Mr. Bergstrom shows the results of an estimate of the available horsepower in the principal countries of Europe and America. In the United States 28,100,000 h.p. are shown as available, 24.9 per cent. of which has been developed; 2,000,000 in



Switzerland, of which 25.5 per cent. has been developed; 4,000,000 in Italy, of which 24.4 per cent. has been developed. Lowest percentages of development have been in Great Britain, with 8.3 per cent. of 963,300 h.p.; Spain, with 8.8 per cent. of 5,000,000 h.p., and Austria-Hungary, with 8.8 per cent. of 6,460,000 h.p. These figures apply, as stated above, only to Europe and the United States of America, and do not include the vast resources in white coal of Australia, Asia, Africa and the South American continent. ("Journal of the Institution of Mechanical Engineers," Feb. and Mar., 1920, pp. 55-151, 51 figs. Also in "Engineering," Jan. 30, pp. 140-143, Feb. 6, pp. 191-195, and Feb. 13, pp. 227-232, 1920, from which journal the illustrations here used have been reproduced.)

An Interesting Instance of Oxy-Acetylene Welding

Conditions in the Building of the Ohio State Fair

ALTHOUGH practically every job undertaken by a welding shop represents a saving of time, labor and money, it is not until some particularly large job comes along that the value of oxy-acetylene welding is driven home with a punch.

One of these large jobs, the execution of which resulted in an imposing saving, was recently undertaken by the Imperial Welding Company of Minneapolis, Minn.

The machinery to be repaired was the fractured high and low pressure cylinders of a 1,000 H.P. compound steam engine employed to furnish power for a flour mill. The damage occurred through the piston rod fracturing close to the cross head and the pistons driving through the ends of the high and low pressure cylinders. The fractures in the low pressure cylinder are shown in figure 1. The crack in the upper left hand corner of the picture extended back to and completely around the inlet valve port. The crack at the bottom of this cylinder extended no further than can be seen in the photograph.

As the casting was preheated the men in Figure 1 could not, of course, have worked from the position shown. They are so shown in the picture to give an idea of the size of the cylinder bore.

The high pressure cylinder, which is indicated at the right of Figure 3, was also badly broken, as the welded section shows.

Inasmuch as the engine was of an obsolete type and occupied excessive space in the engine room, upon a report of the accident the owners decided they would replace it by a steam turbine. However, when the matter was taken up with the manufacturers it was found that no delivery date could be promised within ten months. This delay was, of course, out of the question, no outside power being available.

Then an effort was made to obtain the old patterns from the firm that had originally made the cylinder. Here again the flour mill owners met with disappointment. The original patterns had been destroyed, and new castings would have cost approximately $9,000 exclusive of freight charge and cost of installation.

The location of the engine room and adjacent machinery was such that the cost of installation would have reached a high figure and would have brought the entire bill, exclusive of the costs of delay, up to approximately $15,000.

Having failed to obtain a steam turbine and not caring to spend such a large amount for new castings, the owners at this point took the matter up with the Imperial Welding Company and asked if the cylinders could be satisfactorily welded. Upon being assured that they could, the job of reclamation was given to the Imperial Shop and men were set to work at once to repair the damage.

Four men were employed to do the work, the actual time to weld the castings being forty-eight hours. The total amount of time to chip out the castings and otherwise prepare for welding, as well as to actually make the welds, was three weeks. The operation presented no unusual difficulties, preheating being done one section at a time.

The material used for the work consisted of the following: 30 cylinders Airco oxygen, 26 cylinders Airco acetylene, 4 pounds flux, 407 pounds cast iron rod, 4,150 pounds charcoal, 32 carbon blocks ½x6x12 inches. An Airco "A" welding torch was used to do the work

The actual cost of welding these cylinders was $1,572.22. Not taking into consideration the delay that would have resulted if new castings had been made, the owners were able to save over $13,000 by taking advantage of the oxy-acetylene process.—Acetylene Journal.

FIG. 1—DAMAGED FLOUR MILL ENGINE SHOWING FRACTURE IN L. P. CYLINDER. THE MAN IS SITTING IN CYLINDER TO GIVE AN IDEA OF ITS SIZE.

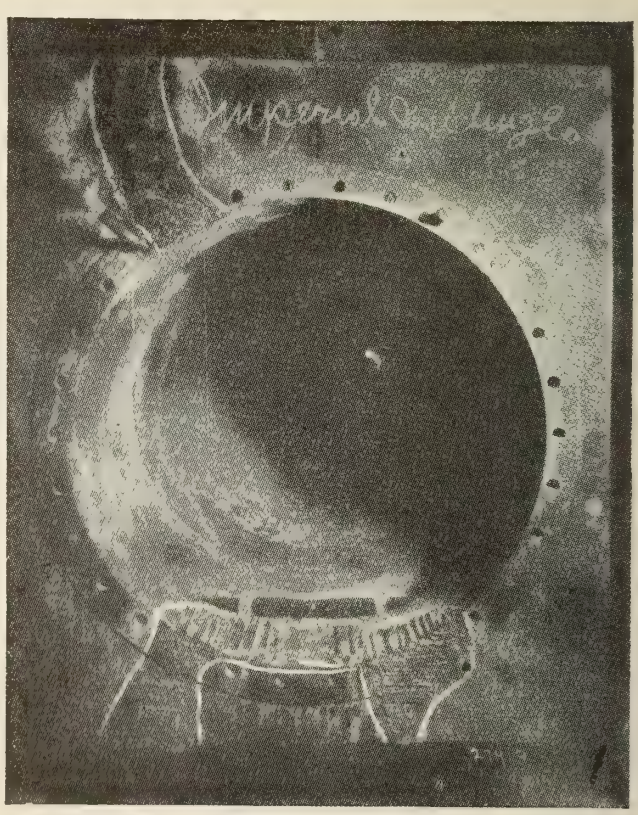


FIG. 2—LOW PRESSURE CYLINDER AFTER WELDING.

Points to Observe in Purchasing Equipment

In This Lecture, Delivered as One of the J. F. Aldred Lectures at Johns Hopkins University, the Author Gives Some Valuable Hints on Choosing Engineering Equipment

By A. S. LOISEAUX

IN THE purchase and erection of engineering equipment certain well-defined steps are generally necessary, which may be outlined as follows: Determination of work to be done by the equipment; choice of general character of equipment to do the required work; specifications to cover construction and performance of the various parts of the structure and equipment; contracts to cover price, terms of payment, time and point of delivery, erection and initial operation; following up manufacture, delivery and erection, inspection of material and equipment, and necessary testing to ensure that all terms of contract are fulfilled.

The engineer's object in choosing methods and equipment to accomplish desired results should be to get maximum reliability and efficiency with an ultimate minimum cost for fixed charges and operation. This object can generally be achieved by the employment of the best equipment obtainable, of ample capacity, and simple and rugged construction. This kind of installation will not be the cheapest to buy or install, but will figure the cheapest in total cost over a period of years of operation. The engineer should realize that the final judgment of his work is not a theoretical or technical matter. His work will be judged by the same hard, practical tests that all other work is judged by. Does it work? Does it pay? Does it stand the test of time?

To illustrate in a practical way the steps mentioned in the purchase and erection of engineering equipment, we will take the problem of unloading coal from barges at a water-front and transferring this coal to the bunkers of a boiler-house about 300ft. distant from the water-front and 70ft. above the water.

Determination of Work to be Done by the Equipment.—The engineer's first step is the determination of the work to be done by the equipment.

The power-plant design in the case which we have taken as an example contemplated an ultimate development calling for a maximum power-house output of about 120,000 kw. If 2.5 lb. of coal is burned per kilowatt-hour, this output would require a maximum use of coal of 300,000 lb. per hour, or 150 short tons per hour. A load factor of 80% would indicate a maximum requirement of 2,880 tons per 24-hour day. It is, of course, desirable to unload coal in daylight in a working day of eight hours, making the capacity of coaling equipment large enough to supply maximum ultimate coal in an eight-hour working day. This condition to supply 2,880 tons per day of eight hours would require an outfit of 360 tons capacity per hour.

It is evident that there is much latitude allowed to the judgment of the engineer in the determination of the first point—that is, the capacity that he shall require of the equipment. One device working eight hours for maximum coaling must be 360 tons per hour capacity, an equipment working twelve hours would be 240 tons capacity, and an equipment working twenty-four hours would be 120 tons capacity.

It must also be remembered that it is not good engineering practice to rely on one equipment of this character for the entire supply of a station. The final judgment as to the best capacity applied to this problem was to provide two duplicate coaling equipments, only one to be installed at first, each equipment to have a maximum capacity of 300 tons per hour, or be able to supply maximum coal requirements in a ten-hour working day. This gives reliability even under break-down conditions, as each tower can supply the plant with coal.

In choosing permanent coaling equipment for the new house, the gantry type was eliminated because of its slow operation. The low-type unloader with cars and skip hoist was eliminated because of its complication.

A low-type unloader with inclined conveyer and belt distribution over bunkers was proposed by a firm manufacturing coal-handling machinery, but it was rejected because of the multiplicity of parts. The equipment finally determined on was a high-speed coaling tower located on the water-front, with a structural-steel boom overhanging the water. A bucket grabs coal from the barges and lifts it into a receiving hopper 105 ft. above the water.

FIG. 3—HIGH PRESSURE CYLINDER AFTER WELDING.

From this hopper the coal passes through a two-roll crusher and into another hopper directly above a cable railroad. The cable railroad is on the level at the top of the coal bunkers in the boiler-house to be served. The cars are circulated in an endless route from the coaling tower over a bridge to the boiler-house, their load of coal is dumped in the proper bunkers without stopping, and the cars return to the coaling tower to be loaded.

This equipment is perhaps as simple as possible. All the elevating is done in one lift when the coal is picked up from the barge. Gravity then causes the coal to flow through hoppers and crushers to the cars. Horizontal transportation is done entirely by cars which are most reliable and efficient for that purpose.

An inspection trip was made by the engineer in charge of the coaling problem to view the actual performance of similar towers, both steam-driven and electric-driven, to determine what were the valuable and undesirable features of each. It should be here remarked that it is most important for an engineer actually to see the operation of equipment similar to what he expects to purchase, because some important features will at once appeal to the eye which may be overlooked in a specification or description. It is also desir-

able to question men in charge of actual operation, as they sometimes give information not available from other sources.

Specifications to Cover Construction and Performance.—Having chosen the general character of coaling apparatus, it is necessary to specify the construction and performance required of its several important component parts.

No engineering student should imagine that an engineer can sit down and evolve complete specifications for highly developed equipment. This method has been sometimes attempted, probably more in European than in American practice, and the results cannot well avoid being inferior. The proper method, and one almost universally followed, is to call upon manufacturing and constructing concerns for their proposed specifications for equipment and construction to accomplish the desired purpose.

To obtain best results it is, of course, necessary to invite the most reliable and capable firms to bid. If the engineer is in doubt who is best fitted to do certain work or supply certain equipment, he can get such information from several convenient sources.

The advertisements of technical and trade journals are constantly revised lists of bidders. The engineering-society journals carry announcements and advertisements of capable firms. Directories sometimes give a full list of manufacturers and outline their products. From these and other sources of information the engineer can quickly get, if he does not already know, the names of proper parties to confer with on the prospective work.

For competition it is, of course, necessary to have two or more bidders. It may be advisable to have as many as five if there are that many entirely competent parties. Beware, however, of inviting the irresponsible or incapable bidder. He will make promises he cannot fulfil, or quote a low price that will not see him through the contract, and then abandon the work. The character of a contractor is important. One will haggle at every doubtful point and seek extras at every turn. Another will fulfil his contract without question and give his client the benefit of the doubt.

A good rule in the selection of bidders is to invite only those whom you are willing to have do the work, and treat them all impartially, awarding the contract to the one offering the best proposition, all things considered, which does not always mean the proposition of lowest price.

Caisson Foundations.—In the case of the coaling tower under consideration the two most experienced foundation concerns in the country were turned to, with the result that one company built the caissons for the first tower, and the other company the caissons for the second. By turning to the engineering and construction firms best fitted in the States for this work, we have not only secured permanent structures, but were ourselves relieved from the serious responsibility of providing foundations that might fail under adverse conditions.

Structural-steel Tower and Bridge.—The steel structure for tower and bridge was roughly designed by the owner's designers—that is, the general size and character of the structure was determined, and loading given. The result is called a setting plan. This drawing or setting plan was then submitted to the structural-steel firms for competitive bids, it being specified that the successful bidder should completely check the design and be responsible for its strength and detail in all of the parts. The price in such cases is given on a tonnage basis, so that moderate changes in design or size of members will not affect the contract.

A personal conference with capable engineers of a manufacturer will accomplish more than weeks of corresponding. It is also highly desirable to have the contracting engineer familiar with conditions on the site.

Engineers or manufacturers are ready and anxious to explain the design and merits of their apparatus, and by giving each bidder an attentive hearing the purchasing engineer can gain valuable knowledge of the apparatus offered with minimum expenditure of time and effort.

The engineer in charge should remember to inquire for possible improvements beyond what the manufacturer's specifications may contain.

In drawing up specifications for automatic equipment it should be remembered that labour is, in general, the most expensive item in operation, and where it is possible to eliminate a single labourer at a wage of 3.50 dols. per day, or, say, 1,000 dols. per year, an investment as high as 5,000 dols., or even 10,000 dols., may be justified. Interest and depreciation on the investment should pay the labourer's wage, and operation will in general be more reliable and rapid than with the labourer. It will often be found that the value of more rapid operation is greater than the saving in operating wages.

Contracts to Cover Price, Terms of Payment, Time, Etc.—After specifications have been evolved, it is necessary to enter into contracts for the different parts of the work to cover price, terms of payment, place and time of delivery, provision for erection, initial operation, and tests of equipment.

Contract form are nearly always provided by manufacturers with clauses protecting them from numerous possible contingencies. The owner's engineer should scan these carefully and eliminate or modify any that may be unsatisfactory or unfair.

A valuable method to compare all important competitive bids is that of tabulation. In tabulating bids parallel columns are provided, headed by different makes of apparatus available. The character of apparatus, with all its important features, method of control, operating characteristics, capacities, speeds, sizes, weights, materials, etc., is tabulated in these parallel columns This method of analysis enables differences to be quickly and accurately located. It discloses which is the best proposal, and enables the best to be improved by requiring changes in the specifications submitted to provide for any superior features that may appear in any of the other specifications. By this means of comparison and selection remarkable results are sometimes obtained in procuring apparatus of high reliability and general efficiency.

Price and Terms of Payment.—Price is a matter of competition with due regard to difference in material and equipment furnished. It is well to have inquiries for prices contain the statement that the owner reserves the right to reject any or all bids submitted. The experience and reputation of the contracting firm must be considered, and price difference allowed in favour of a concern of ample responsibility to meet emergencies that may arise or bear losses that may occur. In terms of payment it is customary to allow 40 or 50 per cent. on submission of bills of lading proving shipment. Contractors will usually call for two additional payments, one at 30 days and one at 60 days after shipment. These terms are in general not satifactory to the owner except in the case of standard equipment. It is necessary for the protection of the owner's interest, when equipment is at all special, to provide a final payment of 25 per cent. or more after complete erection and satisfactory operation of the apparatus. This safeguards the owner from carelessness on the manufacturer's or contractor's part in not putting equipment in final and satisfactory operating shape, and provides the owner with a whip to require the full performance of the terms of the specifications and contract.

Point of delivery should be carefully specified, as many troublesome delays are due to lack of full information as to this matter.

Erection is best placed with the same concern that provides structure or equipment as before noted. If for good reasons it must be given to separate concerns, it is necessary carefully to specify how and where the material is to be delivered, who shall unload and move it to the permanent site. It is necessary to state what responsibility shall be taken by the erector and what by the manufacturer or owner. Insurance is generally necessary to cover accident during erection, and it should be stated that defects of erection shall be made good without loss to the owner.

It is necessary to specify conditions governing overtime in erection. These additional expenses can be placed on the

manufacturer if delivery is late, but only when so specified.

Extra work must be mentioned, giving the terms and rates at which such work shall be done.

Actual operation is the final test of all equipment, and considerable periods of time should elapse whenever possible before final payments are made, as it is possible for radical defects to develop after a short period of successful operation. The owner's engineer must be careful not to commit himself in word or writing as to his final acceptance of equipment until it has been in full capacity operation for a considerable period.

Contracts on Basis of Cost.—There are some situations when it is desirable to enter into a contract on the basis of the cost of the work to the contractor. Such a situation exists when the cost is doubtful, by reason of unknown conditions of soil for foundations, unknown conditions of stream flow or weather, or the like, which may greatly influence the cost. The risk in such cases belongs to the owner, not to the contractor. The contractor could not take this risk unless he included a high figure for contingencies in his bid, or gambled on his chances of good luck in construction. A contract based on cost must define cost carefully, stating particularly what percentage is to be charged for overhead costs, or whether overhead is to be included in a percentage to cover profit as well.

In contracts for field work the cost of "plant" must be explicitly stated. It is generally to the owner's interest to agree on a flat sum to cover all plant rental, specifying, however, the main items of plant that may be required. This makes it to the contractor's interest to finish the job promptly, to use his plant elsewhere.

After paying all costs, including overhead, it is common to allow the contractor a net profit of 5, 10, or 15 per cent., depending on the conditions and the magnitude of the work. Another method, however, which has an important advantage, is to give the contractor a fixed fee for his services over and above his costs, including overhead. This also tends to expedite the work, as the contractor cannot increase his fee by delays or increased costs.

Following Up Manufacture, Delivery, and Erection.—After contracts have been signed embodying all specifications, it might be supposed by the engineering student that the engineer's work was finished, but such is far from the practical fact. To obtain what we have specified at the right time usually requires a large amount of effort in following up the various manufacturers and construction men.

In all important equipment where time has a large financial value, it is wise and often necessary to have a follow-up system, keeping track of the progress and manufacture, especially of the heavier parts such as large forgings and castings to ensure that delivery will not be greatly delayed. It is the customer who follows his work the closest and inquires most persistently and explicitly of the manufacturer that gets the best service from the factory. A trip to the factory to see the exact status is often necessary and profitable.

An effective means of securing results in deliveries and erection is the formation of a tabulated schedule specifying all the important parts of a completed job at the side of the tabulation and making spaces showing time intervals at the top of the tabulation. The desired progress of the work can then be chartered from the beginning of manufacture or field work to the completion of the job.

The foreman in charge of erection decidedly influences the speed and quality of the work. When an unusually capable foreman is known, his services may be called for by the owner with good results. A foreman should have support in getting labour and material, and in some cases where time is valuable, he may be given a bonus for completion earlier than the normal time for erection.

Completion is often specified in number of working days rather than by definite date. This is justified for outdoor construction, especially in winter, when the contractor is prevented by the weather from making progress on certain days.

Operation of Equipment—Operation is not only a test of whether specifications have been met, but is also a gauge of the engineer's success in obtaining desirable features that are not or cannot be included in specifications. For instance, such qualities as quietness of operation, freedom from vibration, rigidity of structure, convenience and ease of control, are not generally subject to specifications in any exact terms, yet they indicate the degree of skill with which the design has been made and carried out.

In companies having a purchasing department the engineer works through such department in most of his official acts, such as the invitation to bid or the awarding of a contract. Engineering interviews are a part of the engineer's duties to arrive at correct decisions, the final results of his work in the form of specifications and orders or contracts being sent through the purchasing department and company's officials to maintain uniform records and secure proper approval of important purchases.

The purchase of electrical machines has been simplified by the issue, some years ago, of the standardization rules of the American Institute of Electrical Engineers. These rules specify standard temperatures, ratings and methods of testing for electrical machines, to which most manufacturers now conform, so that their guarantees are generally directly comparable.

A successful engineer is one who applies common-sense to every step of his work, devising means to get results desired by the simplest and most direct methods. The engineer's educated judgment will enable him to choose the best design and equipment of various alternatives submitted, but he needs great diligence and determination to drive an undertaking through from its inception to a successful and timely completion.

THIS MAN KNOWS THE VALUE

The engineer of a well-known municipal electric light plant in Ontario writes "Power House," as follows:

> "New subscribers who do not really know the value of POWER HOUSE might demur at paying a high price for it, but personally speaking, I would not object to paying double price for double service. **I never miss reading the advertisements. They are real interesting to anyone in this line."**

Anyone associated in any way with power development or combustion should read "Power House" ads. and editorial. The apprentice will find the paper one of great educational value. Hundreds of engineers and others in good positions to-day thank "Power House" for the effective way it has assisted them.

BOOKS RECEIVED

We have received a "Data Book for Engineers" compiled and published by the Locomotive Superheater Company of New York. The book has been prepared with a view to the requirements of the stationary engineer in his every day duty, and it certainly fulfils its aims. The first few pages are devoted to a discussion of superheated steam, after which follow the various tables. These are very complete and cover a wide field, two very useful ones being those dealing with fan sizes and speeds, for various quantities and pressures of air in ashpits. A series of tables giving dimensions of various types of boilers should be of great use to those engaged in installation work, or considering additional installations in an old building. Drill sizes, sizes of standard pipes, boiler tubes, etc., will be found here, and others of practical use to the engineer. The book is strongly bound and will be forwarded on request by the Locomotive Superheater Co. to anyone who is interested in steam engineering.

TRADE ANNOUNCEMENTS

F. H. Imra and partners, civil and mechanical engineers, Hope Chambers, Ottawa, have been appointed agents for the Power Plant Company, Ltd., of West Drayton, England. The company, who are specialists in gear cutting, produced the first turbine reduction gears made, and have achieved a great reputation in this line. They also manufacture flexible couplings, brakes, gear cutting machinery and tools.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

By W. F. SUTHERLAND

IN THE last lesson the relation between electricity and magnetism was discussed and it was shown that every conductor carrying a current of electricity was surrounded by a circular magnetic field and that it was quite easily possible to make use of this circular magnetic field in the construction of an electro-magnet. In this section, this relationship will be further developed, this time from the magnetic side and the action of a magnetic field of force on a conductor.

It should be noticed that we say field of force and the distinction between force and work in this connection should be clearly understood. A permanent magnet exerts force on other magnetic bodies in its neighborhood, but does no work on them unless they be free to move. If they are, and are drawn towards the magnet, then the magnet does work on them, changing their position against the forces of friction, springs or what not. It is as if a weight had been on a table and had fallen off, to the floor, being attracted downwards by gravitational force.

If the piece of iron were now pulled away from the magnet to its former position work would be done upon it and energy stored up in it by virtue of its changed position.

Failure to distinguish between force and work has caused many a misguided inventor to chase that elusive will of the wisp—perpetual motion, and this is true in the electrical field as in other and older branches of science.

If we were to take a permanent magnet and holding it over a piece of steel, fastened in place, by moving the magnet up and down, we would find that while quite easy to approach the steel it would be harder to draw it away and in doing so we would be doing work. Something similar happens when a bar magnet is thrust into or withdrawn from a coil of wire of which the ends have been connected together; only, in this case it will be found that the magnet is just as hard to push into the coil as it is to withdraw. If the ends of the coil are left unconnected the presence of the coil of wire has no effect upon the ease of movement of the magnet. Here is an effect which one might surmise to be caused by a flow of electricity in the coil of wire, work being expended in causing the flow. This is the case and if the heads from the coil were connected to a sensitive voltmeter a kick would be observed every time the magnet was thrust into or withdrawn from the coil. When the magnet is held stationary in any position the current will cease to flow, the mere presence of it having no effect if movement is absent.

When the bar magnet is suddenly plunged into the coil the voltmeter shows a decided deflection, coming back to the zero point as the bar magnet comes to rest, and when the bar magnet is withdrawn, while a similar effect is observed, the needle of the voltmeter swings in the opposite direction.

One can reason out for himself that a changing magnetic field of force or a cutting of the lines of force by a wire creates a tendency for current to flow and if the wire be joined upon itself as in a coil with the ends connected the current will actually flow while the magnet is moving, the work necessary to move the magnet being expended in the form of heat in the wire through which the current passes. The effect of changing magnetic strength is also shown in Fig. 29, which shows two coils of wire wound around a common iron core. One of these coils is connected to a few dry cells or other source of current, with a switch in circuit for closing or opening it. The other coil is connected up to a galvanometer or volt meter. On closing the battery circuit the voltmeter needle will swing in a certain direction, quickly coming back to zero, and on opening the circuit by means of the switch the needle will be deflected in the opposite direction, again swinging quickly back to zero. This is the principle underlying the

FIG. 28.

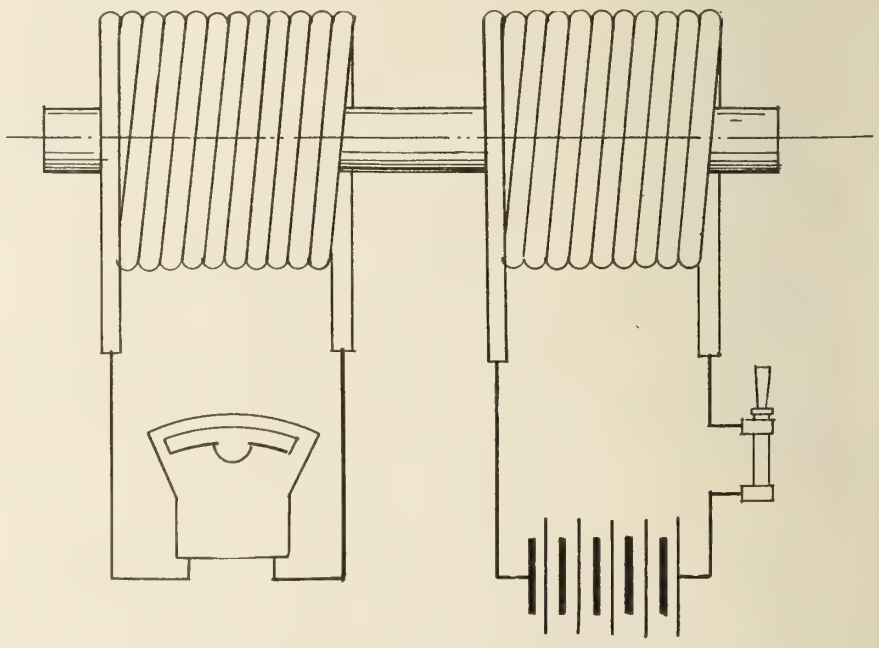


FIG. 29.

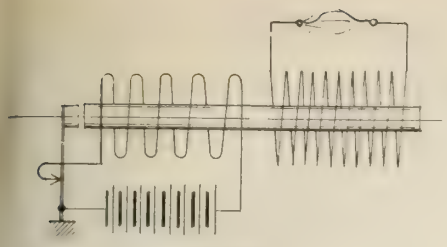


FIG. 30.

familiar induction coil or spark coil of the gasoline engine. An elementary diagram of the same is shown in Fig. 30. Some of the accessory equipment has been omitted for the sake of clearness, notably the condensor. The battery shown is connected to the primary of the coil through a vibrator consisting of a spring with a piece of soft iron

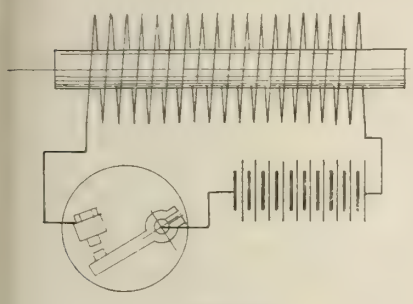


FIG. 31.

attached to the free end. One lead is connected in solid to the vibrator, while the other is attached to a point which just touches the spring in when it is at rest. When a current is sent through the primary the iron core is magnetized and draws the vibrator spring towards itself. In doing so it breaks the primary circuit and this cycle is repeated indefinitely. Each time the primary circuit is made complete the magnetic flux in the coil builds up and at each interruption it dies down. As it builds up a current is induced in the secondary winding and as the flux dies down another current is induced but in the opposite direction. The further operation of apparatus of this type will be better understood when the study of alternating current is taken up.

We need not use two separate coils, but as in the familiar make and break ignition system one cell only can be wound on the iron core. A diagram of a make and break system is shown in Fig. 31. The coil consists of a large number of turns of fairly heavy wire wound upon an iron core and connected up with contact points in the engine itself. When these are closed the current flowing builds up the magnetic flux in the iron core and when the points separate the flux dies down. In dying down an electro-motive force is generated in the many turns of wire which causes a fat spark to jump the points as they separate.

In all the above the induced electro-motive force is produced by an increase or decrease in strength of the magnetic field. In other words the lines of force linking through the coil of wire have been changing in number. It is not necessary that the magnetic flux or the number of lines of force change, exactly the same result can be secured by moving a wire across a magnetic field of uniform strength.

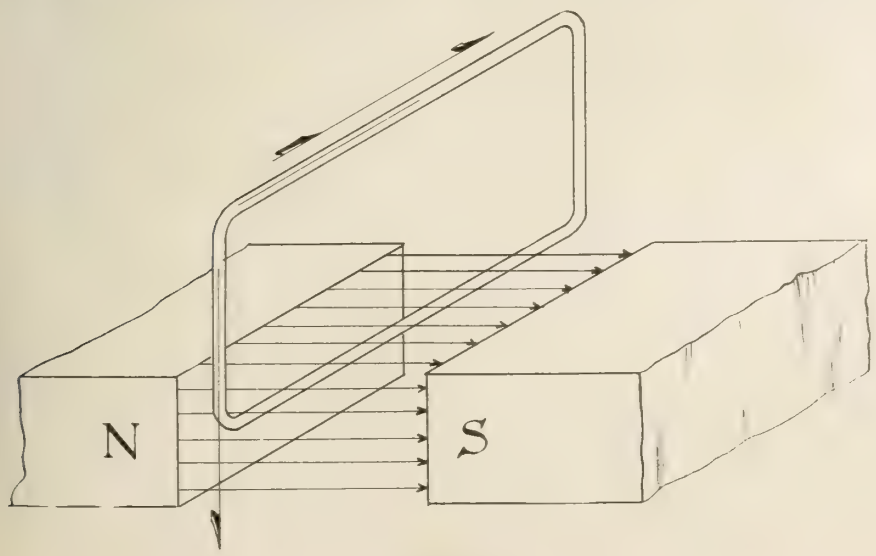


FIG. 33.

When a conductor is moved in a magnetic field in such a manner that it cuts the magnetic lines of force, an electro-motive force is generated in the conductor which tends to cause a flow of current. The magnet is not weakened by the generation of an e.m.f. in a conductor and the consequent flow of current, but the energy necessary for this is derived from the work necessarily exerted in moving the conductor through the magnetic field.

In Fig. 32 are seen the north and south poles of two magnets, with a wire between them. The magnetic flux is shown traveling between the two pole faces from north to south as indicated

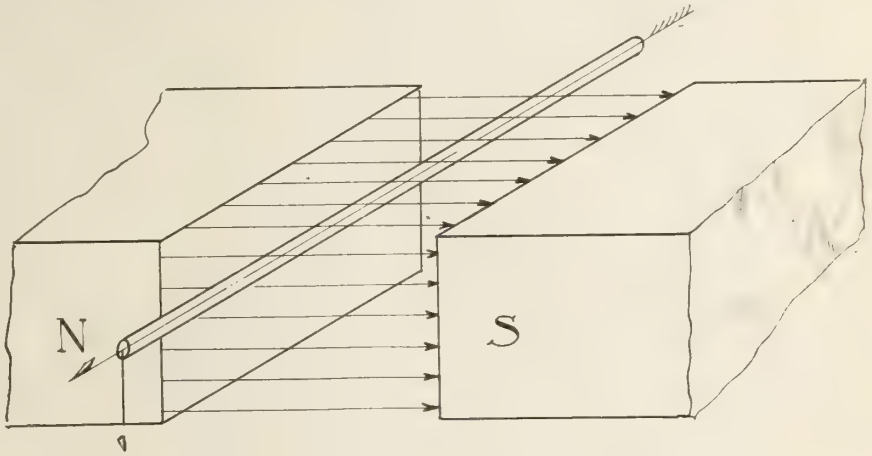


FIG. 32.

by the arrows. If a wire be forced downward between the two poles as shown an electro-motive force will be generated in it which will tend to cause current to flow towards the observer, as shown by the arrow pointing through the wire.

Fig. 33 shows a closed loop of wire being forced through a similar air gap between magnets and in this case it can be said that the e.m.f. is generated by a variation in the number of lines of force linking through the coil.

A MATHEMATICAL CURIOSITY

If you were told that 4 was equal to 5 you would immediately conclude your informant had escaped from a home for the feeble minded. Yet it can be proved. Here it is:

$$16-36=25-45$$

$$16-36+\frac{81}{4}=25-45+\frac{81}{4}$$

$$\left(4-\frac{9}{2}\right)^2=\left(5-\frac{9}{2}\right)^2$$

$$4-\frac{9}{2}=5-\frac{9}{2}$$

$$4=5$$

Authorization has been received by The Ontario Steel Products Co., Ltd., to increase their capital stock from $1,500,000 to $2.750,000, the increase to consist of 12,500 shares of $100 each.

Report of the Committee on Prime Movers

The National Electric Light Association Committee Presented This Report on Hydraulic and Steam Prime Movers at the Forty-Third Annual Convention of the Association.

THE important feature of the past year's development is the increased size of water wheels installed. The growth of operating systems makes feasible this increased size, individual units of approximately 40,000 h.p. capacity having been installed and larger ones being contemplated. One large manufacturing company reports the starting of a total of nearly one-quarter of a million kilowatts in large hydro-electric generators in units of over 12,000 kw. each. In addition there are a large number of smaller vertical direct-connected wheels being installed as additional or replacement units.

Progress and Development of Hydraulic Prime Movers

The tests of the large water wheels in place show remarkably high efficiency, which makes it profitable in a great number of cases to replace old installations with new. The new large units are uniformly distributed over the United States. Many of the older hydraulic developments which used dams and canals, supplying widely scattered individual water wheels, are now planning a single hydro-electric station to utilize the entire fall and transmit the power electrically.

Several large units have been started and continuously operated for over a year without a single shutdown on account of wheel troubles.

A new type of water wheel for low-head plants using an exceptionally high-speed runner has been developed by Forrest Nagler of the Allis-Chalmers Company.

Four 15,000-h.p. tangential wheels for operating under an effective head of 1,008 ft. have been ordered by the Great Western Power Company. These wheels contain 21 buckets, each 36 in. wide and 24 in. deep, and water is supplied from 13 nozzles. They are to operate one each overhung from the ends of a 22,000-kva. generator shaft running at a speed of 171.4 r.p.m. It may be of interest to state that several water-wheel manufacturers designed and recommended Francis-type wheels for this head at a speed of either 600 r.p.m. or 750 r.p.m. The operating engineers, however, were afraid that the erosion on the clearance passages and gate mechanism might be rather severe when operating under a pressure of over 430 lb. per sq. in. This, coupled with the fact that it would require a turbine-type generator with smooth-core field which was not suited for charging conditions on their long-transmission line, led them to choose the impulse wheel.

There are at present under construction some 800-ft. Francis wheels for the Southern California Edison Company, to be run 600 r.p.m. and deliver a maximum horsepower of 22,500.

Automatic hydro-electric plants are receiving considerable attention. These plants operate without attendants, and the gate openings and output are regulated according to the water supply available, by means of a float control from pond level. These plants may be tied into a local power system or be run in connection with a stream station which takes care of the fluctuation of load and varying flow of stream.

There is a radical tendency, where climatic conditions are favorable, to confine the power station building to the housing of control apparatus only, locating generating apparatus step-up transformers and high-tension equipment outdoors.

General practice is divided between the centralization of auxiliaries and a tendency to make each large unit self-contained with its own exciter, governor, pumps, etc. A satisfactory solution of this problem is accomplished by having individual speed-control sets for each of the main units and by having an emergency pipe connection from each individual set to each adjacent set. Each main oil-pressure set is of sufficient size to operate two main units under emergency conditions. Thus all of the advantages of the central oil-pressure system are combined with the advantage of the individual system.

Hydraulic Operation and Combined Operation of Hydraulic and Steam Plants

The combined operation of hydro-electric and steam-electric generating stations has become a subject of vital interest to the central-station industry. It will be increasingly important in the future, since the marked trend toward interconnection will bring more and more steam plants into paralled operation with hydraulic plants, and will make possible the development of water powers which cannot now be utilized economically. Yet intensive study of the subject is comparatively new. Individual companies and systems have made more or less careful analyses of their own conditions and problems, but there has been little information exchanged or published. During the past year the committee has considered or has had brought to its attention a large number of problems. These are listed below with the idea of having before the committee an outline to be followed in future work.

The problems of combined operation and hydraulic operation may be classified under the three heads outlined below: namely, (1) problems of the combined system; (2) problems of the steam plant; (3) problems of the hydraulic plant. Some problems of purely hydraulic operation are included in the third group, although they do not depend on combined operation.

I—Problems of the Combined System

A—Parallel operation of co-operative systems:

1. Contract relations between hydraulic and steam plants.
2. Advantages and disadvantages of interconnection.
3. Division of load between hydraulic and steam plants.
   (a) High-flow operation.
   (b) Low-flow operation.
4. Division of wattless current between hydraulic and steam plants.
5. Frequency regulation and governing.
6. Relative reliability of hydro-electric and steam-electric service.

B—Parallel operation of non-co-operative systems:

In this group there are other problems which are chiefly electrical and do not fall within the scope of the prime movers committee, but it should be mentioned that a complete study of combined operation would include the following problems: Increased damage to property and interruption to service which may result from greater capacity feeding in so short-circuits; protective methods; the use of reactance to limit short-circuit currents; the effects of such reactance on voltage and synchonizing power; voltage regulation; synchronizing power of tie lines.

II—Problems of the Steam Plant

1. Standby service.
2. Minimum load on steam turbines.
3. Time required to start up steam turbines.
4. Shutting down steam plant during "off-peak" hours.
5. Banking practice as related to combined operation.
6. Novelties and difficulties in operating.
7. Station design as affected by combined operation.

III—Problems of the Hydraulic Plant

1. Efficiency measures to secure maximum output or water economy.
2. Measurement of water.
3. Dispatching of water and hydrographic methods.
   (a) When the water is used by one plant.
   (b) When the same water is used by two or more plants.
4. Ice troubles and methods of fighting same.
5. Power requirements and operation of auxiliaries.
6. Planning of maintenance, inspection, and repairs.

7. Operating rules and procedure.
8. Novelties and troubles in operating.
9. Station design as affected by combined operation.

From this analysis of the problems of the combined operation the report considers the points in detail, outlining the information required for further reports and giving some data that have been discovered in the solution of the subdivisions of the problems. The report states that every system must constitute a separate problem, but it is believed that many principles and conclusions will have a common application to a large number of systems. In abstracting the remainder of the report, material will be included where new information has been submitted.

I—Problems of the Combined System

A—Parallel operation of co-operative systems

1. Contract Relations Between Hydraulic and Steam Plants.—The ideal in every combined system should be minimum over all cost of delivery to the ultimate consumers. The solution of the problem, where hydraulic and steam stations are separately owned, lies in some sort of flexible arrangement on a co-operative or cost and profit-sharing basis in which rigid limits of power and energy are disregarded and the maximum output of the hydraulic plant is utilized as far as possible. Such a solution furthers the conservation of our natural resources in which the central-station industry is vitally interested.

3. Division of Load Between Hydraulic and Steam Plants.—Under this head the report calls attention to some instances where steam generation is necessary in spite of the fact that the hydraulic plant is carrying the load. Such steam generation may be necessary for maintenance, economy or safety of steam-plant equipment, or reliability of service. Unnecessary steam generation may be caused by faulty governing or load dispatching. Under a discussion on the unnecessary steam generation due to faulty governing or load dispatching, the report points out the necessity for a graphic meter giving total station output for each generator station, and the necessity of means of communicating output figures from all generating stations to one central point.

The importance of not having the hydraulic capacity of the turbine limited by the generator capacity is also emphasized.

4. Division of Wattless Current Between Hydraulic and Steam Plants.—In the case of a hydraulic plant operating in parallel with the steam plant, the problem consists of comparing aggregate steam costs for high load factor but increased steam generation due to hydro losses, with steam costs for a poor load factor but a smaller amount of energy output. If the hydro plant has large storage or high head and little tailrace backwater, so that the reduction in head due to low load factor is not great, it will usually be found that it is most economical for the hydro plant to take the poor load factor. The result may be reversed if the percentage loss of delivered output from the hydro plant is considerable and if the percentage increase of steam costs due to lower load factor and variations is negligible.

6. Relative Reliability of Hydro-electric and Steam-Electric Service. The report is quite positive in its statement that in recent years particularly the individual hydraulic prime mover is more reliable than the individual steam turbine. The present-day single-runner vertical-type water-wheel-driven generator equipped with a Kingsbury bearing seems to give almost perfect continuity of service. It has been nearly always found that hydro service can be restored before the steam plant can pick up a large proportion of the load even with a number of boilers held ready under "hot bank." As a result, with modern conservative construction of transmission lines, there is very little pure stand-by service in the East and Middle West. On the Pacific coast, where use of fuel oil makes quick firing possible and transmissions of great length with considerable inherent voltage drop, extensive stand-by service is more common.

II—Problems of the Steam Plant

1. Stand-by Service.—It is stated that in coal-burning plants underfeed stokers with forced draft and fan and ram speed control, or chain grates with forced draft may be found most satisfactory for quick starting. Future developments will be along the line of using oil and coal under the same boiler, and of adapting pulverized fuel for large central station use.

The example of the municipal plant of Zurich, Switzerland, is cited as demonstrating that during off-peak hours stand-by boiler pressure may be supplied electrically from the hydro-electric plant. In this case, the use of electricity for which there was no market was more economical than paying for banking coal.

2. Minimum Load on Steam Turbines.—Motoring, even with a certain amount of steam entering the turbine, dropping below a certain minimum turbine load, and sharp fluctuations of load are regarded as injurious to large high-speed steam turbines by many operating engineers in eastern plants.

On the Pacific coast, however, the steam turbines have been floated on the line with practically no load, and in some cases, as synchronous condensers, with less than no load steam entering the turbine without apparent damage.

4. Shutting Down Steam Plant During "Off-Peak" Hours.—To avoid the difficulties caused by accumulation of water in pipe lines and leaky joints, occurring in the steam plant during shut-downs, some plants operate at least one boiler at near normal rating during the off-peak hours and use the steam thus generated to operate a small unit, circulating the steam through all the steam mains before it reaches the unit. In other cases the generating plant is shut down entirely, but steam is blown off for some time near the turbine inlet before the unit is started up.

5. Banking Practice as Related to Combined Operation. A steam plant carrying the peak loads of a combined system operates at a poor load factor and therefore has an increased amount of banking. The report gives the result of a 42-hour banking test on a 822-h.p. Stirling boiler with underfeed stokers as 0.112 lb. of 13,500 B.t.u.. coal per rated boiler h.p. banking hour. The pressure being allowed to drop about 15 lb. below normal, coal was added after 16¾, 28¾ and 40 hours. The steam generated after the bank had nominally begun was approximately measured and an equivalent amount of coal deducted. In a similar test on oil-burning boilers a value of 0.046 lb. of oil per h.p.-hour was found. This is equivalent in heating value to 0.063 lb. of 13,500 B.t.u. coal.

6. Novelties and Difficulties in Operating. The percentage changes in load on steam plant are very greatly increased when the hydro plant takes flat load during high flow. This condition makes a foreknowledge of load variations essential to avoid excessive blowing off through safety valves or reduction of hydraulic output. To assist in estimating load in the boiler room, the Ashley Street Station of the Union Electric Light and Power Company of St. Louis operating in parallel with the Mississippi River Power Company and equipped with a number of varying sizes and types of generating units of which a kilowatt load does not give an accurate idea of the boiler room, has adopted a novel unit called the "kilber." The kilber is 1,000 lb. of steam per hour. The boiler room is regulated by the number of kilbers required, an estimate of which is furnished from the switchboard at half-hour intervals.

III—Problems of the Hydraulic Plant

1. Efficiency Measures to Secure Maximum Output or Water Economy.—The report contains a detailed consideration of the operation of the Holtwood Station for information under the above heading. This station operates most of the time in parallel with one, frequently two, and rarely with three, steam-generating stations. Energy is transmitted at 70,000 volts to Baltimore, Md., 40 miles distant, and to Lancaster, Pa., 15 miles distant.

The Holtwood Station is on the Susquehanna River, the flow of which varies from about 3,000 to about 700,000 cu. ft. per sec. The average height of the dam is about 55 ft. and flashboards of a height of 2½ ft. or 4½ ft., according to the season, are usually installed on the crest. Except during high floods and extreme low flow, the working head varies from about 47 ft. to 62 ft. The area of the pond at the elevation of the dam crest is less than four square miles. There are eight main turbines of the vertical shaft, inward and downward flow Francis type. The total of the turbine ratings is 118,000 h.p. (ratings are not, however, at the same head). (Report of committee on prime movers, presented at 43rd convention of the National Electric Light Association, May 18-22, 1920, pp. 105-128.)

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE considered in the last article the various forms of lap joints, and now come in logical sequence to the butt strap type. These are double riveted, triple riveted, and quadruple riveted, the triple riveted being most in use. They are called butt strap joints because the edges of the plates to be joined are butted together and are secured by straps or plates of metal, which cover the joint, inside and outside, and are riveted through straps and plate to make a solid joint. This type of joint makes for a high percentage of strength, and at the same time preserves the truly cylindrical shape of the boiler. The rivets, being in both double and single shear, thereby gain in strength. A rivet is said to be in double shear when it holds together three plates, and therefore before it can be sheared has to be cut through in two places instead of one. The shearing strength of such a rivet is usually allowed to be 1¾ times the shearing strength of a rivet in single shear.

In the double riveted double strap butt joints the straps are usually made equal in width on the inside and outside of the joint and the full number of rivets is used in each row. In the treble riveted double strap butt joint the outside strap is only made wide enough to take in the two inside rows, and every alternate rivet is left out of the outside row. In the quadruple riveted double strap butt joint the straps are also unequal, and besides every alternate rivet being left out of the third row, two rivets are left out of the outside row. In some cases the strap is cut away on the outside edge to conform to the rivet line of the third row, thus securing a better caulking edge. This is not universal practice, but is a feature of some well-designed joints. The writer knows of at least one joint of this type with an efficiency of 92½ per cent.

When designing a joint of the butt strap variety, the same procedure is gone through as in the others. We have also to consider the thickness of the straps, and the Ontario regulations give a definite rule for determining this dimension. The thickness of straps where the full number of rivets in each row is used and double straps is found from the formula

$$T_1 = \frac{5}{8} T$$

where T_1 is the thickness of strap and T thickness of shell plate. For double straps when straps are unequal in width and every alternate rivet omitted in outer row

$$T \frac{5T \times (P - d)}{8 \times (P - 2d)}$$

Suppose we consider first a double strap double riveted joint, with equal straps and full number of rivets in each row. In a joint of this kind all rivets are in double shear, and therefore we must reckon for the number of rivets in a pitch $2 \times 1.75 = 3\frac{1}{2}$. This will of course have the effect of increasing the rivet strength, and in order to equalize it we must increase the pitch, which brings up the plate strength.

Suppose we wish for a plate strength of about 80 per cent., let us see what results we can obtain. We have $\frac{p - d}{p} \times 100 = 80$, and if we assume a ⅜-inch plate and ¾-inch diameter rivet we get

$$\frac{p - d}{p} \times 100 = 80$$

$$p - d = .8p$$

$$d = .p - .8p = .2p$$

Then if d = .75, the pitch will be

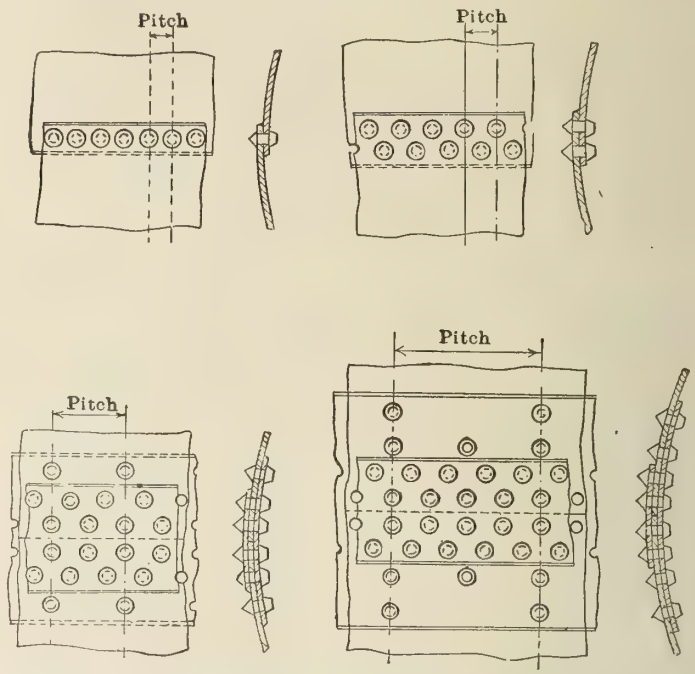
$$\frac{.75}{.2} = 3.75$$

With a pitch of 3.75 inches, diameter .75, and plate strength efficiency of 80 per cent., what will be the rivet strength efficiency? Let us work it out, taking C as .7:

$$\frac{a \times n \times c}{p \times t} - \%$$

$$\frac{3 \times 3 \times .7854 \times 7 \times 4 \times 8 \times 70}{4 \times 4 \times 2 \times 15 \times 3 \times 100} = 76.9$$

say 77 per cent. which is within 3 per cent. of the plate strength, and may be taken as a pretty evenly balanced joint. We could increase the strength of the rivet section by decreasing the pitch, but this would also decrease the plate strength, and as we have allowed a low constant for the rivets, we may feel safe in leaving it as it is.



THE LOWER FIGURES ILLUSTRATE A TRIPLE RIVETED DOUBLE STRAP BUTT JOINT, AND A QUADRUPLE RIVETED DOUBLE STRAP BUTT JOINT, BOTH WITH UNEQUAL STRAPS.

We must now consider the joint from the point of view of possible failure, or as we say, analyse it. In a butt joint the rivets on one side of the centre line only are considered, as conditions on each side of the centre line are exactly the same. Taking the plate from the centre line it may crush in front of a rivet in the inner row and shear one rivet in double shear in the outer row. It may shear two rivets in double shear, or it may tear between the rivets of the inner row and shear one rivet in the outer row. It may tear between the rivets on the outer row, and this is usually the weakest point.

Suppose it crushes in front of one rivet and shears one rivet. We have

$$d \times t \times 90{,}000 + a \times 1.75 \times 42{,}000$$

$$\frac{3}{4} \times \frac{3}{8} \times 90{,}000 \times \frac{3}{4} \times \frac{3}{4} \times .7854 \times 7 / 4 \times 42{,}000 = 57{,}726$$

The unit section is $3.75 \times .375 \times 60{,}000 = 84\,000$ lbs. Therefore the percentage in this case is $\frac{57{,}726}{84{,}000} = 68.7$ per cent. which is lower than either percentage already obtained. If we look into this a moment we will see why. Comparing

this joint with the double riveted lap we see that although we have the advantage of the rivets being in double shear, for this particular case of crushing the plate and shearing one rivet, the greater pitch of the butt joint offsets this advantage. It is obvious that to bring this part of the joint up to a closer strength proportion, we must increase the rivet area. This will decrease the percentage of plate strength, but we shall have to make a compromise. By making the rivets 13-16 dia. instead of ¾ in. we shall get a closer relation.

First $\frac{3.75-.8125}{3.75} \times 100 = 78.3\%$ plate strength,

and $\frac{13x13x.7854x7x4x8x70}{16x16x2x15x3x100} = 90.3$ rivet strength.

Now to consider again crushing in front of one rivet and shearing one rivet in double shear.

13/16 x ⅜ x 90,000 + 13/16 x 13/16x.7854 x 1.75 x 42,000
= 27,414 + 38,106
= 65,520 lbs.

As the unit section is 84,000 lbs. we get

$$\frac{65,520}{84,000} \times 100 = 78\%$$

In the case of shearing two rivets we will have

13/16 x 13/16 x .7854 x 1.75 x 2x42,000 = 76,212 lbs., which gives a percentage of 90.

For tearing between one row and shearing one rivet we have

(p—d)t x 60,000 + a x 1.75 x 42,000
66,090 + 38,106

which gives over 100 per cent.

Tearing between the rivets of the outer row gives (p—d)t x 60,000 = 66,090, and this, of course, gives 78 per cent.

We have therefore a joint not very much higher in strength than a good lap joint, and considerably more expensive to manufacture. This is the reason that comparatively few of these joints are met with.

The Triple Riveted Butt Joint

Coming to the triple riveted butt strap joint, we have reached probably the most widely used joint in high class boiler manufacture. The efficiency of this joint is high, usually running about 86 per cent. It is not unusual to find the rivet strength in these joints considerably higher than the plate strength, and this is accounted for by the large number of rivets in double shear. The weakest part of the joint is the plate section at the outside row of rivets, and if this is high enough the rest will be pretty near right. The high efficiency is due to the large pitch in the outer row of rivets where each alternate rivet is omitted. In a joint of this type there are five rivets in a pitch, and of these four are in double shear, thus making 4 × 1.75 + 1 = 8 rivets practically, when considering rivet strength. The methods of considering the joint are exactly the same, except that the analysis is more complicated. After the dimensions are determined on, we must also check up and see that the diagonal pitch does not exceed the limit set by the Ontario regulations. We will take for purpose of example a double strap triple riveted butt joint, with unequal straps, and every alternate rivet omitted from the outer row, and an efficiency of say 86 per cent. The plate thickness is 7-16 inches.

The first step is to obtain the pitch for the outer row of rivets. With 7-16 inch thickness of plate, we can assume a 15-16 inch rivet. Then we have

$$\frac{p-d}{p} \times 100 = 86$$

$$p-d = .86p$$

$$d = .14p$$

And if $d = .9375$ then $p = \frac{.9375}{.14}$ which gives 6.69, or nearly 6¾. We can take this pitch as a basis to work on.

For rivet strength we shall have then

$$\frac{.69 \times 8 \times 4 \times 16 \times 70}{27 \times 7 \times 100} \times 100 = 130\%$$

Which is ample, being stronger than the solid section.

In how many ways can this joint fail? As in the last case, take from the edge of the plate and work outwards. The first case in which failure may occur is by crushing the plate in front of the rivets in the inner row, and shearing two rivets in double shear, and one rivet in single shear.

The unit section is

p t 60,000 = 6.75 x .4375 x 60,000 = 177,000
15/16 x 7/16 x 2x90,000 + .69x4.5x42,000
= 204,210

This is sufficiently high to allow it to be neglected.

In the next case the plate may tear between the rivets of the inner row, and shear two rivets in double shear, and one in single shear. This would be

(p—2d)t x 60,000 + ax1.75x2 + a x 42,000
= (6.75—1.875) x .4375 x 60,000 + .69 x 4.5 x 42,000
= 258,378

which is also above the unit strength. The joint may fail in the third instance by tearing at the second line of rivets and shearing one rivet in single shear. (p—2d) t x 60,000 + a x 42,000 = 156,948 and the percentage to unit strength is 88.6, which is higher than the plate strength at outer row.

If the joint fails through shearing all the rivets it will have to shear four rivets in double shear and one in single shear.

4a x 1.75 + a x 42,000 = 231,840

which is much higher than the unit strength. The last case to consider is tearing at the outer row, which is

(p—d)t x 60,000 = 15,258

and the percentage is 86.2, which may be considered the efficiency of the joint.

The minimum diagonal pitch is found for the inner and middle row from the formula, Diag. pitch $= \frac{3P+4d}{10}$

and for the outer and middle row $= \frac{D.P}{3}$

$= \frac{3}{10} P + d.$

The minimum distance between middle and outer rows is obtained from the formula

$$\sqrt{\left(\frac{11}{20} P + d\right)\left(\frac{1}{20} P + d\right)}$$

and for the inner and middle rows from

$$\sqrt{\frac{(11P + 8d)(P + 8d)}{20}}$$

We will not enter into the solution of these formulae immediately, but will use them when designing the actual joint for the boiler we are considering.

The Quadruple Riveted Joint

This is a further development of the butt joint, and is used where a very high joint efficiency is required. The rivet section in this joint is very large, there being eight rivets in double shear, and three in single shear, giving a total of 17 rivet areas in the joint. The outside strap covers only the two inside rows of rivets, and the third row of rivets leaves out every alternate rivet, and the outer row has twice the pitch of the third row. The efficiency of the joint will depend on the efficiency at the outer row, which will be as usual P—d. This pitch must never exceed 10 inches in any case. With a 90 per cent. joint the pitch of the outside row would be 9⅜ inches, that of the next row 4 3-16, and the inside row 2 3-32 inches. The joint may fail by crushing the plate in front of four rivets in double shear and three in single shear. It may tear between the rivets of the inside row, and shear four rivets in double, and three in single shear. It may tear across the second row of rivets and shear three rivets. It may tear at the third row and shear one rivet, or it may tear at the outer row. Shearing all rivets is hardly likely. The reason for fixing a minimum diagonal pitch is to preclude failure by tearing across a diagonal pitch line. The least value of the joint is the plate percentage at the outside row, and this, as we know, is 90 per cent.

We will take up in the next article the calculating of the boiler where we left it in order to consider riveted joints.

Will Rebuild.—The first sod of the new factory of the Imperial Steel & Wire Co. at Collingwood was formally turned by Deputy Reeve William Williams, in the presence of members of the municipal council, the chamber of commerce, and other business men. Lt.-Col. J. A. Currie, president of the company, said the new buildings would be much larger than those destroyed by fire in May, 1919, while the plant would be so expanded as to give an output of about 200 tons of wire products per day. Contracts for the building, Lt.-Col. Currie also said, have practically been awarded, local firms being the successful tenderers. Construction will be proceeded with immediately.

Cement Joints for Cast Iron Water Pipe

The Following From the Journal of the American Waterworks Association Will Be of Interest to Many Power Plant Engineers Who Have Work of This Kind

By GEORGE W. PRACY

Superintendent, Spring Valley Water Co., San Francisco, Calif.

TWO sections of 4-in. cast iron pipe, using cement instead of lead in making the joints, were laid in April, 1917, by the Spring Valley Water Co. This was in the nature of an experiment, none of the men ever having made a cement joint before. The line was thoroughly tested for leakage before being put into use and the results were so satisfactory that cement has been used in some 16,000 ft. of 4-in., 5,000 ft. of 6-in. and 16,000 ft. of 8-in. cast iron pipe laid since that time. No larger size mains were laid during or since the war period; had any such been laid, cement would have been used. Over one mile of these lines has been in use more than two years under 175 lb. pressure without requiring any repairs. An 18-in. line is about to be laid in a neighboring town in which cement will be used for making the joints.

The use of cement is pretty general along the Pacific Coast. Clark Shaw of Long Beach describes the use of cement joints in Long Beach, California, in an article printed in the April, 1917, Proceedings of the American Society of Civil Engineers. F. M. Randlett, of the Portland, Oregon, water works, in the 1916 report of the department of public utilities, recommends cement joints for all new work. P. D. Rice, formerly engineer for the San Jose Water Co. and now connected with the Spring Valley Water Co., used cement to a considerable extent in San Jose. The East Bay Water Co. of Oakland, California, the Los Angeles water department, as well as several smaller systems, also have used cement in some of their work.

Making the Joint

In making the cement joint, the spigot end is put into the bell just the same as for a lead joint. Two rings of jute or yarn are then put around the pipe and driven into the bell in the regular manner. The jute used must be free from oil or tar. In some joints the jute was put in dry and in some it was soaked in grout before being used. There was no apparent difference in the results.

When the jute is in place the cement is mixed. Neat cement of standard Portland cement brand is used. The mix is very dry, the proportions being about 13 to 14 lb. of cement to 1 pound of water. This leaves the mixture so dry that it will crumble readily when handled. At no time should the mixture be wet enough to become sticky. The mixing is done in a pan or bucket, enough cement for one joint being mixed at a time. At first the men guessed at the amounts, taking what cement and water they thought was right. Later, measures were used, calibrated to give the amount of cement and water necessary, including waste, for a 4, 6 and 8-in. joint.

When the cement is mixed ready for use, a canvas is placed under the joint to catch the waste. The operator takes a handful of cement and with an ordinary calking iron shoves the cement into the joint until the joint is full. He then takes a calking hammer and calks the joint until the cement is rammed in as hard as possible. The joint is then again filled and the operation repeated until the joint is completely filled with the rammed cement. At first a bead was put around outside the bell, but this was discontinued as being unnecessary. In handling the cement the men must wear gloves. After the joint is finished, it is covered with earth while the cement is hardening.

Amount of Cement Used

In putting the cement into the joints, considerable is lost, even though a canvas be placed to catch it. The amount used in making a joint depends entirely upon the carefulness of the operator. In some careful checks made it was found that from 5½ to 10 lb. of cement were used in making an 8-in. joint. On an average, however, a 4-in. joint will take 5 lb.; a 6-in., 7 lb.; and an 8-in., 9 lb. As cement out here costs less than one cent a pound, the cost for material is not very great and it does not pay to slow up the men by exacting the extreme of carefulness.

Cost of Cement Joints

Careful observation on the cost of lead joints made in laying over 45,000 ft. of pipe in 1915 and of cement joints made in laying the 37,000 ft. during the last three years, has resulted in the following comparative table of costs. The wage scales and material prices have been adjusted to meet present conditions.

	Size of Joints		
Lead Joints:	4-in.	6 in.	8-in.
Labor Calker at $5.50; leadman at $4.75	$0.527	$0.723	$0.850
Lead—at 9½ cents per pound	.831	1.165	1.495
Coal—at $14 per ton	.015	.025	.026
Total	$1.373	$1.913	$2.371
Cement Joints:			
Labor—$5.50 per 8-hour day	$0.30	$0.44	$0.58
Cement	.05	.07	.09
Total	$0.35	$0.51	$0.67
Saving per cement joint	$1.02	$1.50	$1.70
Saving per foot for 12-ft. lengths	.08½	.12½	.14

The cost of yarn, amounting to a few cents a joint, has not been included, as it is the same in both cases.

Initial Leakage

When water is first turned into the line with cement joints, every joint weeps badly and in some cases the water oozes out quite readily. In a few instances small pin-like streams have squirted out. In 24 hours this has practically all stopped and in two or three days the line is tighter than a line with lead joints.

On some jobs a meter was cut in on a by-pass around a closed gate so that the water to replace the leakage from the line was measured. The meter showed a leakage of 100 cu. ft. or more the first day, dropping to a few cubic feet on the second day and practically nothing thereafter.

Four sections of pipe, about 1,500 ft. long, tested for leakage at the joints after the water had been in the pipe for a week, gave the following results: In the first section the leakage was 1-3 gal. per linear foot of pipe joint per 24 hours. The second section leaked so slowly that the leakage could not be measured. The last two sections were practically tight, the line being pumped to pressure and left standing in one case for ½ hour and in the other case 2½ hours without any drop in the pressure.

Flexibility of Cement Joint

At San Jose a test section of 6-in. pipe was made, somewhat over 70 ft. long, using cement joints. This was first pumped to a pressure of 300 lb. without any leakage through the joints. The line was then put on supports so that it was elevated about 4 ft. off the ground. With a normal working pressure of 60 lb. on the line, all but the two end supports were knocked out, permitting the pipe to be self-supporting over a span of 70 ft. The pipe dropped 2 ft. in the centre without causing any leakage at the joints. The line was then again lowered until it lay flat on the ground, while under normal working pressure; still no leakage. It was then emptied and left empty, exposed to temperature varying from 40 deg. to 110 deg. F. for nearly one year, after which it was again filled and the joints were all found to be tight.

In the first block of pipe laid, containing about 40 joints, 3 joints had to be cut out and remade. Since that time only 2 joints have continued to leak after the water was turned on. Both these joints were repaired by cutting out only that portion of the joint that was leaking and calking in lead wool. The pressure had to be taken off the line while the work was being done. Cutting out the joints

on the 4-in. line took about 20 minutes. No joints in large pipe have been taken out.

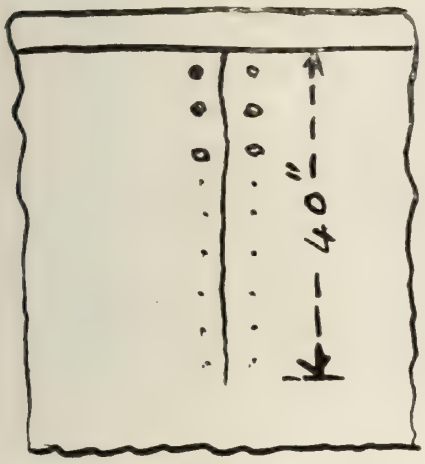
One indirect advantage of cement joins is that they act as insulating joints and reduce the amount of current carried by the line. This feature is of particular importance in the larger cities where electrolytic action has done considerable damage. The cement joint increases the resistance of the pipe as a conductor to such an extent that the current carried is negligible.

Taking all things into consideration, it is believed that the cement joint has come to stay. Improvements over the present methods of making the joint will undoubtedly be made, but even at the present cost they are cheaper than any other joint known, and from all the experience out here on the Pacific Coast they are entirely satisfactory.

*From the Journal of the American Water Works Association.

AN UNUSUAL WELD

A repair job of interest to all engineers was recently carried out by means of the electric arc welding process to the main engine cylinder of the steamer Chippewa.



SHOWING CRACK EXTENDING 40 in. DOWN FROM TOP OF CYLINDER, STUDDED READY FOR WELDING.

Our readers will be familiar with the Chippewa's old-fashioned beam engine or "walking beam," as it is sometimes called. Needless to say the engine only has one cylinder, so that when a vertical crack some 40 inches long developed in the cylinder wall during the busiest part of the season, something had to be done about it. The cylinder is 5 ft. 6 in. in diameter by 12 ft. long, and carries a working pressure of 60 lbs. per sq. in.

After consultation with the Lincoln Electric Co. as to the possibility of successfully welding the crack, it was decided to proceed with repairs as quickly as possible, by means of a method which has been very successful in repairing large iron castings subject to heavy working stresses.

Holes were drilled down each side of the crack, and steel studs were screwed in and cut off about 3-4 in. from the cast iron. By the time the last stud was in, the Lincoln Electric Co's. motor truck carrying the portable electric welding outfit was on the dock within 20 feet of the Chippewa's engine room. The cables were connected up and the welder went to work to weld those studs and the cast iron of the cylinder into a solid mass of metal. Twenty-four hours later the job was complete and shortly afterward the Chippewa steamed out into the lake for a trial trip.

The weld was found to be quite tight and appeared to be a perfect job. The Superintendent Engineer deemed it advisable, however, to make assurance doubly sure by re-inforcing the weld with two steel bands placed right around the cylinder.

Electric arc welding has been used extensively of late along the water-front in Toronto for boiler and hull repairs but this is one of the first local instances that has come to our notice of the use of the process for a major repair to a large and important iron casting.

FINISHED WELD RESEMBLING STEEL PLASTER ABOUT 1 IN. THICK, APPLIED TO OUTSIDE OF CYLINDER WALL FOR FULL LENGTH OF CRACK.

Note:—It was found that this method of welding had the effect of drawing the edges together and closing up the crack as the weld was made, from the bottom up.

WESTINGHOUSE STAFF PICNIC

Over 40,000 persons, employees of the Westinghouse Electric & Manufacturing Company, thir wives and families, attended the 34th annual outing and basket picnic at Kennywood Park, Pittsburgh, on August 14. This outing was featured by the many athletic events both for men and women of the company, a great many prizes being given to the winners. An event that created considerable interest was a baseball game between two girls' teams.

This picnic was one of the largest of many held in the Pittsburgh district by industrial plants and its success was due largely to the employees of the company who had complete charge of all arrangements.

Companies included in the picnic arrangements were: the Electric, Machine and Meter Works, East Pittsburgh; Trafford City Works, Trafford City; Linhart and Copper mill at Turtle Creek; Homewood service station and Pittsburgh Office, Pittsburgh and Braddock Foundry, Braddock, Pa.

VIEW FOR AEROPLANE PILOTS

A most ingenious invention is the "clear-view screen" which a British firm has produced for the benefit of navigators. Rain, spray, or snow renders it difficult or impossible to see through an ordinary port hole or other glass screen. The invention consists simply of a glass disc, which forms part of the screen and is rotated at so high a speed that any water or snow falling upon it is immediately spun off. The glass remains so clear that its rotation is extremely difficult to detect. This device has now been introduced on aeroplanes in order to assist the pilot when rain or snow encountered. The disc is driven either by a small windmill fixed on one of the struts, or by vanes fixed to the edges of the disc itself. When the aeroplane is travelling at 75 miles per hour the disc spins at 1,200 revolutions per minute. At anything over 800 revolutions the glass will keep clear in all weathers.

In connection with the forthcoming trans-continental air flight from Halifax to Vancouver, the Quebec Harbor Commissioners have been approached as to the using of Lampson's Cove as a seaplane harbor, which will serve as a permanent station for transcontinental flights, and will place Quebec on the all-red air route. Capt. Leroyer, of the Canadian Air Board, has stated that one of these flights will take place towards the end of this month. The object of these flights is not only of military value but it is to demonstrate the practicability of the airplane for commercial purposes.

The Superheater Company, Limited, will manufacture the type of fire-tube superheaters now in general use in locomotives of all Canadian railways, and also fire tube superheaters for marine installations, of which there are now over two thousand in daily service. In the case of the water tube boilers in marine service, the company designs and manufactures the superheater to suit each individual case. This likewise applies to stationary installations, either water-tube, fire-tube, or separately fired. The conditions are studied in each case with a view to supplying the most economical and effective installation. The company employs a form of return bend which is made by a forging process from the metal of the superheater pipes, making an exceptionally strong construction which is proof against high temperatures. This form of return bend has also been considerably sought after for the use in pipe coils for refrigerating purposes, condensers and other uses.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.
UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.
GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, SEPTEMBER 20, 1920 No. 18

PRINCIPAL CONTENTS

Some Recent Utilization of Water Power 415
Interesting Instance of Oxy-Acetylene Welding 418
Points to Observe in Purchasing Equipment 419
The Theory and Practice of Electricity 422
Report of Committee on Prime Movers 424
A Course of Instruction 426
Cement Joints for Cast Iron Water Pipe 428
Editorial Page 430
Progress in New Equipment 431
The Operator's Point of View 433

Can Anyone Prove It?

IN a newspaper report of a recent disaster on the Great Lakes, the statement is made that as the vessel was sinking, the boiler exploded. This is not an unusual statement, but we venture to say it has little but the reporter's imagination to back it up. Is there any good reason why a boiler should explode on a sinking ship? The thoughtless individual usually jumps to the hard-worked explanation of the sudden contraction and lets it go at that. What then does this sudden contraction perform? Does the shell contract so much that the pressure is increased beyond the resisting strength of the metal? Most assuredly not. The sudden contraction theory does not hold water. The fact is that the boilers do not explode when the ship is sinking. If they did, it would be of little use trying to salvage sunken steamers, as they would be damaged to such an extent that salvage would be impossible. Of all the steamers sunk by mine and torpedo during the war, were there any cases of boiler explosions unless the boiler shell was actually ruptured by a piece of shell, or other projectile? As a matter of fact, the boilers on steamers sunk and afterwards salvaged are usually found intact and fit for use again. This idea of the boilers on a sinking ship exploding is one that has been fostered by non-technical writers in the daily press, and accepted without question by men who should know better, and who would recognize the error of the statement if they gave the matter a little thought.

Looking for Ideas

FORBES' MAGAZINE, in a recent issue, refers to the success of Thomas Edison, and remarks "One invention was the result of 5,000 experiments. When he was working on his improved electric lighting he sent men into remote corners of the world in search of some fibre or other material which could provide the electric bulbs with the right kind of filament. Such is his spirit of enterprise that he reads more trade publications probably than any other business leader."

Leaders in manufacturing life in this country are coming to the point where they are depending more and more on the trade and business papers for help in their particular line of business.

Only a few weeks ago there was recorded in these columns the case of the master mechanic of one of the leading Canadian railroads. In going through one of the mechanical papers he found an idea that he was able to apply to his work in the shop, and by so doing saved the railroad company hundreds of thousands of dollars in time of repair, and also enabled the rolling stock to be put out much sooner in order that it might be earning revenue instead of eating its head off in the repair shop.

There is something worth thinking about here. If you put your ideas in print in a mechanical or technical paper you are sure of an audience of interested readers, and it is almost certain that some one is looking for the idea you have. The amount that may be paid for the material is only a small part of the service. It may not be very much, but it may be as much as the paper can afford. The big idea is that you can, through the medium of the technical pages in such a paper, pass along an idea that may be the means of giving great assistance to some mechanic who is having troubles of his own. The passing on of these ideas does not impoverish the person having them, neither is he enriched by withholding them.

Trade Follows the Flag

THE saying which is used as a caption for this article is not always true. In some cases, and perhaps the majority, the flag follows trade, and it is in this manner that the British Empire has been developed. The originators of the Canadian Government merchant marine, however, saw that the possession of a fleet of modern commerce carriers, which could go to all parts of the world, could become a great drawing power for Canadian trade, and that in this case trade would follow the flag. The Canadian Government fleet, conceived in the first instance as a measure to tide the shipbuilding yards over a doubtful period, has expanded into a ship-owning concern that will have no less than sixty-six first class modern cargo carriers under its flag. This flag is the flag of the Dominion of Canada, and it does not require a very great imagination to see what an advertisement for Canada this fleet can be. Sailing from Canadian Atlantic and Pacific ports, these Canadian built and Canadian manned steamers will carry holds full of goods manufactured in Canada to every port on the shores of the seven seas. This fleet would justify its existence were it as a great advertising scheme only, but it has already justified itself as a commercial success. The Canadian Government Merchant Marine is a fleet in being, of which every Canadian can be justly proud.

Progress in New Equipment

RECENT DEVELOPMENT IN SMALL VACUUM PUMPS

By F. A. McLean

As the successful outcome of a long series of experiments and tests the Ingersoll-Rand Company recently placed on the market a new line of small vertical vacuum pumps which will be known as their "Imperial Fourteens."

These little machines are built in six sizes at present, and are said to be far superior to any machine of their rated capacity heretofore obtainable, in fact, it is claimed that they will deliver from two to a hundred times as much air as any other pump of the same piston displacement and will require less power per cubic foot of air handled, regardless of the degree of vacuum maintained.

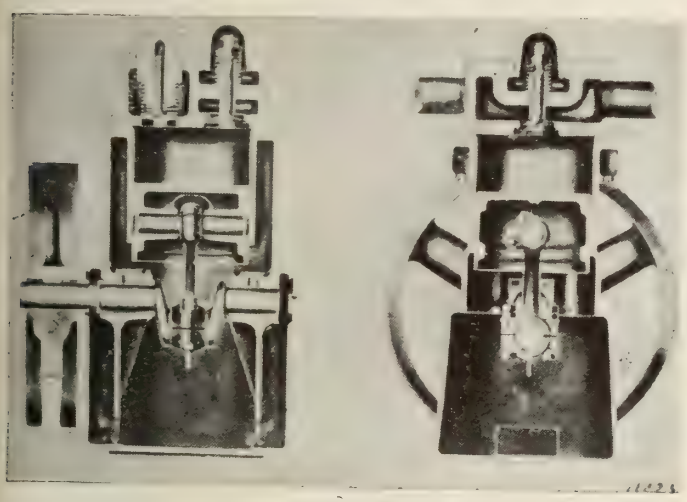


FIG. 1—CROSS SECTIONAL VIEW OF 2, 3, 4, AND 5-INCH STROKE VACUUM PUMP, SHOWING NOVEL METHOD OF COOLING.

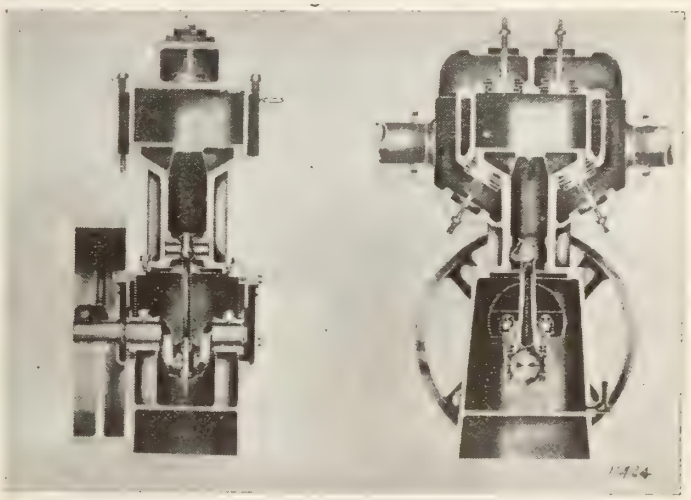


FIG. 2—CROSS SECTIONAL VIEW OF 10 x 5 AND 12 x 6 INCH PUMPS, SHOWING CONSTRUCTION OF "T" PISTONS AND ARRANGEMENTS OF PLATE VALVES.

In such points as the design of the frame, drop forged crank shaft, and connecting rod, renewable die cast bearings, accurately balanced flywheel, automatic splash lubrication system and freedom from oil on their exteriors, these pumps resemble the company's "Imperial Fourteen" compressors which were brought out a year or two ago.

The four smallest pumps are of the single acting type and have air cooled cylinders measuring respectively 4, 5, 6, and 8 inches diameter by 2, 3, 4, and 5 inches stroke. By a novel method of cooling, the need for water jackets or fragile and unsightly vanes or ribs is done away with. Cooling is accomplished by the "breathing" of the crank case, which takes place through an annular space around the cylinder; thus on each stroke of the piston, air is alternately drawn into and forced out of this "air jacket" through two special openings, the location of which may be noted by referring to the right hand sectional drawing in figure one.

The two largest machines, 10 x 5 and 12 x 6 (illustrated in figure two), although of the double acting type, are singularly free from the usual complication of piston rod, stuffing boxes, crosshead, and crosshead guides usually found in machines of this class. Due to their larger capacity, the cylinders are provided with integral water jackets. The pistons on these machines—as will be seen by reference to figure two—are similar to a letter "T" in cross section and are provided with an opening or chamber sufficiently large to accommodate the piston pin, and small end of the connecting rod.

Pistons in all six machines are manufactured to very close limits and are fitted with a 3 piece and one snap ring, assuring maximum tightness without sacrificing simplicity or strength.

On the 2, 3, and 4 inch machines, inlet and discharge valves of the mushroom poppet type, made from chrome vanadium steel, so proportioned that breakage is almost impossible, are used. The valve springs are carefully adjusted to permit easy opening and quick closing of the valves, and a cap screwed into the opening over the inlet valve prevents any chance of leakage at this point. The discharge valve guide is screwed into the cylinder head, thus making the discharge chamber tight; a feature that is desirable at all times, and especially so where a pump is required to handle gases at discharge pressures of one to four or five pounds.

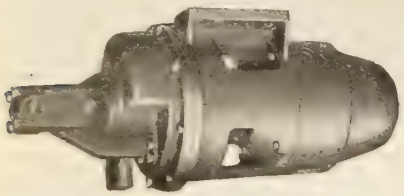
Plate valves, consisting of a flat disc of special valve steel held from any lateral movement by the tension of a light spring steel guide plate to which it is permanently attached, are employed on the 5 and 6 inch stroke machines. Coil springs held in a stop plate bear on the valve disc and force it against its seat with definite and predetermined force. Valves of this type have been found to be absolutely tight throughout their life.

The tightness of the valves and piston rings used, the efficiency of the design and the excellence of the workmanship, in combination permit the maintenance of very high vacua. The three largest machines have a pulling capacity of 29 to 29.25 inches of vacuum, while the smaller machines equipped with poppet valves will pull 28.6 to 29 inches, depending on the size.

These pumps are adapted for use in connection with vacuum filters, pans and kettles, vacuum melting and digesting apparatus, milking machines, evaporating and distilling equipment, steam condensers, air dryers, impregnating and insulating machinery, industrial and experimental research laboratories, glass manufacture, the canning and bottling of foodstuffs, etc.

SMALL TURBO GENERATOR SETS

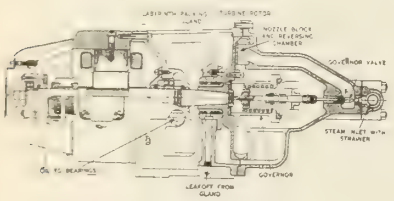
Although developed especially for supplying energy for locomotive headlights, the turbine-generator units just placed upon the market by the Westinghouse Electric & Manufacturing Company



may be used for lighting service in small isolated steam plants such as pumping stations, small steam shovels, oil well derricks and in other applications where a small amount of lighting is required. The construction is especially advantageous for portable application, as it is designed for severe outdoor service.

This unit is small, light and compact, requiring no foundations. It can be set up on a floor, heavy board or in any horizontal place and held in position with four small bolts, studs or lag screws.

While totally enclosed all parts are readily accessible by removing the end cover on the generator and the turbine end casing on the steam end. There



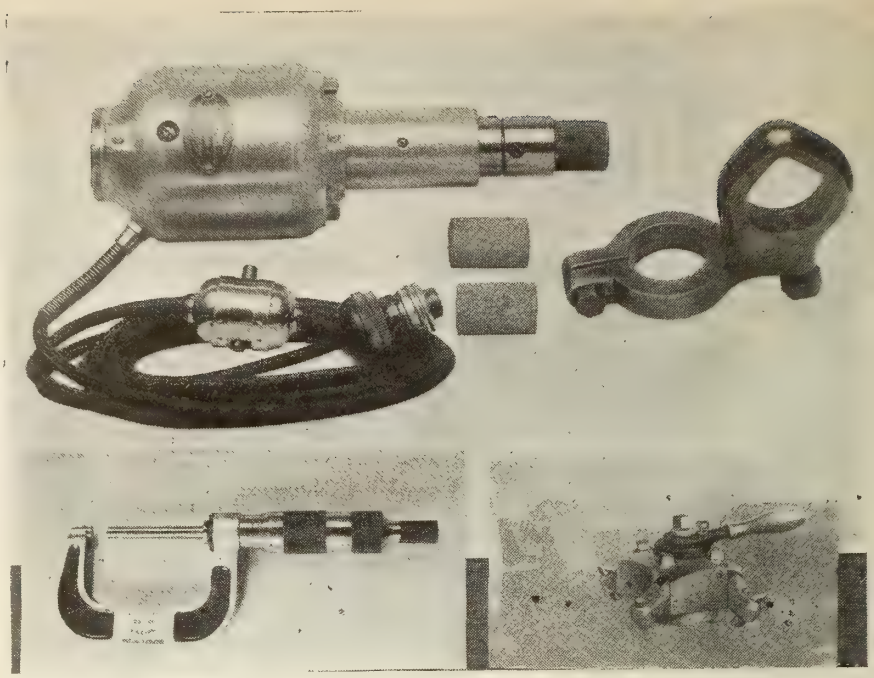
are only five moving parts—the shaft carrying the generator armature and the turbine rotor, two governor weights, governor spindle and governor steam valve stem—thus making for simplicity of operation.

As there are no levers to wear and stick and no packing to adjust and renew, no adjustments are necessary after the unit leaves the factory.

The unit is self-contained, each part being built for each other. The single shaft carrying the generator armature and turbine rotor with governor is supported by two standard self-aligning ball bearings at each end of the armature—the turbine rotor with governor being overhung.

The generator end consists of one casting containing one bearing and the field poles with windings. To this is bolted the middle section, which carries the second bearing and holds, by a web, half of the turbine rotor housing.

This middle section supports the whole unit. The steam space, governor valve and steam strainer are contained in the third or turbine casting. This construction eliminates all chance of temperature distortion, insures no leakage of steam to the generator, and gives a rugged perfectly balanced unit.



TOP VIEW SHOWS GRINDER, LOWER LEFT HAND VIEW THE MICROMETER, AND REMAINING VIEW THE TOOL POST.

BLUSH MULTIPLE MICROMETER

A. T. Blush Tool Co., 1145 West 11th St., Erie, Pa., have placed on the market the micrometer as illustrated. The purpose of the instrument shown is to eliminate the necessity of using two instruments in taking measurements ranging from 0-in. to 2-in. This is accomplished by the use of two threads of different pitches, namely, a 20 pitch for the measuring screw and a 40 pitch for the thimble carrier. Although the mechanism embodies two screws, the accuracy of the instrument depends only and entirely upon the 20 pitch thread as the 40 pitch thread only functions in keeping the thimble in proper alignment with the graduation on the hub.

The difference in the pitch of these threads makes it possible to obtain a 2 inch movement of the spindle with only a 1 inch movement of the thimble. The adjustment for wear on the anvil and the spindle is taken care of without moving either the anvil or the measuring nut which makes a very desirable feature as it is impossible to throw the anvil and the spindle out of parallel when making adjustments.

Due to the fact that the spindle is actuated with a 20 pitch thread this makes a very fast acting instrument as the thimble travels half as fast as the spindle. Another feature is the graduation, which is said to be much easier to read than the old style of graduation.

It is their intention to make these instruments in larger sizes having a range of 2 inches on each size, also a special instrument for very close work ranging from 0 inch to 1 1-2 and 1 1-2 to 3 inches.

STERILISATION OF SOLUTIONS

Many ideas have been tried out relative to the sterilisation of cutting solutions, but the most successful one for the average industry, according to "Safety Engineering," is to have a set of drains running from the machine to a large pit consisting of two large tanks. The solution is run into one tank, which collects a great deal of the sediment, and then over to the other tank to be used again. Each week, and sometimes twice a week, the solution is taken out and the pit cleansed thoroughly. The solution is then returned to the pit, if it is not broken down, and is heated up to 148 deg. by steam pipes running through the pits, and maintained at that temperature for a half-hour. This process has been in successful operation at the plant of the Ford Motor Company. Examination with the microscope of the solution at the Ford plant showed from 10,000,000 to 15,000,000 bacteria per cubic centimetre in the infected solution, whereas but 400,000 to 600,000 bacteria per cubic centimetre appeared in the sterilised solution.

PLANER IMPROVEMENTS

The Cincinnati Planer Co. have incorporated a number of changes in the design of their planers which add to the serviceability of the machine. The top arch is now being made of the box pattern, which gives increased strength and bearing surface on the housings. The cross-rail is likewise of the box type and it is claimed that increased rigidity is a feature when the tools are cutting. An automatic stop has been added to the machine so that the clutch for elevating the cross-rail may be released at any desired point in the vertical range. Improvement has also been made in the holding device for the tool post harp.

The Operators' Point of View

ILLUSTRATING REPAIR ON TUBE SHEET.

BUILDING UP A LIGAMENT IN A TUBE SHEET

By R. McLAREN

Recently a tube in a return tubular boiler sprang a leak of such a nature that the metal was eroded from part of the ligament, as indicated by the sketch. Putting in a tube would only have meant that the tube would have been cut through in a short time at the point of erosion unless the depression were first built up. We had both the torch and the arc processes available in the plant, and on account of its greater convenience, it being portable, the torch was advocated by some for doing the job.

However, the high temperature to which the metal over a considerable area must be raised before deposition of the filler can be effected makes the torch objectionable for such a job, the contraction stresses resulting being such as to possibly strain the ligament. The deposition of the filler by the arc process being instantaneous, no overheating can result.

PORTABLE LIGHT STAND

By JOHN THORN

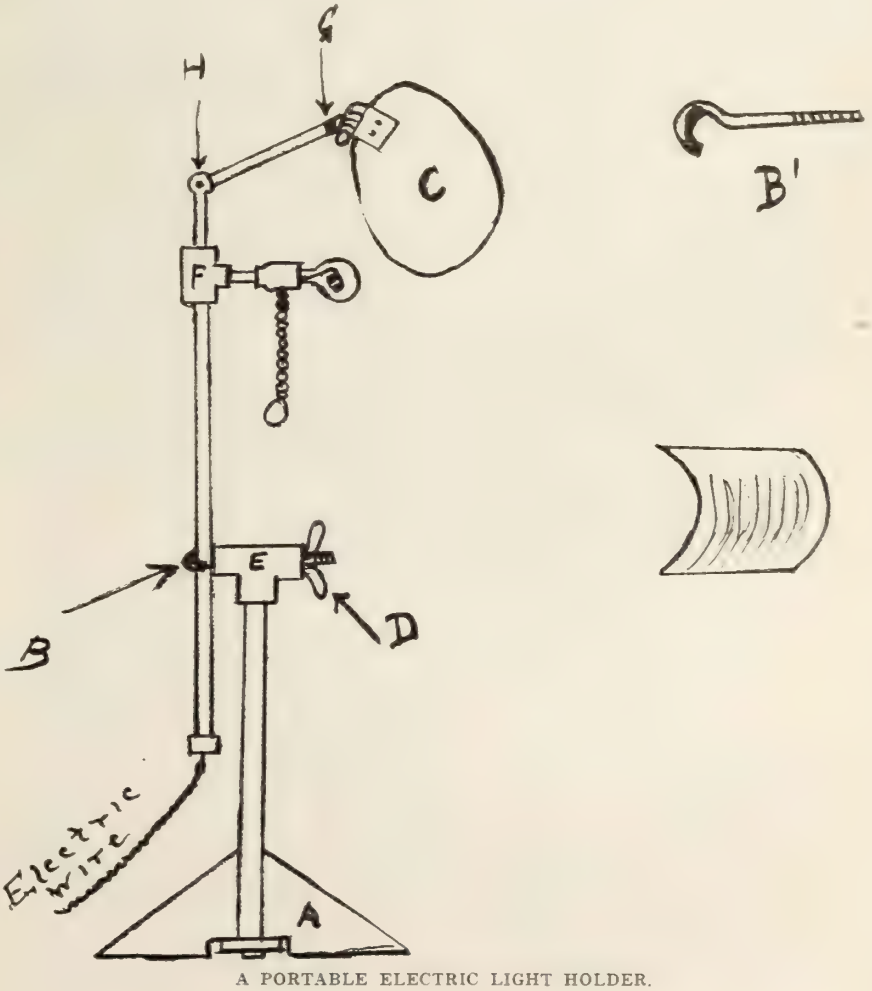
The sketch shows a useful, easily made, portable electric light lamp with adjustable height arrangement and an adjustable reflector; a threaded socket is attached to one side of the reflector at C, and the hinge at G and joint at H are held fairly stiff by using a small threaded bolt, by these means the reflector can be moved in any direction, so that the rays of light will be directed where needed. The reflector can be bent into the shape shown at Fig. 2 if desired.

The piece B is shown in B¹, on the end of it is a wing nut D.

The base A is made from scrap lead, the standard is a piece of ¾ inch iron pipe with a lock-nut on the bottom and a ¼x¼x¾ tee on the end at E.

The pipe F is a ⅜x⅜x⅛ inch tee.

When the whole lamp is put together and nicely bronzed it has a fine appearance.



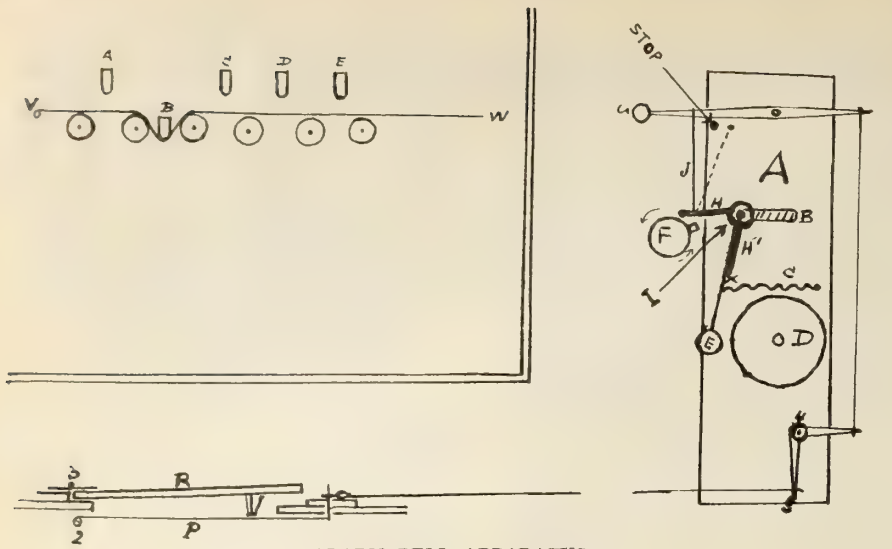
A PORTABLE ELECTRIC LIGHT HOLDER.

ALARM BELL SIGNALS

By J. E. McCORMACK

Even slight freezing damages dry cells to some extent and they can be ruined by frost. During the past winter when using dry cells in cold places I was obliged to be careful about them freezing and return them to a house at night. The enclosed sketch shows how alarm bell signals may be worked without cells or a battery providing their use is where machinery is in operation. I had not yet "happened on this" and was not using it when carrying the cells about.

A is a piece of board in an upright position and into which a slot to hold a coil spring B is cut, D is a bell or gong and C is a coil spring which pulls the hammer E to hit the bell or gong. F is a shaft belonging to some part of the machinery in operation, which



ALARM BELL APPARATUS.

of course must be guarded, but the guard must permit access of the said device to the shaft. H H¹ is a bell crank which swings on axis I. The arm of the hammer E also swings on axis I, but independently of H H¹ except that H¹ can pull the arm and the hammer E away from gong D. J is cord from H to the weighted lever arm above; its purpose is to hold H away from shaft F. If H drops to the shaft F then the key shown, or some projection provided, raises H by passing under it until upon reaching the highest point of travel it passes from under H, allowing H to drop again. H in rising pulled E away from the gong by means of H¹ and when H dropped then spring C drew E against gong D. If the hammer arm is rigid a rubber buffer or a flat spring must be placed at X to force the hammer a little away from the gong again instantly else the device will make merely a series of hits instead of producing a ringing sound. If the hammer arm is itself springy enough a pin at X will suffice. The exact location must be found by experiment. If the device is set up at a shaft end then a pin in the end of the shaft and enough from center to act as a crank will serve to raise H; but to prevent H falling too far again an elastic cord (indicated by a broken line in the sketch) will be required to support it, but the cord must not be too tight. The remark above as per guards applies here also. Another method would be to put on to the shaft two split safety collars a little way apart and with a triangular or a half round piece between them and its ends recessed into each a little bit, its flat side concaved slightly to fit the shaft snugly enough that if the shaft were to revolve backward H could not run under the piece and get caught or broken. The idea of the elastic cord with the pin-in-end-of-shaft method and of the coiled spring B with the key or the two-collars-and-the-piece-between methods is to allow the shaft to revolve backward without doing damage to the device and the same applies to the idea of having H H¹ and the hammer arm pivoted independently on I for then H¹ cannot break the hammer arm by forcing it too hard against X or D.

From the other end of the lever arm above them to which J is attached a cord passes down to one arm of a bell crank below, and from the other arm of this piano wire, or some other light wire, passes to the trip device shown to the left in the sketch. P, hinged at 2, has its other end bent at right angles and passing up through the floor or a board and through a ring attached to the end of the fine wire used. R, hinged at 3, and having its other end held up by a spring, has a projection on its under side and when pressed down by a weight coming on to it from above the projection comes against P, forcing it down and thus releasing the ring on the end of the wire and allowing the weight G to lower and slacken cord I, thus allowing H to engage the projection on the shaft F, the final result being the ringing of the bell or gong; one stroke being made per each rev. of F. A pin must be inserted some place in board A where it will prevent G dropping much further than is necessary.

Before trying it I thought the bell from an alarm clock would do for D but I found something larger was required. One of the old fashioned dinner bells is more like suitable.

As compared with dry cell circuits the above has the disadvantage of requiring to have the ring replaced over the end of P each time, but for cold weather it has the advantage of immunity to damage from frost. Then, too, bells are not left ringing and exhausting the battery for a time at noon or night because a switch has been forgotten.

As for the use of R, a belt falling onto it (crosswise) indicates that the belt is off. A conveyor chain falling onto it (lengthwise) indicated that the chain is broken or is off the wheel. A tank float may be made to press it, a door or gate to push it, or if it is wide enough pedestrians crossing it will step on it. One can set it for any one of several signal requirements. In the event of wishing to connect up a number of the P-R devices to one gong the insert in the sketch illustrates an idea that can be utilized. Let A B C D and E in the insert represent bell crank arms, corresponding, in service to the bell crank arm 4-5 below D. The circles represent small pulleys or sheaves G and changed over to the other end of its lever, and the cord V W is so connected that when tightened the effect is to slacken cord J and allow D to ring. It is obvious that any one of the arms A to E, in the insert, will, if allowed to drop, tighten the cord V W to cause the ringing of D. The set may be placed as best suits the surroundings and the direction in which the trips or P-R devices lie.

CLEARANCE IN GASOLINE ENGINE

Question

We would appreciate very much if you will publish in your next issue of Power House the proper size of combustion chamber for a marine gasoline engine. The engine is water cooled by a continuous stream of cool water being pumped through the engine while running. As an example, say we take an engine with a 5 in. bore and 4½ inch stroke, what is the proper size of combustion chamber when piston is up?

Answer

The amount of clearance or combustion space in a gasoline or any internal combustion engine, is governed by the required compression pressure. The compression pressure in an engine of the type mentioned is usually from 60 to 80 lbs., according to the ideas of the manufacturer. The ratio of compression is found from the formula

$$(p\ v)^{1.35} = (p.\ v.)^{1.35}$$

absolute pressures, of course, being used.

This formula gives the final volume into which the suction air is compressed and is the adiabatic ratio of the compression for stroke and clearance. If we subtract this from 1, we get the ratio for obtaining the clearance. This is done by dividing the stroke by the ratio, and subtracting the stroke. thus

$$\frac{\text{stroke}}{\text{ratio}} - \text{stroke} = \text{linear clearance}$$

This gives us

$$\left\{\frac{14.7}{84.7}\right\}^{1.35}$$

This must be worked by logarithms, and we get

log 14.7=1.167317
log 84.7=1.927883

T.239434

This must be multiplied by 1.35, the product being T.03323, the number corresponding to which is .108. Subtracting this from 1 we get .892, which is the ratio we want. Then

$$\frac{\text{stroke}}{\text{ratio}} - \text{stroke} = \frac{4.5}{.892} - 4.5 = .547 \text{ ins.}$$

The volumetric clearance will be

$$25 \times .7854 \times 4.5 = \text{stroke vol.}$$

$$\frac{\text{stroke volume}}{\text{ratio}} - \text{stroke volume}$$

which gives

$$\frac{88.375}{.892} - 88.375 = 10.675 \text{ cub. ins.}$$

The above shows the method of obtaining clearance. The amount of compression depends on the ideas of the designer.

Trade Gossip

Have Contract.—A contract for the mechanical equipment of the Hudson's Bay Company's store at Victoria, B.C., has been awarded to Greene and Lister, plumbing and heating contractors, Winnipeg.

A Busy Shop.—Favorable reports are received regarding operations by the Ontario Steel Products, Limited. The plant at Gananoque, where shovels are made, is running at capacity, and business at the other factories is also reported to be very good.

Toronto.—Mr. F. S. Wood, formerly Agent for the Canadian National Railways at Pittsburgh, is being transferred to Toronto to look after the interests of the Canadian Government Merchant Marine. Mr. Wood has been located at Pittsburgh for the past five years.

Build Machine Shop.—The Gunnel Company of Canada, 2410 West Dundas Street, Toronto, received a permit from the city architect for the erection of a three-storey brick and reinforced concrete machine shop, which, when completed, will cost in the neighborhood of $100,000.

Vancouver.—The Canadian Pacific Railway coast-service will be augmented by a new steamer which will replace the "Princess Sophia" which was lost last year in the Alaskan straits. The contract has been let to the Wallace Shipyards of Vancouver, and the vessel will be 326 feet long with a speed of 17 knots. She will cost about $1,500,000.

Make Steel in West.—Rolling mills and blast furnaces for the manufacture of steel, will, it is expected, be established in this province as soon as the necessary market for the product of such an undertaking has been assured, according to a statement made by Major Martyn, Industrial Commissioner for the province, who, with James H. McVity and Nichol Thompson, of the Advisory Council of the British Columbia Department of Industries, has left for Chicago and San Francisco in connection with the matter.

Want Yards Open.—Business Manager Herbert Wright, of the Toronto Union of Shipbuilders, is in Ottawa conferring with the Minister of Marine and Fisheries, urging that they proceed with the construction of the two ships on the ways of the Dominion Shipbuilding Company. These were started before the company was forced into liquidation. The third vessel, that was under way for a New Orleans firm, is being finished by the owners. Mr. Wright will urge upon the Government the fact that if the work does not go on many men will be out of work this winter.

Change in Welland.—The plant of the Dillon Crucible Alloys, Limited, Welland, has been purchased by the Canadian Atlas Crucible Steel Co., Limited, and Canadian interests will be strongly represented in the company as well as on the board of directors. Atlas products, which include "L-XX" brand of high speed steel and other Atlas brands, carbon and special alloy tool steels, will now be made in Canada. The general sales office of the company will be located at 133 Eastern Ave., Toronto, Ont., with a warehouse in conjunction, and branch warehouses and sales offices at 326 Craig St. W., Montreal, also at Winnipeg, Man.

Toronto.—The Canada Steamship Lines will build a new steamer for their Lewiston service, which will be in commission for next season. She will be the largest passenger boat in the fleet, and will be thoroughly modern in every respect. She will be propelled by geared turbines, and will have a speed of about 22 knots. She will have four decks, and a restaurant, dancing floor, moving picture theatre, and a children's playground are spoken of. Pressed steel fittings will be used entirely in the interior, reducing the fire risk to a minimum Passenger accommodation will be provided for 4,000.

B. C. POWER DEVELOPMENT

The development of the Bridge River power site near Lillooet, Vancouver, is in its initial stages, surveying and preliminary work now being carried on. The plans, which will involve the expenditure of 30,000,000 dollars, call for a tunnel a mile and a half long under Mission Mountain, discharging into Seaton Lake, six miles from Lillooet. The fall will be 1,400ft., and it is estimated that 400,000 horse-power will be developed.

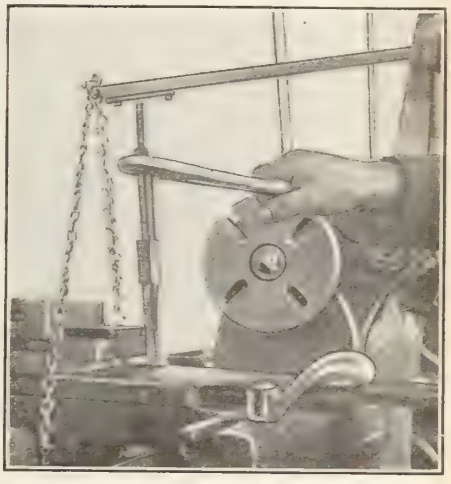
ELECTRIC HAULAGE ON BRITISH CANALS

Plans have been drawn up for the application of electric haulage to an important section of the canal which connects Birmingham with the Severn. The speed of the barges will be raised to double the limit with horse haulage, but no damage to the banks from the wash is anticipated. Current will be supplied from an overhead trolley to the electric haulage gear. Investigations are also being made into the use of electric battery haulage for canal barges. The whole question of the future of British canals is now being considered by a special committee formed by the ministry of Transport.

ACKLAND SCREW DRIVER

The screw driver as depicted is the product of the Ackland Specialty Co., Springfield, Mass. It is said that this driver will remove any rusted or stuck screw which could not be budged by an ordinary driver.

The principle involved is an old established law of mechanics. A few pounds of pressure at the end of the upper bar and on the rachet handle results in a much greater pressure at the slot of the screw. This feature of course eliminates the danger of the driver slipping and ruining the screw slot.



HOW THE SCREWDRIVER IS USED.

Automatic and machine manufacturers are said to be especially interested. The blades are made from special heat-treated and tempered steel. The post is attached to the blade by a case hardened socket and sliding on the post is a rachet which permits using the driver in narrow and restricted places. The cross bar is secured to the post by a ball joint permitting movement in all directions.

The chain is attached on the end of the cross bar and looped around some projecting lug of the machine. A glance at the photo illustrates clearly the method of using.

Trying the Coal.—E. H. Oliver, chief engineer of the Alberta Government power plant, has been sent to Winnipeg to conduct a series of tests with Alberta coal for the purpose of demonstrating to consumers in that province that coal from Alberta will stand the shipping and the climate conditions and will burn well.

Canal Work Handicapped.—Work on the Welland Ship Canal is held up on account of shortage of coal, shortage of Hydro power, and shortage of labor. While there is hope of overcoming the latter difficulty, there is not much hope for overcoming the first two. When work stopped last year there were 2,500 men working on it. There was little chance of the same number being employed this year.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
¼	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel Black	Steel Galv.	Gen. Wrot. Iron Black	Gen. Wrot. Iron Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal	06
Lard Oil, per gal	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	10%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	15
Stove bolts	55
Wrought washers	25
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank ..... add	$1 50
Nuts, square, tapped ..... add	1 75
Nuts, hexagon, blank ..... add	1 75
Nuts, hexagon, tapped ..... add	2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs ..... 40 and	5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals ..... 0 18 to	0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

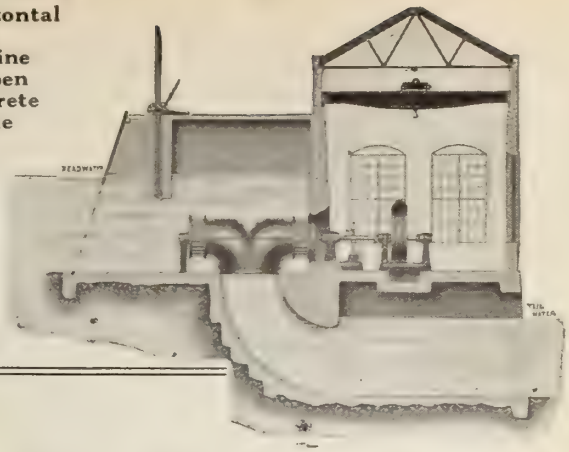
Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Horizontal Twin Turbine in Open Concrete Flume



Water Wheels and Hydraulic Power Plant Equipment

Send for Bulletin No. 54

Hydraulic Turbines
Governors
Head Gate Hoists
Stop Log Winches
Steel Feeder Pipes
Trash Racks
Butterfly Valves
Surge Tanks

William Hamilton Co.,
Limited
PETERBOROUGH, ONT.

COPPER-ALUMINUM-IRON BRONZE AS AN ACID-RESISTING ALLOY

By O. L. Kowalke

Copper-aluminum-iron bronze is known to possess many valuable qualities. In tensile strength it ranks with mild steel. It can be forged while hot, and also rolled into sheets; it can be machined to a nice finish, and sound castings can be made of it, free from shrinkage-holes and blowholes. These among other qualities render the alloy suitable for bearings and gear. But very little has hitherto been known concerning its acid-resisting properties. With a view to acquire knowledge in that direction, a systematic series of tests have been made at the University of Wisconsin laboratories. The results of these tests, which were made with various acids and alkalies, are set out for detailed comparison in three tables. Only two of the bronzes experimented with are reported on; they are distinguished as A and B. Their average compositions and properties were:

	Bronze A	Bronze B
Copper	87.0 %	85.6 %
Aluminium	9.8 %	10.81%
Iron alloy	3.14%	3.57%
Ultimate unit stress	74,800 lb. sq in.	66,600 lb. sq. in.
Reduction in area	19.0 %	13.0 %
Elongation in 2 in.	21.0 %	11.5 %
Specific gravity	7.71%	7.58%

The specimens for the corrosion tests were approximately 1 in. by 0.07 in., and were finished smooth, with square edges. Most of the tests were made at room-temperatures of 72 deg. F. and 85 deg. F., but a few were made at 194 deg. F.

Bronze A was found to be resistant to several acids, particularly to sulphuric, lactic, phosphoric, tartaric, and acetic acids. Nitric acid attacked the metal readily, the concentrated acid acting violently. Hydrochloric acid and ammonia solution both attacked the metal too readily for commercial purposes. Caustic soda had but little effect. In the case of bronze B, a strikingly higher resistance to sulphuric acid is shown. Also ammonia did not corrode it so readily as bronze A. Nitric acid attacked bronze B also too readily; and hydrochloric acid attacked it more readily than bronze A. It is interesting to note that the corrosion, in 35 per cent. sulphuric acid, of a forged specimen of bronze A is only about half that of the rolled-sheet and cast forms.

ELECTRICALLY DRIVEN PUMPS.

At a meeting of the Institution of Water Engineers, held at Birmingham, Mr. C. F. Bekenn, A.M.Inst.C.E., contributed a paper on "The Application of Turbine-pumps to Water Supply." In the course of the paper the author remarked that while turbine-pumps could be driven by any type of prime mover, he placed the electric motor in the first place as regarded efficiency and convenience. The installation costs, including foundations, were low, and the space occupied was small. The pump and motor required very little attention, as the bearings were automatically lubricated with oil-rings. Low installation costs permitted the sets to be conveniently

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

To Buyers' Directory Page 50

distributed. They were easily started up, and could also be operated from a distance or automatically stopped and started, either by varying levels in the reservoir or by varying pressures between pre-determined limits. The alternating-current motor was preferable to the direct-current machine owing to the absence of a commutator, and most of the installations at work were driven by A.C. motors. If a heavy current rush on starting was permissible, it was advisable to install squirrel-cage motors, as the turbine-pump, owing to its low-starting torque, could easily be started up by this type of motor. One point that had to be noted was that the slip between synchronous and asynchronous speeds could not be exactly determined, and might vary as much as 2 to 4%. The B.H.P. required to drive the turbine-pump varied as the cube of the speed, so that should the slip be less by, say, 2% than the makers' original estimate, the B.H.P. would be considerably increased, with a proportionate increase of water. For squirrel-cage motors, auto-transformer starters of the oil-immersed type should be installed, with no-volt and overload release on the three circuits, these operating in the stator circuit. The starter consisted of a transformer with tappings on the windings, of varying percentages of the line voltage. The tappings should be selected as best suitable for the starting torque, and as that was not more than 50% of full load torque, a low percentage, say, 25 or 30%, was sufficient. The automatic features were arranged in the "running" position only, because in the "starting" position they would at once break the circuit owing to the rush of current, which was generally two or three times the ordinary running current. This type of starter required only three terminals on the motor and six on the starter—namely, three for the motor and three for the line. In cases where low starting currents were necessary, slip-ring motors should be installed, as those would start up with 50 per cent. of full load torque using normal running current. With reference to motor terminals, trifurcating boxes were recommended as providing an extremely neat finish and effectively enclosing all the live parts. In large pumping-stations, where the current had to be carried some distance and the motor-power was at least 150B.H.P., the motors could be wound for 6,000 volts, and so dispense with transformers. For motors of less than 150B.H.P. a lower voltage was necessary on account of the difficulties of insulation in the coil windings.

Proceeding to discuss the relative costs of steam and electric pumps, the author gave several examples as showing that economy was on the side of the latter. Thus, the City of Hereford had three electrically driven pumps working off a three-phase, 50-cycle circuit, two sets delivering 60,000 gals. per hour, and the other set deliver n~ 20 000 gals. per hour, against a total lift of 120 ft. in each case. The costs, as recently determined, showed that with electricity at 0.75d. per unit, the cost of electric pumping was 0.5d., as compared with 0.426d. per 100,000 gals., the cost of steam pumping. Those figures included men's wages, lubricating oil, waste, etc. The Newbury District Water Company, early in the year 1912, made careful tests of its compound condensing steam pumps, and of its electric pumps. The latter were driven by direct-current motors, one set having a capacity of 30,000 gals. per hour against 185 ft. lift, one set 20,000 gals. per hour against 150 ft. lift, and a further set 3,000 gals. per hour against 164 ft. The 1912 costs worked out at 1.18d. per 100,000 ft.-gals. for steam, as against 0.957d. for electrically driven pumps, but for 1920 the figures are 2.61d. and 1.576d. respectively. The Chester Waterworks Co. had installed a Diesel engine and dynamo supplying power to drive turbine pumps built by Sulzer and the Rees Roturbo Company, at two separate stations connected by cable. The costs, including all transmission losses and "shut-downs" due to interruption in working consequent on erection of additional plant, came to 0.657d. per 1,000 gals. 100 ft.

You Try This

When you desire any information on matters pertaining to the trade it will be gladly furnished free upon application through the columns of this paper. If you enclose stamped, addressed envelope we will also reply direct to you. Don't hesitate to ask us. We will do our best.

BOILER ROOM FOREMAN WANTED — CAPable of assuming entire charge of operation and maintenance of large steam plant. Must be a man of proven ability and understand the principles of combustion, able to organize his department in such a manner as to obtain efficient and economical operation. Good salary and permanent position to the right man. Reply giving details of previous experience to Box 14920, Power House.

WANTED
One Water-Tube BOILER

New or second-hand—Babcock & Wilcox—400 Horse Power, good for 200 lbs. Must be in first-class condition. Send price and particulars to E. R. Gray, City Engineer, Hamilton, Ont.

Saves Labor—Saves Steam Saves Products Being Spoiled

These are some of the advantages of installing Sarco Temperature Regulators to automatically regulate your temperature conditions.

The action of the Sarco is so positive and dependable that it is being used extensively for some of the most delicate manufacturing processes. Also widely used for controlling the temperature of rooms. Is suitable for operating steam, gas or water valves.

SARCO
Temperature Regulator

is a complete power plant in itself. Requires no air compressors, electricity, water supply or anything else to make it work. Can be installed in 60 minutes without any outlay for materials.

Has no rubber or leather diaphragms or other perishable parts. Costs less than others to start with. Costs nothing for upkeep.

To prove the Sarco's superiority without cost to you, we'll ship one on 30 days' free trial.

When you write, ask for Booklet.

SARCO CO., Inc.

Ellicott Square, Buffalo.
Majestic Bldg., Detroit.
Monadnock Block, Chicago.
Drexel Bldg., Philadelphia.
6523 Euclid Ave., Cleveland.
Peacock Bros., Montreal.

FAIRBANKS-MORSE

FAIRBANKS-MORSE QUALITY F M 100%

Mastering the Waters of the World

Mastering of the waters of the world has been and is an important factor in the advancement of civilization. The Canadian Fairbanks-Morse Co. Limited, claims its share in this advancement.

No matter where you live, or what your business, you are constantly dependent on pumps for the water you drink, for the protection of your home from fire, or the production of the things you use, wear, and eat. And quite likely it is a Fairbanks-Morse pump, for Fairbanks-Morse pumps have long been recognized as standards—dependable pumps, constantly giving maximum service under the most exacting conditions.

The Canadian Fairbanks-Morse engineers know the pumping problems of Canada and, with all the resources and reputation of this national institution behind them, have developed pumps that meet every requirement and meet it with a product that is worthy of being branded "Fairbanks-Morse 100% quality."

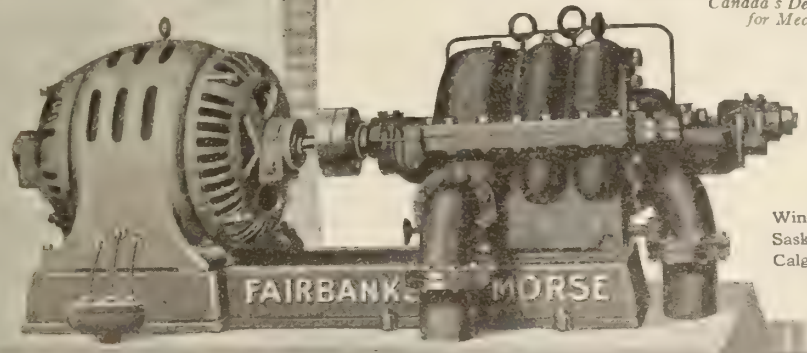
Make this mark your guarantee of satisfaction and our catalogue your buying guide.

The Canadian Fairbanks-Morse Co., Limited

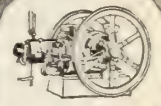
Canada's Departmental House for Mechanical Goods

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, St. Catharines, Windsor, Winnipeg, Saskatoon, Regina, Calgary, Vancouver, Victoria.

15

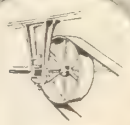


VALVES AND STEAM GOODS


OIL ENGINES

MACHINE TOOLS

PULP AND PAPER MACHINERY


TRANSMISSION

AUTOMOTIVE EQUIPMENT

PUMPS

DYNAMOS AND SUPPLIES

SCALES

MACHINE SHOP SUPPLIES

CONTRACTORS' EQUIPMENT

RAILWAYS SUPPLIES

You guess so; don't you know?

What's the temperature of your exhaust? Does it contain enough heat to be available for drying or any other purpose?

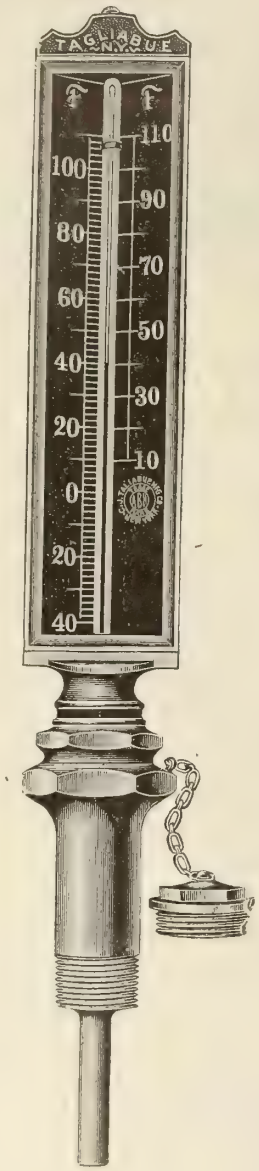
You guess so. Don't you **know?**

A TAG Thermometer on the exhaust pipe will **tell** you.

You may be using live steam when exhaust steam will do. No other kind of waste is more unnecessary or more expensive.

TAG Thermometers can be used in countless ways in the power plant.

Send for Bulletin P-505.

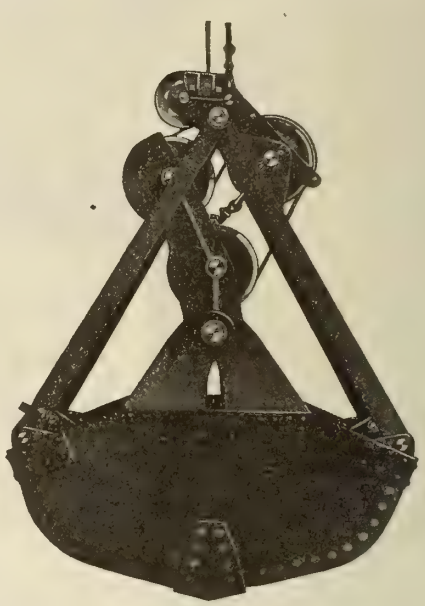


C.J. TAG LIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St. Brooklyn, N.Y.

Trade Mark
Reg. U. S. Pat. Off.

"MEAD-MORRISON"
CANADIAN MM ©
CANADIAN MM ©

Coal Handling Machinery



Coal and Ore Handling Machinery

Manufacturers of

Coal Bridges

up to

1,000,000 tons storage

GRAB BUCKETS
STEAM HOISTS
ELECTRIC HOISTS

AGENTS:
HARVARD TURNBULL, TORONTO
KELLY POWELL, WINNIPEG
ROBERT HAMILTON, VANCOUVER

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT

Republic

CO_2 RECORDER

Is it not a fact that you, Mr. Engineer, have been looking for a CO_2 Recorder that will operate accurately and continuously?

You have not found this because the REPUBLIC has not, until now, been placed on the market.

Can you imagine a CO_2 Recorder with

NO SMALL TUBING, the smallest ¼" internal diameter;

NO GLASS tubing or otherwise;

ONLY TWO MOVING ELEMENTS—one a single unit with no moving parts and the other consisting of a float with Pen Arm on a staff and Pen Retainer?

The whole apparatus actuated by the flow of water and controlled by a syphon system which operates regardless of any change of flow in the water supply, insuring continuous flow of gases from the furnace.

Each charge for analysis is taken from the passing gases. The gas is forced 2 in. into the absorbent solution and must flow 8 in. through the solution before it can rise to the surface, thereby insuring complete absorption of the Carbon Dioxide.

No complication of mixture of fluids, such as Caustic Potash, Oil, Mercury, etc.

The instrument is complete in one case, making it convenient for adjustment, yet the chart may be changed by opening the small door and not disturbing the instrument proper, exposing it to dust, etc.

This instrument is not an experiment, having been in operation without stoppage or attention for three and a half years.

Republic Flow Meters Co.

OF CANADA, LIMITED

145 WELLINGTON WEST TORONTO, ONT.

HINTS TO BUYERS

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

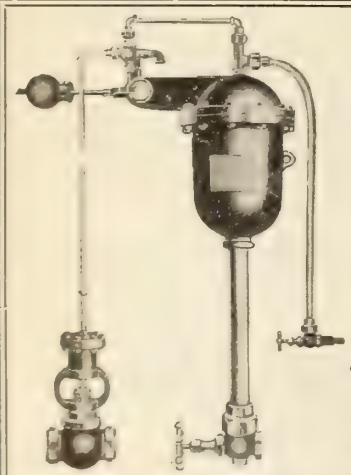
SCANDINAVIA BELTING

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

Tuck's Genuine Packings
Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.
Insist Upon Having the TRADE CAOUTCHOUC TRADE MARK Packing Bearing Our MARK
TUCK & COMPANY, LIMITED
London Liverpool Cardiff, Etc.
Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
Stocks Carried in All Sizes TEL. No. MAIN 2387

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE
THE E.S.MANNY Co
27 COTE ST MONTREAL, QUE



ACT NOW!
You will be safeguarded against boiler explosion due to low water, if you use VIGILANT REGULATORS. They cannot fail to operate and keep the water level where it will enable the boiler to produce the dryest steam at the highest economy figures.
The slow uniform feeding of these regulators means fuel economy because the feed water is then heated uniformly to a higher degree.
Our instructive catalog will tell you more about the reason why the Vigilant will accomplish all that we claim for it, and more. Write.
The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penna.
Also Manufacturers of the Fulton Pump Governor

CRANE MALLEABLE FITTINGS
CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

Largest manufacturers of white metals in the world
Solder
Wire Solder
Ingot Metals
DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings
Lead Wool
Lead Sheets
Lead Traps
and Bends
HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo — **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

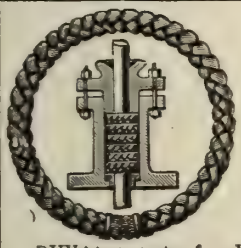
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

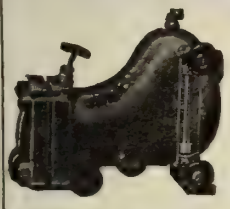
SOLE AGENTS FOR CANADA

LAURIE & LAMB
Board of Trade Building, Montreal

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street - - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.



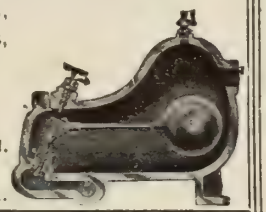
McDANIEL IMPROVED **STEAM TRAP**
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

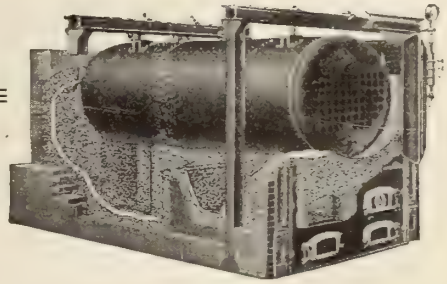
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



For Furnace Linings and Baffles

That are easy to install—air and gas tight, that cannot crack, chip, spawl or peel off—no separate fire brick, no mortar joints and not affected by expansion and contraction use

BETSON'S TRADE MARK PLASTIC FIRE BRICK

a plastic, unbaked fire brick material—made of the best fire clays and refractories—proportioned and mixed to withstand all strain, heat, gas and chemical action to which it may be subjected by the hardest usage. It outwears all other boiler furnace linings.
Write for informing pamphlet.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386,-6, Rome, N.Y.

Canadian Distributor:
INTERNATIONAL CHEMICAL CO.,
44-6 Lombard Street, Toronto, Ontario, Canada
Warehouses in principal cities

MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

G. & J. WEIR

Make Announcement of New Company

We wish to announce that the company of G. & J. Weir (Canada) Limited has been incorporated to take over the business of the Clyde Engineering Company Limited, and will manufacture their complete line of power plant auxiliaries and marine auxiliary machinery.

For this purpose land has been secured and work has been commenced on foundry and machine shops in Montreal. This extension has been found necessary as a result of the increasing demand for the G. & J. Weir products in Canada.

PEACOCK BROTHERS

SALES

(CANADA) LIMITED

Weir Pumps
For Feed and Other Duties

Weir Feed Pump
Weir Service Pump
Weir Twin Compound Feed Pump
Weir Tandem Compound Feed Pump
Weir Hydraulic Pressure Pump
Weir Turbine-Driven Rotary Feed Pumps

In addition to our standard pumps, we have a large variety of designs for special duties. For high duty installations for water or oil, we can supply special patterns, simple, compound or triple, for pumping against pressures up to 1,000 pounds per square inch.

WEIR SERVICE!

With Weir Power Plant Auxiliaries we furnish something which is difficult of definition, something which for want of a better expression we call **Service.**

To offer to our customers the whole resources of our organization—Research, Designing, Manufacturing and Operating—this service is one of the foundation stones of our ideas of business.

After thirty years of concentration on specific lines, it is natural that we should have accumulated a vast amount of specialized knowledge which is of vital assistance in the solving of our customers' power problems. Our experience, our data, and our results we place at their disposal. We may have just the information required. If this is the case the value of Weir Service is at once apparent.

Such is the aim of our organization—to serve our clients efficiently, satisfactorily and to the full extent of our ability.

LIMITED 179 DELORIMIER AVENUE MONTREAL
ENGINEERS

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal

AIR HOSE
Holden Co., Ltd., The, Montreal

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

REGISTERED
COPPUS
U.S.PAT.OFFICE

COPPUS TURBO BLOWERS EFFECT STEADY SAVINGS

In the modern plant of the New York Ice Company, New York City, this 22" COPPUS Turbo Blower has been saving time, money and labor ever since installation in April, 1917. It has **made possible** the use of cheap fuel, and **made sure** the maintenance of constant steam pressure. So satisfactory has been the service of this COPPUS Blower that two more blowers have since been purchased for other plants of the New York Ice Company.

COPPUS Turbo Blowers are cutting down fuel costs and keeping up steam pressures in cold storage and artificial ice plants all over the country. Automatically regulated, self-oiling, quiet-running—COPPUS Turbo Blowers are by far the most efficient means of securing mechanical draft.

Let our engineers tell you just what COPPUS Blowers can save you in your boiler room. Write for Blower Catalog.

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block
Calgary, Alberta

COPPUS TURBO BLOWER

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

Plibrico Jointless Fire Brick can be molded to fit any place in the furnace or setting.

PLIBRICO

Better Than Fire Brick

Jointless Furnace Lining for Industrial Boilers

It can be used for front door arches, side walls, bridge walls and rear arches and wherever fire brick can be used. It is also unexcelled for baffle construction and repairs. Made for hard service and fuel economy.

Easy to Install

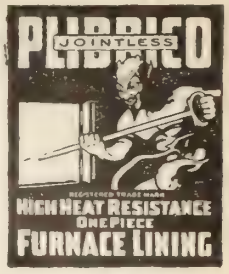
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory: 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto. Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

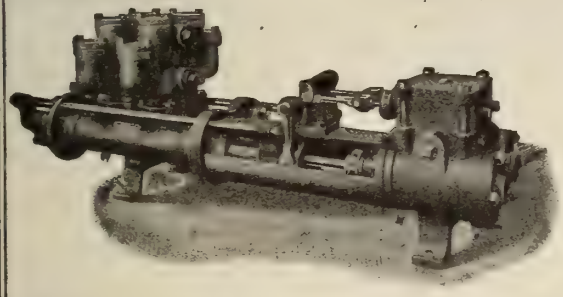
AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.



PUMPS

that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

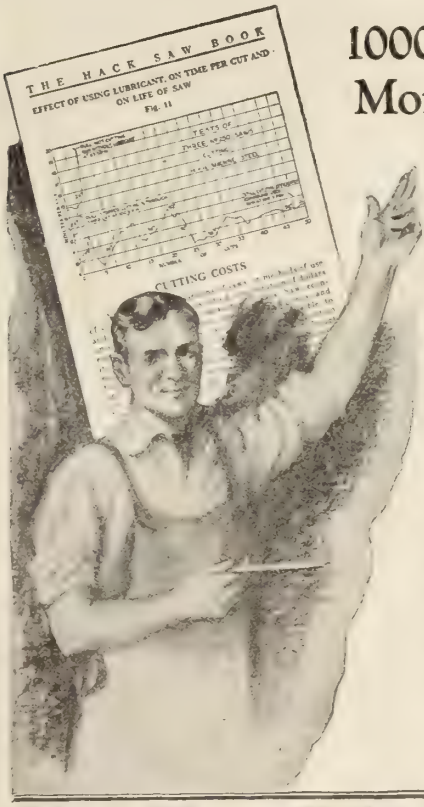
WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL
MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300



1000 Percent More Work

That's what lubricant does for hack saw blades.

Look at the chart above. Three identical blades cutting the same piece of stock. Two of them were run without lubricant—and in each case failed in less than five cuts. The third made over 50 cuts and was still cutting when the test was stopped,—because it was flooded with lubricant.

—That's just one of the charts in "Hack Saws and Their Use". There are more of them in this new Starrett Book, showing the effects of different cutting speeds and weights. There's also the Starrett Hack Saw Chart.

If you use hack saws, you need "Hack Saws and Their Use". Write for a free copy and for Catalog No. 21 "(D)"

THE
L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Mfrs. of Hack Saws Unexcelled
ATHOL, MASS.

2265

Use Starrett Hack Saws

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Phillip & Sons, Toronto, Ont.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

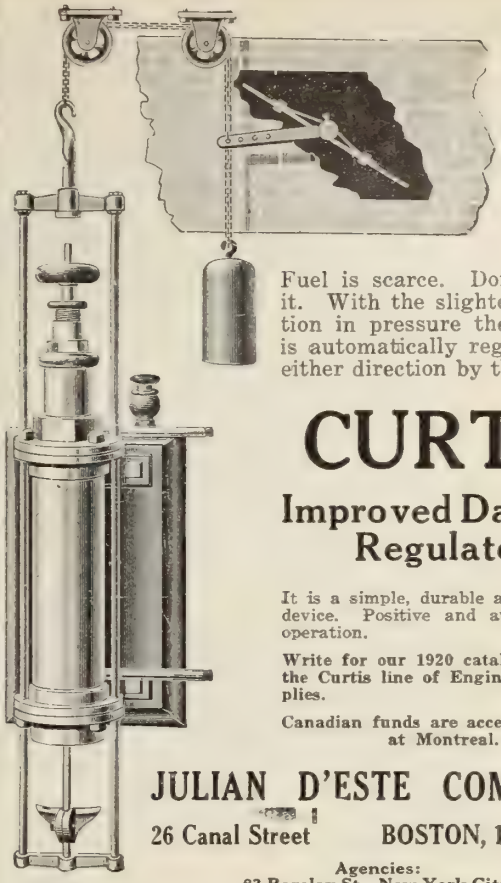
S. & C. BISHOP & CO., St. Helens, Lancashire.

LADD
WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

THE GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN., U.S.A.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS
Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1920 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
26 Canal Street BOSTON, 14, MASS.

Agencies:
83 Barclay St., New York City
174 North Market Street, Chicago, Ill.

HOMESTEAD
Quarter-Turn Valves

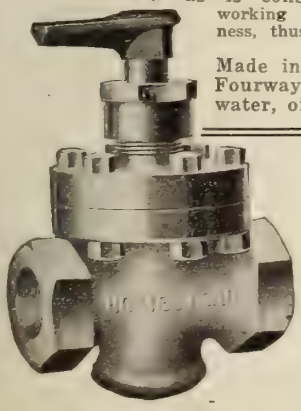
Simplicity is Their Dominant Feature

It is the simplicity of Homestead Quarter-Turn Valves, in operation and in construction which makes them so effective and dependable.

Instead of the six to ten turns of wheel necessary to ordinary globe or gate valves, a quarter-turn only is required to change a Homestead from absolute tightness to a straight, unobstructed flow, or vice versa.

The Homestead is as simple of design as is consistent with efficiency. All working parts are of exceptional thickness, thus ensuring long, reliable service.

Made in Straightway, Threeway and Fourway patterns for air, steam, water, oil and acids.



Homestead Valve Mfg. Company
PITTSBURGH, Pa.
Works: Homestead, Pa.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'
Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman
(SOLE MAKER)
9, Westfield Road Birmingham Eng.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Wilford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lunkenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Power Specialties Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Power, Montreal
Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

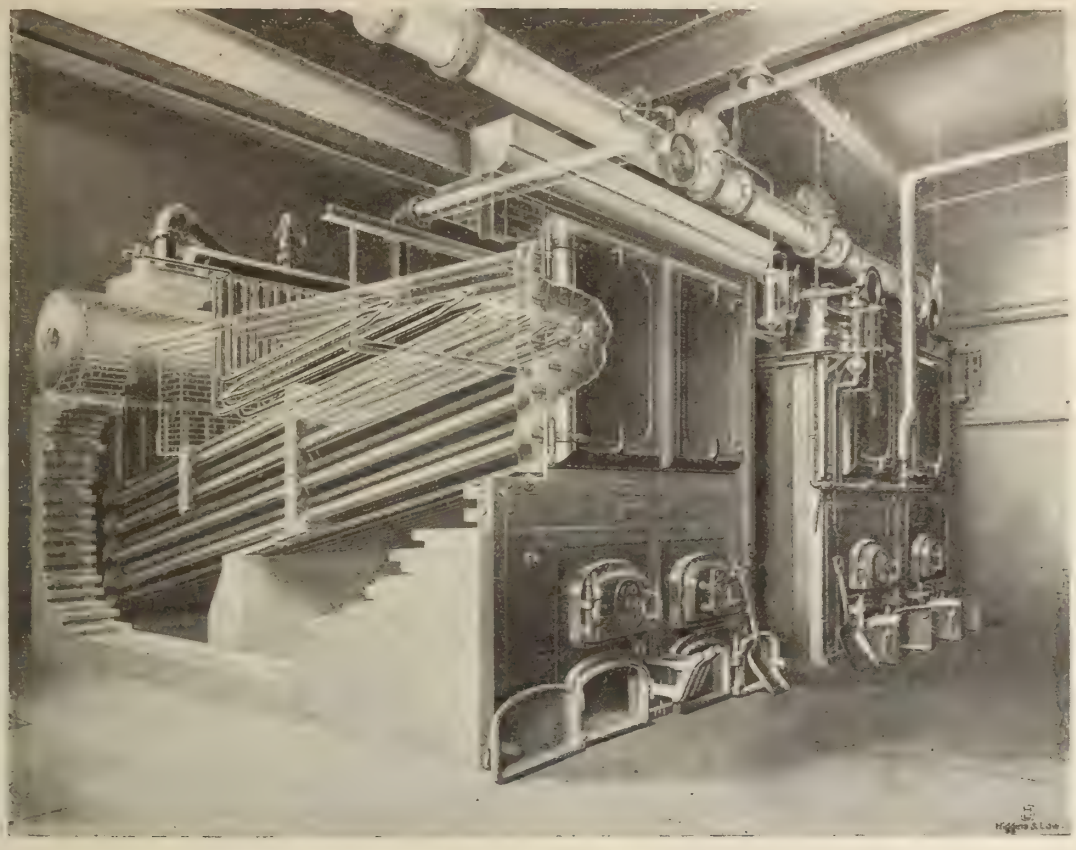
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



Cutting Costs By Saving Fuel

Elesco Superheaters will solve the problem of high fuel cost in your plant.

This saving is possible for you regardless of the product you manufacture, or the type and size steam plant you operate for power.

Fuel is too great an item in your manufacturing costs.

Made in Canada

THE ELESCO SUPERHEATER

applied to meet your operating conditions, will enable you to meet your production schedule on less fuel.

The fuel saving ranges as high as 25 per cent.

It will pay you to outline your fuel problem to our Engineers. They will gladly suggest a practical means by which you can cut the cost of operating your power plant.

Write for Bulletins.

The Superheater Company, Limited

Transportation Building, MONTREAL *Works at Sherbrooke, Que.*

Designers and Manufacturers of Superheaters and Pipe Coils for all purposes

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Pitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng. Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

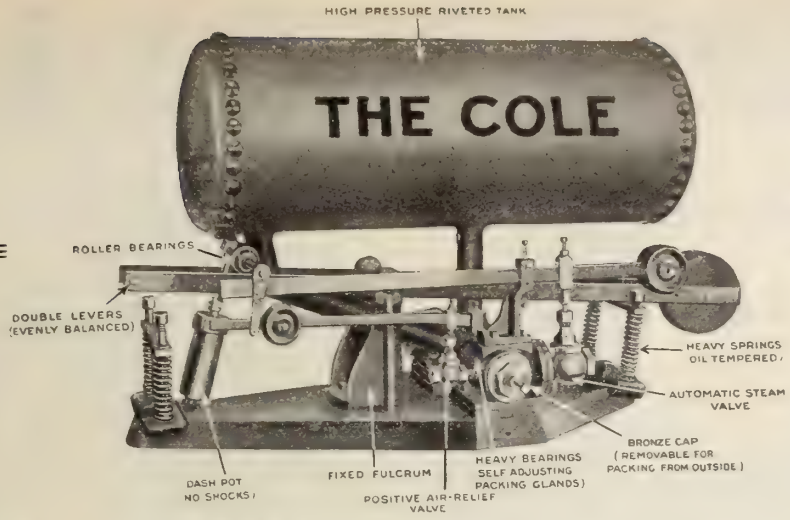
TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.



Several Reasons Why "The Cole" Is Superior

By the installation of a COLE Return Trap system in your plant, you not alone get superior machines, but you get the best engineering service.

Do not leave it until too late. Consult us on how to decrease your fuel consumption and increase your circulation.

Our new catalogue is just off the press. Write for your copy.

GEO. W. COLE LIMITED

2002-4 Dundas St. W.

Montreal **Winnipeg** **TORONTO** **Vancouver** **New Glasgow**

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilsen Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

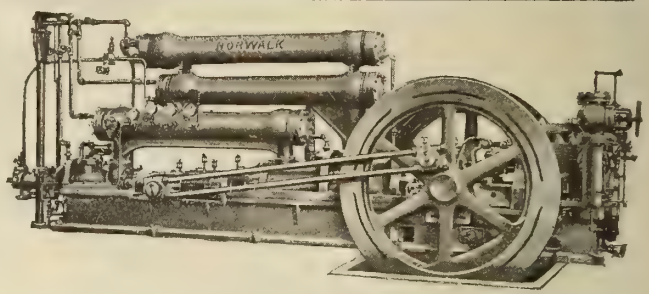
WRENCHES, PIPE
Williams Machinery Co., A. E., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

NORWALK
AIR & GAS · COMPRESSORS

Experience

We feel justified in emphasizing repeatedly the great value to you of the experience behind Norwalk air and gas compressors. When an organization has consistently satisfied its markets, at home and abroad, for forty years it must possess the stability and engineering thoroughness which you are anxious to have placed behind your compressor investment.



24-in. Stroke Large Four Stage Single Steam Cylinder-Driven Air Compressor.

Norwalk compressors for air, oxygen, hydrogen, acetylene and carbonic acid gas are described in a series of illustrated bulletins. Write for one or all.

The Norwalk Iron Works Company

Pioneer Builders of Compressors

South Norwalk — Conn.

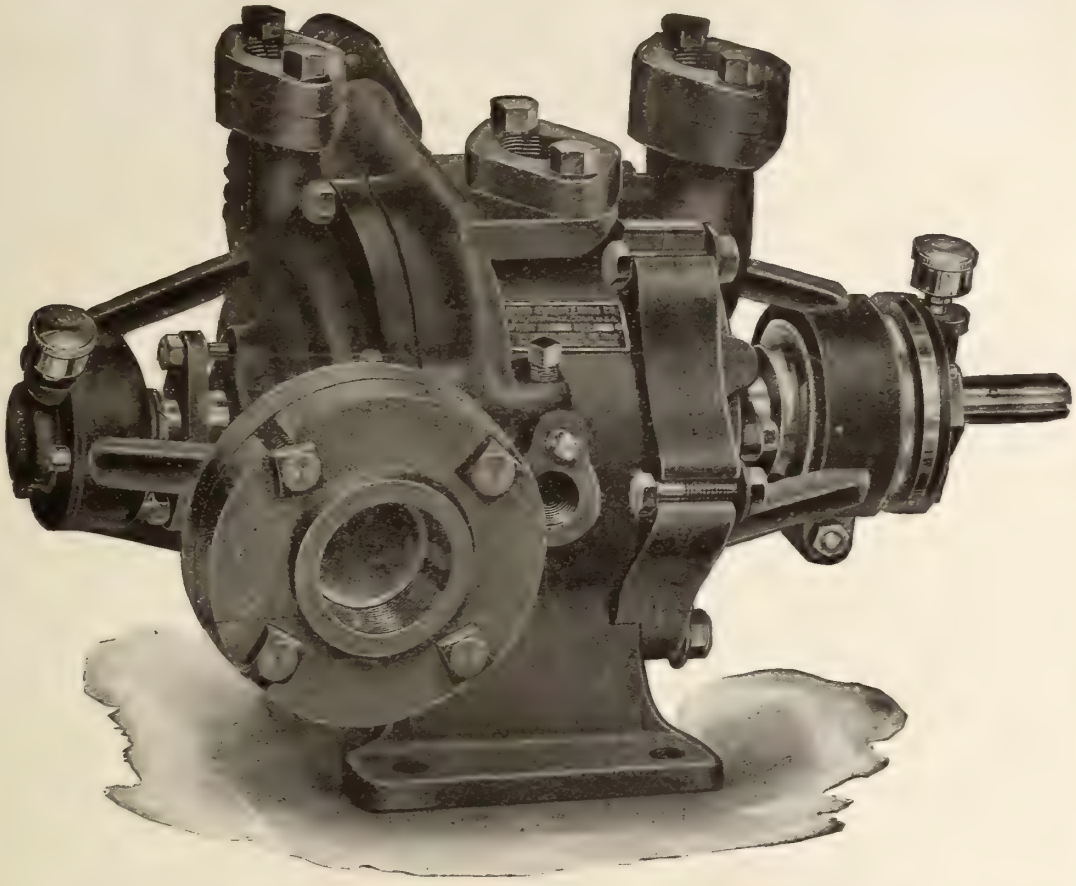
A. S. Leitch Company, Toronto, Canadian Sales Representatives

ANY·CAPACITY ANY·PRESSURE

INDEX TO ADVERTISERS

Anderson, The V. D. 13
Holden Co., Ltd., The 2
Badger & Sons Co., E. B. 6
Betson Plastic Fire Brick Co. 51
Bishop & Co., S. C. 59
Brown, Wm. J. 50
Busch-Sulzer Bros.—Diesel Engine Works 57
Can. Fairbanks-Morse Co. 47
Can. Mead-Morrison Co. 48
Can. Link Belt Co., Ltd. 8
Chaplin-Fulton Manufacturing Co. 50
Cole, Limited, Geo. W. 63
Coppus Eng. and Equipment Co. .. 55
Crane, Limited 50
Darling Bros. 50
Dart Union Company. 15
Department of Labor 51
D'Este Company, Julian 59
Dominion Belting Company 12
Durabla Manufacturing Co. 11
Electric Welding Co., The 57
Federal Engineering Co. 50
Gates, W. W. 4
Gilman, Frank 59
Goldie & McCulloch Co. 22
Green's Economizer, Ltd. 7
Hamilton, Wm. Co., Ltd. 45
Homestead Valve Manufacturing Co. 59
Hoyt Metal Company 50
Imperial Oil Company 3
Jeffrey Manufacturing Co. 5
Jenkins Bros., Ltd. 10
Jointless Fire Brick Co. 57
Ladd Co., The George T. 59
Laurie & Lamb 51
Leitch Co., The Arthur S. ..... Inside back cover
Leonard & Sons, E. ..Inside front cover
Lunkenheimer Company 29
Manny Co., The E. S. .... 45 and 50
Mason Regulator and Engr. Co. 16
McLaren, D. K. 14
Ministry of Munitions 9
Moore Steam Turbine Co. 12
Morrison Brass Manufacturing Co., Jas. ....Outside back cover
Murphy Iron Works 13
Norwalk Iron Works Company.... 64
Page-Hersey Iron, Tube and Lead Co. 15
Penberthy Injector Co., Ltd. Front cover
Peacock Bros., Limited 52-53
Pilley Packing and Flue Brush Mfg. Co. 51
Republic Flow Meters of Canada, Limited 49
Robb Engineering Works 7
Sanford-Riley Stoker Company ... 13
Sarco Company, Inc. 46
Scaife, Wm. B., & Sons Co. 64
Shell-Bar Boico Supply, Ltd. 6
Smart-Turner Mach. Co. 57
Starrett Co., L. S. 57
Steel Mill Packing Company 6
Sterling Engine Company 4
Superheater Co., Ltd., The 61
Tagliabue Company, C. J. 48
Taylor Instrument Company 45
Tuck & Company, Ltd. 50
Underfeed Stoker Co., of Canada Ltd., The 17, 18, 19, 20
Victoria Foundry Company 50
Wall, J. W. 51
Watson & McDaniel Co. 51
G. & J. Weir, Ltd. 52, 53
Williams Co., J. H. 1
Worthington Pump and Mach. Co. 1
York Manufacturing Company ... 11

WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.



JENNINGS TURBINE VACUUM AND LOW PRESSURE BOILER FEED PUMP

The distinct advance in principle and design of the Jennings over all other types is the result of many years' experience in the building of turbine vacuum pumps. For return line heating systems, dryer exhaust systems in paper mills, or other vacuum work where large percentages of liquids have to be handled with gas, the Jennings is without equal.

The horsepower required to operate this pump is less than half that consumed by any other vacuum heating pump of the same capacity. The Jennings has two independent turbine units, an air pump and a water pump, combined in one casting, with the impeller of each mounted on the same shaft.

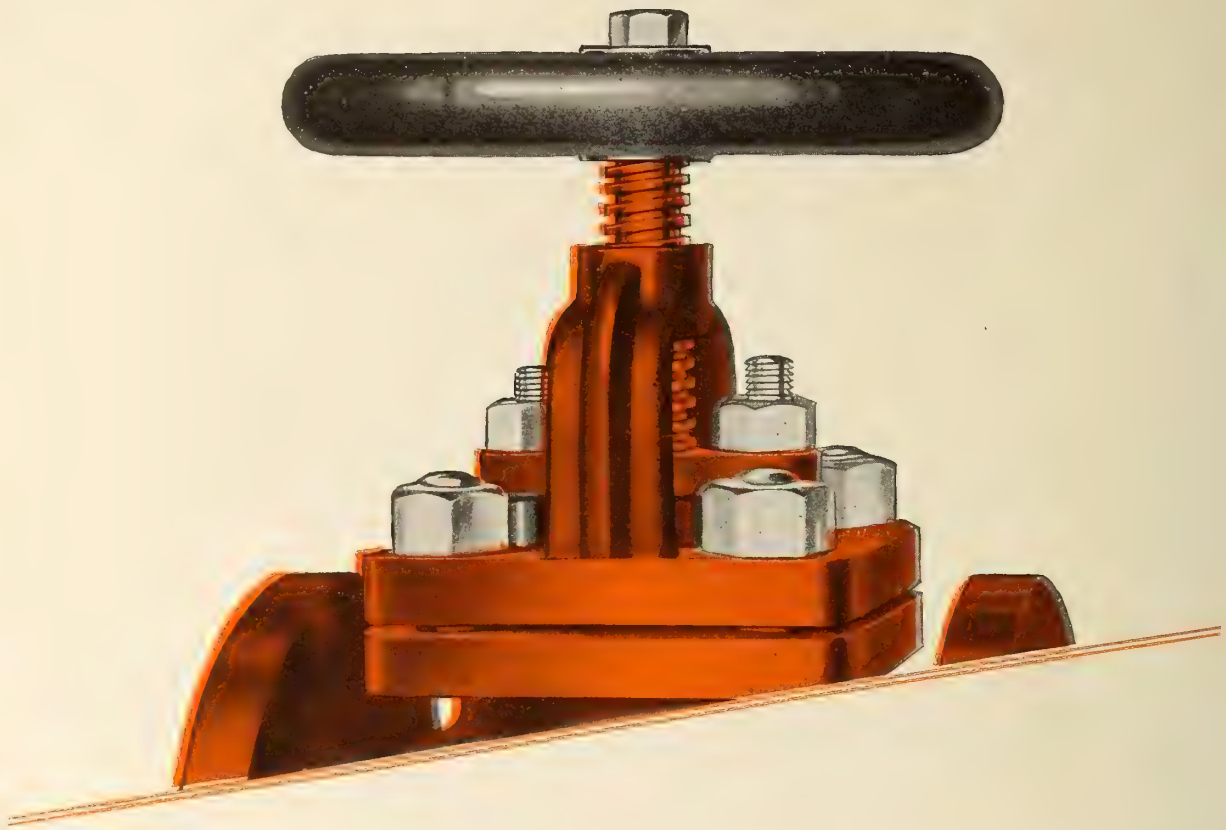
We shall be glad to tell you more about the many distinct features of this pump. Write for full information.

THE ARTHUR S. LEITCH CO

1001-2 Kent Bldg., Toronto, Ont.

MORRISON

STEAM SPECIALTIES



"Every Installation is a Demonstration of Merit"

Four aces is a mighty good poker hand—but a straight flush is better. The Steam Specialties you are now using may be likened to the four aces. They look good until subjected to comparison. Morrison Steam Specialties are as the straight flush—invariably winners.

The **James Morrison Brass Mfg. Company Ltd.**

93-97 Adelaide St. W. TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 1103 Union Trust Building

Vol. XIII. No. 19. Publication Office, Toronto, October 5, 1920 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Service—

That one word furnishes the secret of the world-wide popularity of Jenkins Valves.

The genuine Jenkins Valve—with the well-known Diamond Trade Mark cast on body—is made to furnish efficient, lasting service under the most trying conditions of usage. The occasional bit of extra pressure which works havoc with inferior valves will not affect the genuine Jenkins because it is made to withstand strains in excess of that which it will be called upon to endure in actual operation.

And the Jenkins line is complete—a valve for every purpose.

Write for free copy of Catalog No. 8. It describes the entire Jenkins line in detail.

Jenkins Bros.
LIMITED

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO *European Branch* VANCOUVER

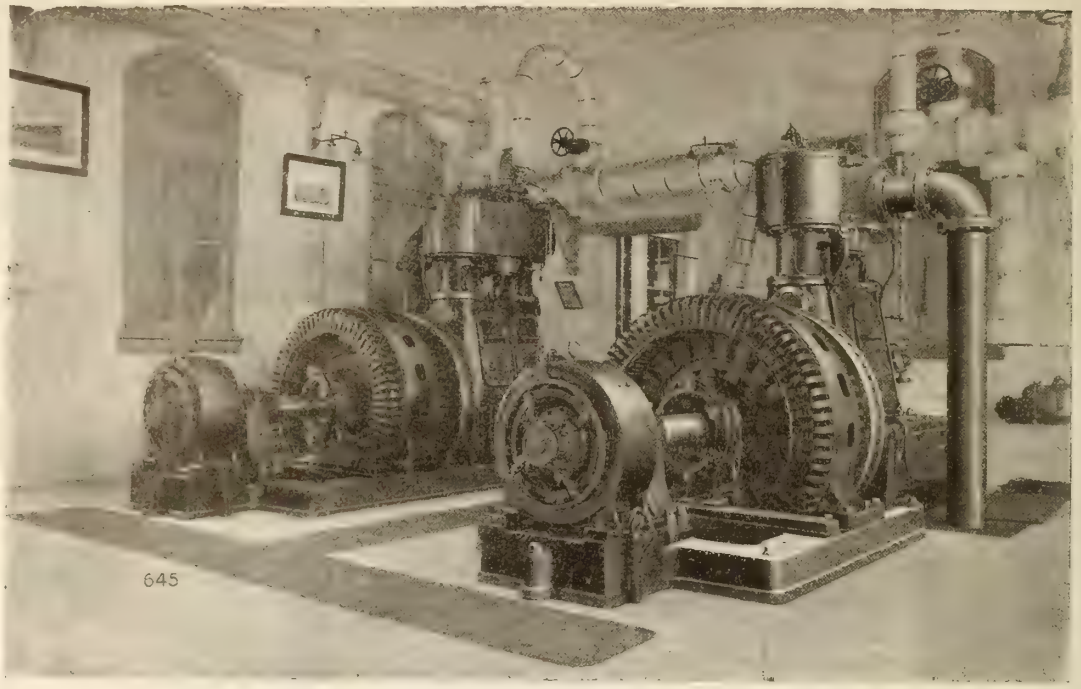
6 Great Queen St., Kingsway, London, W.C.2. Eng.

AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

TRADE JENKINS MARK Jenkins Bros

BELLISS & MORCOM

High Speed Engines



Belliss & Morcom Engines at the City of Verdun, P.Q., Waterworks.

Equipment Bearing an Established Reputation

To the buyer of Power Plant Equipment its reputation should be of first concern. It is of far more consequence than any written guarantee.

The reputation of Belliss and Morcom Engines for long, reliable Service has placed them in many of Canada's largest power plants. They are the invariable choice of Engineers and men who know. When you're in the market do not fail to consider the Belliss & Morcom line.

We would be glad to forward you a list of names of power plants having Belliss & Morcom installations so that you may have an opportunity to investigate their reputation in actual service. Write to-day.

Everything for the Power Plant

Steam Engines
Gas Engines
Oil Engines
Diesel Engines
Steam Turbines

Air Compressors
Condensing Plants
Centrifugal Pumps
Boiler Feed Pumps
Pressure Filters

Gravity Filters
Water Softening Plants
Refuse Destructors

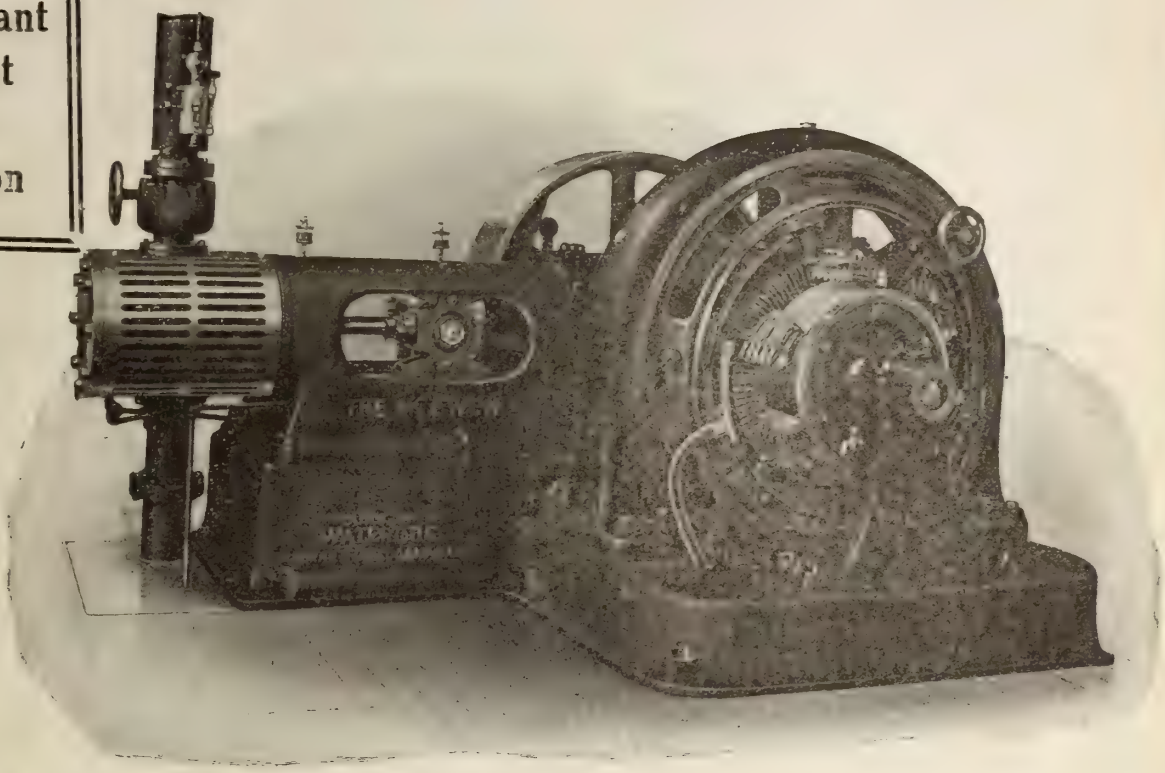
Enquiries Promptly Answered

LAURIE & LAMB

ENGINEERS

211 Board of Trade Building MONTREAL, Que.

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

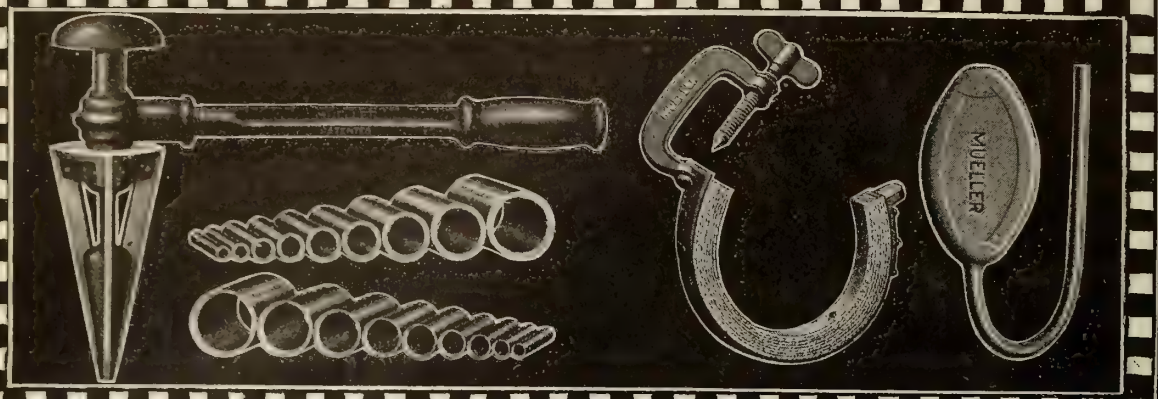
Your careful investigation of their actual service performance record in all parts of the country specially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

Waterous

BRANTFORD, ONTARIO, CANADA

POWER HOUSE, October 5, 1920. Vol. XIII., No. 19. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Mueller Tools for Gas and Water Works

When you find the name *MUELLER* on any tool, it means that no better tool has yet been made for that particular need.

MUELLER Pipe End Reamers (A 3201), Pipe Jointers (A 3166), Gas Main Bags (A 3162), Seamless Steel Ladles (A 3163), Steel Melting Pots (A 3171), Lead Melting Furnaces (A 3150), are but a few of the *MUELLER* Standard Tools—all of which are illustrated and described in *MUELLER* Catalog A, which will be sent on request to any interested Company.

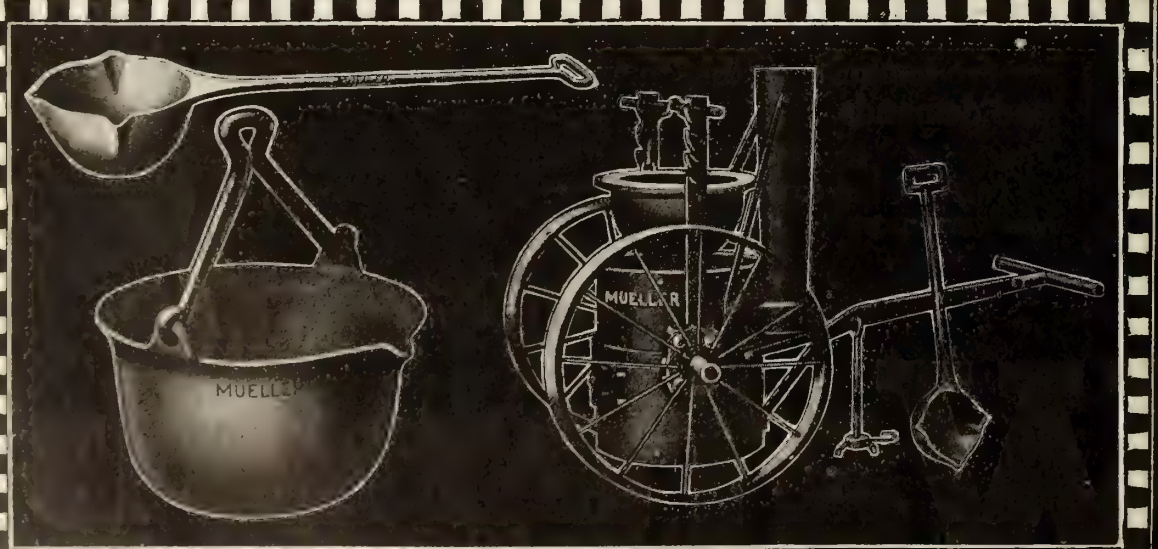
Mail orders given immediate attention. It is advisable to place orders early.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

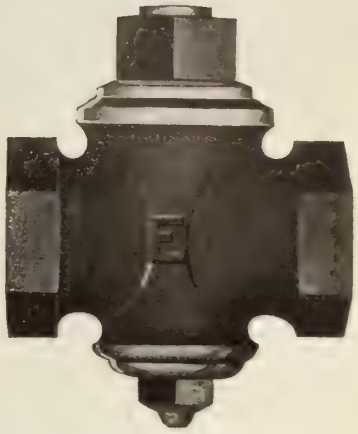
Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Illinois, U.S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.



A Vital Part of Any Steam System —A Place for "Empire" Stop Cocks



A-810

The stop cock may be the weak point in your steam system; bolster it up by installing Empire Steam Stop Cocks. They are always dependable and durable, and our rigid factory tests and guarantee fully protect the engineers who recommend their use. They stand for service.

"If it's an EMPIRE product you know it's right."

When buying, specify our lines. They are carried in stock by the larger and more progressive jobbers in Canada.

Empire Brass Manufacturing Co.
Limited

London and Toronto

Canada

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

Theoretically a shaft rests in the bearing upon a thin film of oil or "floats" upon it, and as long as this condition prevails, the true intrinsic value of a babbitt is masked to a considerable extent; and under moderate speeds and loads a babbitt of most ordinary quality will keep going, but the use of such metals involves a greater degree of wastefulness in power, oil, wear, metal, etc., and they are always on the verge of trouble.

It is most important, therefore, to select lubricants of the proper gravity and viscosity to correspond to the size, load and speed of bearings and that will follow quickly the rotation of shaft and thereby always interpose an oil film; the oil grooves must also be cut to facilitate the flow of oil in the direction of rotation. Metallic contact between the shaft and bearings will invariably cause quick heating, and result in seizing and scoring with most metals. It is under just such crucial conditions that Magnolia Metal proves its real intrinsic worth because of its self-lubricating quality.

A white metal alloy of any composition will become too soft to support the load if its temperature reaches around 300° Fahrenheit; and the lower its fusibility, the more susceptible it is to the influence of heat and no degree of hardness will protect it, as we shall undertake to show later.

"White Brass"—a tin-zinc mixture—is affected in the same way, under the same heat conditions, only it loses all cohesion and crumbles into small pieces and also has a tendency to seize. These serious faults have limited its use to bearings not likely to heat or that can be cooled by the application of water. It shows desirable qualities when in a cool state, but is most disappointing in actual service and drosses heavily.

(Continued Next Month)

For copy of complete article:
"New Truths and Old Fallacies"
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

Office and Factory:
Montreal : 225 St. Ambroise St.

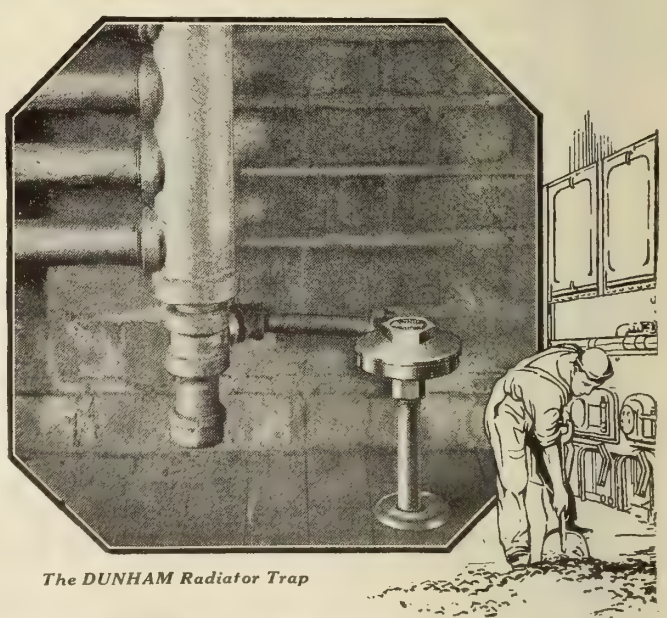
IT SAVES

even where steam is plentiful

Waste is waste wherever you find it. Even where coal is mined, it is poor economy to be prodigal with fuel. By the same sign, even where steam is plentiful, it is a waste of fuel to waste the steam.

If, for instance, each radiator can be heated to 100% efficiency at lower steam pressure, and at the same time not let any steam into the return line, then considerably less fuel is needed. You will not need jet water on a Dunhamized vacuum heating system.

The Dunham Radiator Trap has some very interesting fuel-saving records to its credit—to say nothing of its ability to keep radiators hot all over. May we send you the facts?



The DUNHAM Radiator Trap

The DUNHAM HEATING SERVICE

Made in Canada.

C. A. DUNHAM COMPANY, Ltd.
TORONTO, ONTARIO
Halifax Ottawa Vancouver Montreal Winnipeg Calgary
London : 64 Regent House, Regent Street, W. 1

TRADE
PENBERTHY
MARK.

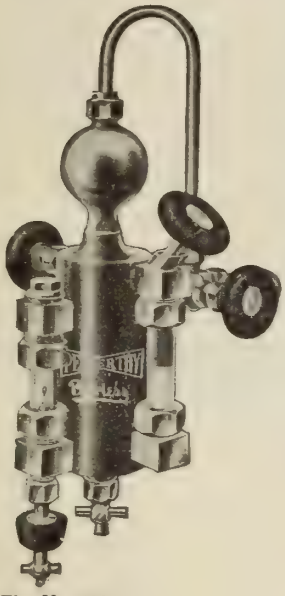


Fig. No. 419
Single Connection

Peerless

SIGHT FEED LUBRICATORS

STRICTLY
HIGH GRADE

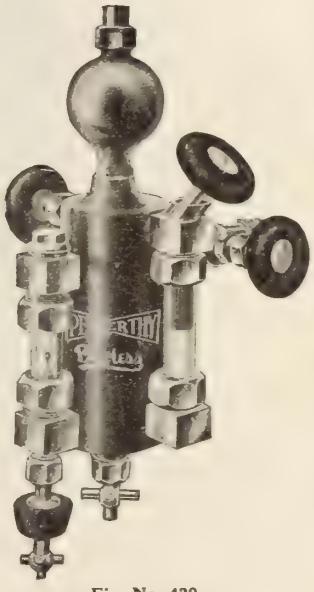


Fig. No. 420
Double Connection

ARE YOU THE ENGINEER OF AN EXPENSIVE POWER PLANT?

IF YOU ARE, THIS IS THE LUBRICATOR YOU SHOULD EQUIP YOUR ENGINES AND PUMPS WITH.

THEY EMBODY THE NEWEST AND BEST FEATURES IN LUBRICATOR CONSTRUCTION AND ARE SPECIALLY DESIGNED FOR HIGH-CLASS ENGINE ROOMS.

STOCKED BY LEADING MILL SUPPLY HOUSES.

MADE - IN - CANADA

SEND FOR DESCRIPTIVE CIRCULAR

Manufactured by

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

What is your Equipment Doing?

The Weston Model 310 Portable Wattmeter is the ideal instrument for checking switchboard models or to accurately measure the load of any particular circuits.

This instrument and the kindred models — 370 Ammeter and 341 Voltmeter—are suitable for use on either A.C. or D.C. circuits. The accuracy of this group is within ¼ of 1 per cent. of full scale value on D.C. circuits and on A.C. circuits with any frequency up to 133 cycles in any wave form.

Write our nearest house for further information and recommendations on these or any other Weston instruments.

Northern Electric Company
LIMITED

Montreal Quebec Toronto Winnipeg Calgary Vancouver
Halifax Ottawa London Regina Edmonton

Snow-covered for hundreds of feet—*Superheat all the way*

THIS outdoor superheat line is covered with 1½ inch thick Asbesto-Sponge Felted Sectional Insulation, wired on, without canvas, over which are three layers of ½ inch thick Arctic Brand Keystone Hair Insulator, with an outer Johns-Manville weather-proof roofing jacket bound on with independent strands of copper wire.

The remarkable heat-saving quality of Johns-Manville Insulation is clearly apparent when the loss of heat is so slight that snow rests on it, and the steam retains its superheat all the way.

This is but one of the many special insulation problems that Johns-Manville has solved in twenty-five years of experience.

Send to our nearest branch for information about the Johns-Manville Line of Asbestos and Magnesia, Pipe and Boiler Insulations.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto	Montreal	Winnipeg	Vancouver
London	Hamilton	Ottawa	Windsor

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

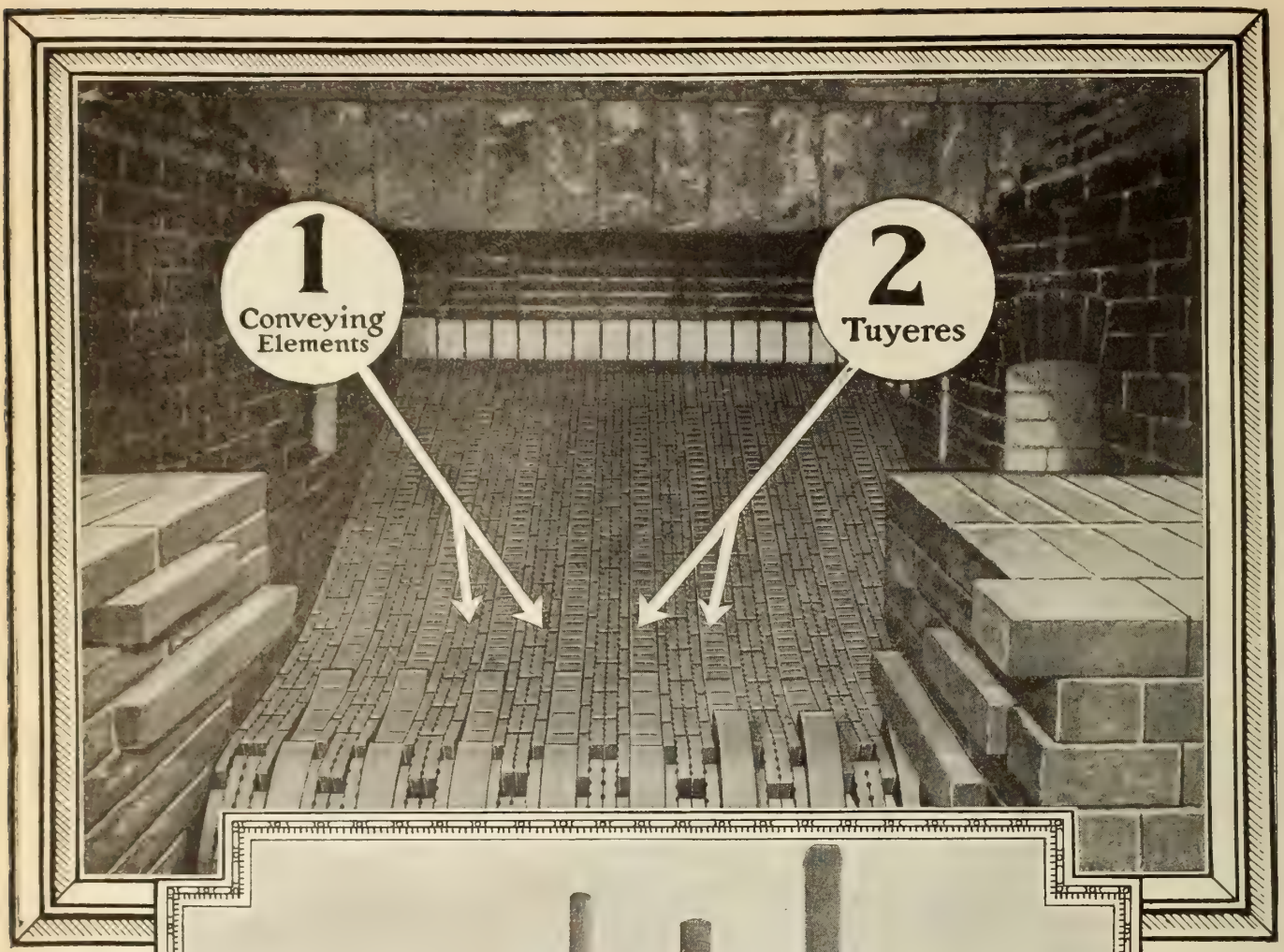
and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE

POWER PLANT MATERIALS



Central Illinois Light Co., Peoria, Ill.

LACLEDE

A BUSINESS INSTITUTION

THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor-feed, positive in action from coal-hopper to ash-pit.

Why the Central Illinois Light Co. Purchased the Stowe Stoker

Mr. George Daniels, Mechanical Engineer of the Central Illinois Light Co., Peoria, Ill., who recently purchased a single Stowe Stoker for use in connection with a 1200 H. P. boiler to be operated at 300% of rating, makes the following comment in connection with their selection of mechanical stoker equipment:

"From our experience with various types of automatic stokers, we are convinced that as to the matter of feed, the conveyor feed is the only one to consider where positiveness in action and the automatic translation and discharge of the fuel and its resulting ash are considered. What appeals to us most in the Stowe Stoker is the fact that Laclede-Christy have combined with the Conveyor Feeding a system of Stationary Tuyeres that allows them to graduate the air spaces and the air supply so that each stage of combustion receives a varying amount of air in proportion to its needs."

See Reference 1

See Reference 2

We also manufacture the L-C Chain Grate Stoker — the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices: CHICAGO, 1366 Peoples Gas Bldg. PITTSBURGH, 901 Oliver Bldg. NEW YORK, 504, Fifty E. 42nd St.

Agents:

PHILADELPHIA, PA.
A. C. Warner Co.,
Bulletin Bldg.

KANSAS CITY, MO.
Thermal Efficiency Co.,
1210 Scarritt Bldg.

CHARLOTTE, N. C.
J. R. Purser,
406 Com. Bank Bldg.

BOSTON, MASS.
Eastern Service Co.,
131 State St.

DENVER, COLO.
Schwarz Eng. Co.,
310 Mack Bldg.

WINNIPEG, CAN
Wm. A. Goold,
701 Merch. Bank Bldg.

MONTREAL, CAN.
John C. Russell,
109 Place D'Youville.

D134

CHRISTY

FOUNDED 1844 ST. LOUIS

LINDE

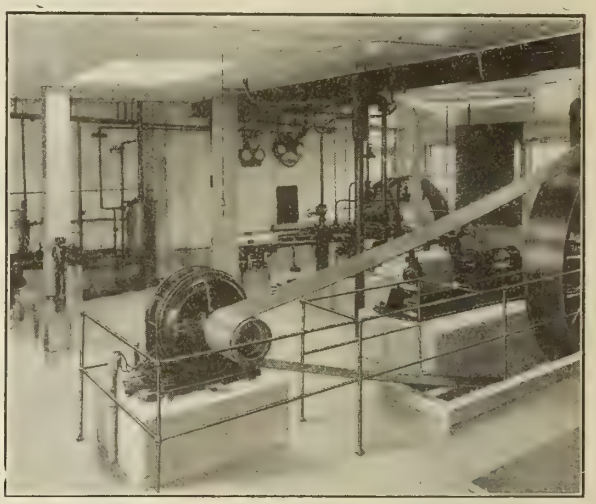
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating **Machinery**

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

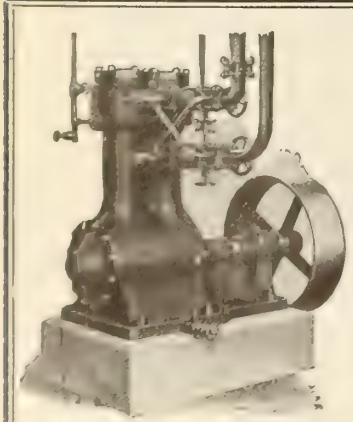


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

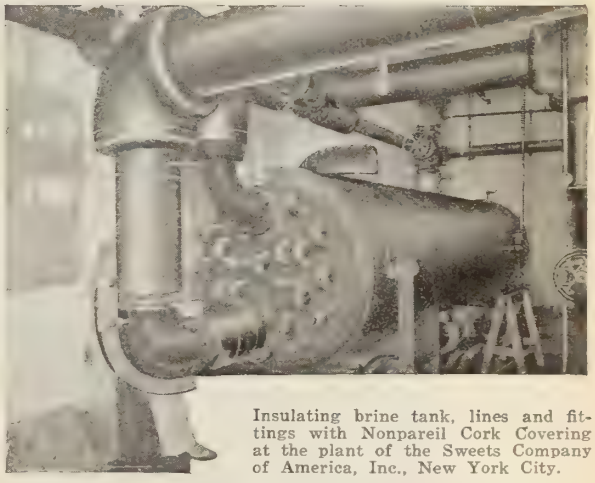
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Who "Pockets" the Loss?

BARE brine and ammonia lines are wasters of money—destroyers of profits, yet in many plants the loss from bare and improperly covered cold lines goes on year after year.

Figuring refrigeration at 75 cents a ton, 120 feet of bare 3-inch pipe carrying brine at 15 degrees F. through a room at 90 degrees F., wastes one ton of refrigeration every 24 hours. Owners of uninsulated equipment are, therefore, "pocketing" a considerable loss, 80% of which can be saved by the use of Nonpareil Cork Covering.

The superiority of Nonpareil Cork Covering for reducing waste of refrigeration from bare pipes, tanks, and other cold surfaces is due to the material of which it is made—clean granulated cork. Being cellular in structure, not fibrous, cork is not only a remarkable insulator, but it does not absorb moisture by capillary attraction, become water-soaked and lose its insulating efficiency. Hence, the recognized supremacy of Nonpareil Cork Covering.



Insulating brine tank, lines and fittings with Nonpareil Cork Covering at the plant of the Sweets Company of America, Inc., New York City.

Send for the 64-page book, "Nonpareil Cork Covering for Cold Pipes," and read the evidence by which the superiority of Nonpareil Cork Covering is established.

ARMSTRONG CORK & INSULATION COMPANY, 504 McGILL BUILDING, MONTREAL, QUEBEC, CANADA

Also manufacturers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for b settings; Nonpareil Cork Machinery Isolation for deadening the noise of machines; and Circle "A" Cork Brick for cold storage room floors.

Nonpareil Cork Covering

For Brine and Ammonia Lines

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

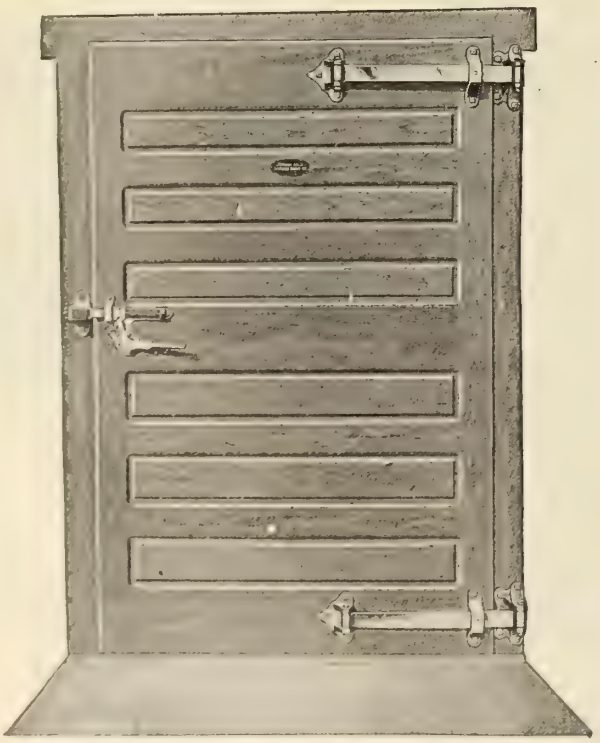
The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative:

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.
CALGARY: 605 Second Street



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

Sectional View Economy Ferrule Type Fuse and Economy "Drop Out" Renewal Link

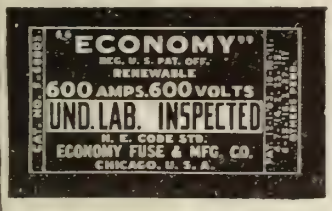
ECONOMY *renewable* FUSES

Sectional View
Economy Knife Blade Fuse

Consider the Fuses in Your Plant

Proper protection of lives, property and machinery in all industrial plants using electrical energy depends upon the accurate functioning of fuses used.

Economy Fuses are absolutely accurately rated. They operate unfailingly when overloads, short-circuits and lightning discharges cause hazards to lives, apparatus and property.



Nothing is destroyed but the inexpensive strip of fusible metal — quickly and easily replaced by a new Economy "Drop Out" Renewal Link.

This feature cuts annual fuse maintenance costs 80% as compared to use of one-time fuses.

Avoid production delays; it requires but a minute to restore a "blown" Economy Renewable Fuse to its original efficiency.

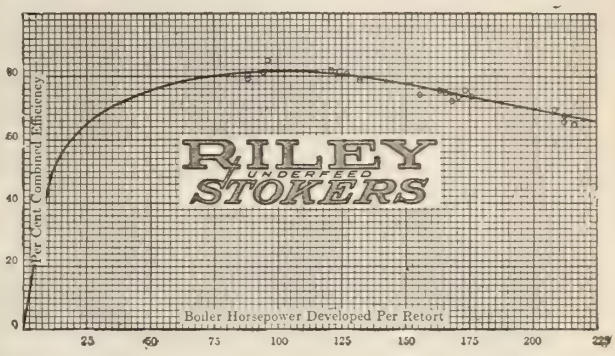
Instruct your electrician to install Economy Renewable Fuses at once.

For sale by all leading electrical jobbers and dealers.

Economy Fuse & Mfg. Co. of Canada, Ltd.
Unity Bldg., Montreal, Canada

Economy Fuses were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be approved in all capacities by the Underwriters' Laboratories.

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

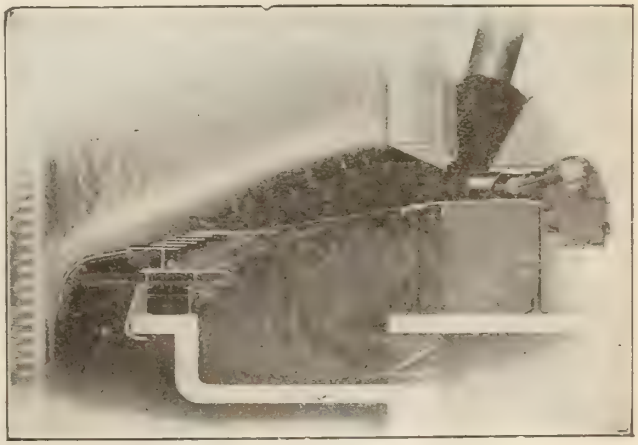
The first year after installing Riley Stokers, the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

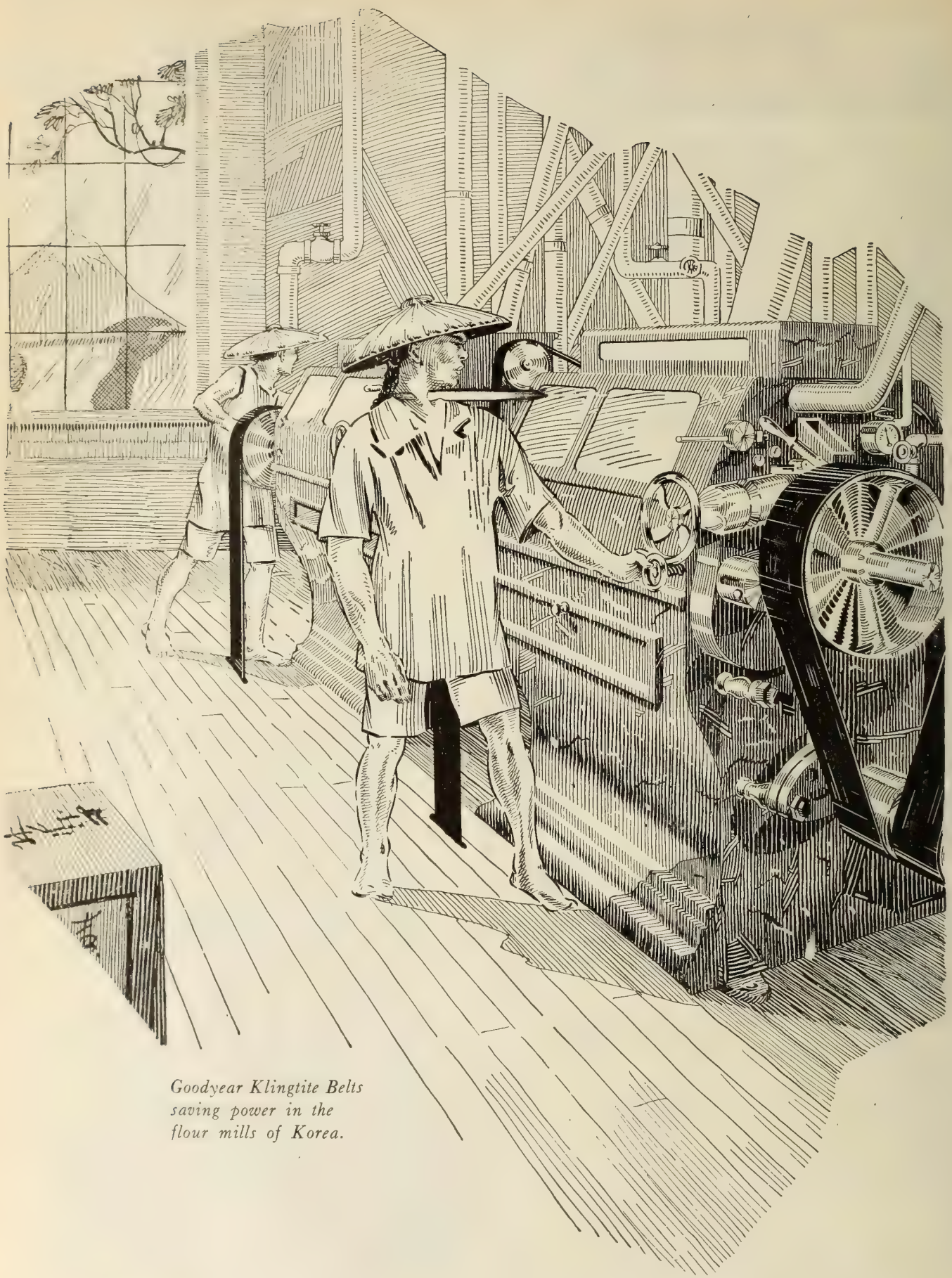
Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

Catalog HR-10 sent on request.

For information on Murphy Automatic Furnaces for small boilers, see Sept. 20 advertisement, or send for Murphy Furnace Catalog H M-10.

Sanford Riley Stoker Co.
Worcester, Mass.





Goodyear Klingtite Belts saving power in the flour mills of Korea.

World-Wide Acceptance of Goodyear Belts

THERE is a world-wide acceptance of the Goodyear Belting which dominates in Canadian industry.

This direct endorsement of the Goodyear principles of manufacture and application gives us no little pride. It means that the technical men of the world see eye to eye with Canadians in the matter of economical and satisfactory power transmission.

But it means much more to Canadian industry. It means a world-wide fund of data for the Goodyear men who advise with you on belting problems. It means that the cotton spinners of Lancashire, the silk manufacturers of Lyons, the steel plants of Sweden, the shipyards of Seattle, the flour mills of the far East—all will contribute their experience to help solve power problems in Canada.

In order to meet world-wide market conditions it has been necessary to change some of the familiar Goodyear brand names—but the change is in name only.

For example, Goodyear Extra Power Belt is now Goodyear Klingtite Belt, and when the Goodyear belting man specifies Goodyear Klingtite for a certain drive you are getting the old Extra Power in every particular.

Ask any Goodyear branch to send a man who is making transmission problems his special study. No obligation. Phone, wire or write.

The Goodyear Tire & Rubber Co. of Canada, Limited

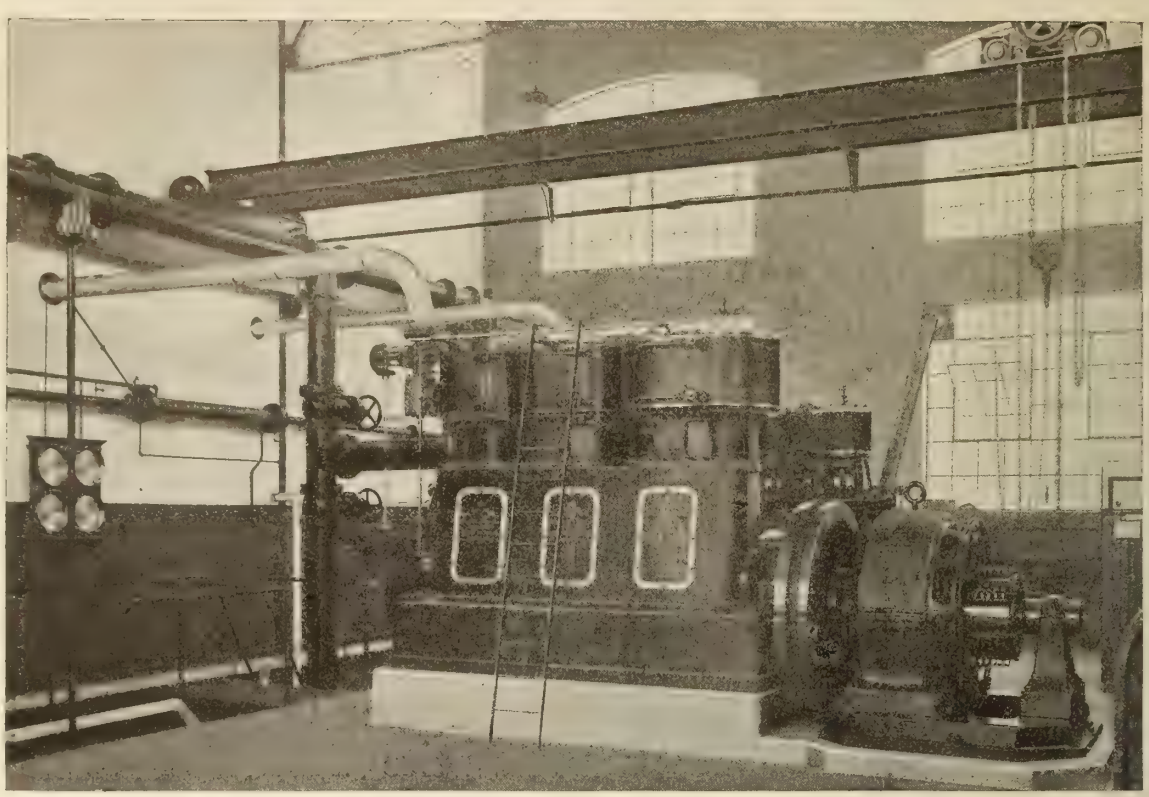
Branches: Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in other cities.

GOODYEAR BELTS

MADE IN CANADA

KLINGTITE GLIDE BLUE-STREAK

DEPENDABLE POWER EQUIPMENT



Steam Engines

Vertical Enclosed Forced Lubrication

Single, Twin, Compound, Triple Expansion and Three Cylinder Compound

The G. & McC. Co. Vertical, Enclosed, Forced Lubrication Steam Engine satisfactorily meets the demands of modern high speed service. The design gives perfect regulation, is quiet running, durable, simple, and all parts are easy of access.

Our catalog gives full details.

Ask for a copy.

The Goldie & McCulloch Co., Limited

Head Office and Works : GALT, Ontario, Can.

Toronto Office: Suite 1101-2, Traders Bank Bldg.

Western Branch: 248 McDermott Ave., Winnipeg, Man.

British Columbia Agents: Robt. Hamilton & Co., Vancouver, B.C.

Quebec Agents: Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the 'Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Simple Low-Pressure Steam Control Device

This Paper Read Before the Gloucestershire Engineering Society, Gained the First Prize for the Best Essay Written by an Associate Member of the Society.

By J. W. SMITH

FIGURE 1 shows a British Westinghouse mixed pressure steam turbine and electric generator; speed 2,500 revs. per minute; output of 368 kilowatts, at the Gloucester Wagon Company's central power station. It will give full output with either mixed pressure steam or high pressure steam only. It will give half output with exhaust steam chest at a pressure of 1 lb. per square inch. The high pressure steam enters the first expansion stage of the turbine through the steam chest "A," and the exhaust steam enters the last expansion stage of the turbine through steam chest "B." When working under mixed pressure conditions, that is, with both starting valves open, the governor throttle valves are arranged so that the exhaust steam does half load (if a full supply is available) and the high pressure steam does the balance of what the whole load may be. If the supply of exhaust steam diminishes, the governor automatically admits more high pressure steam; when more exhaust steam is again available, the governor admits less high pressure steam, keeping the generator output fairly constant while the supply of exhaust steam fluctuates considerably.

As supplied by the makers the machine was not complete, no provision having been made for automatically cutting off the last expansion stage of the turbine from the exhaust main, when the supply of exhaust steam failed. When the supply of exhaust steam fell below the quantity which could be passed by the low pressure starting valve, a partial vacuum was induced in the exhaust main (which is about 400 yards long), with the inevitable result that air was drawn in through some leaky joint or open drain cork. The starting valve could of course be regulated by hand to pass just the quantity of exhaust steam which was available, but, apart from occupying one man's whole time, this hand regulation was very troublesome and caused a waste of a lot of exhaust steam. The device described herein completely removed all serious troubles arising from fluctuations in the supply of exhaust steam.

A low pressure receiver, which diminishes the fluctuations in pressure of the exhaust steam from some steam hammers and non-condensing steam pumps, is outside the door shown in the background. After leaving the receiver the exhaust steam enters the low pressure chest through the pipe "C," then passing downwards through the starting valve and upwards through the emergency stop valve and the governor throttle valve into the turbine. A section of these two valves is shown in Fig. 2.

Before the control device was fitted, the driver had to stand by the low pressure starting valve and partially open or close it according to the pressure in the exhaust main, which is shown by one of the gauges on the panel behind the two steam chests.

The lift rod of the control device passes up through the floor plate "D," and the lever lies alongside the wall underneath. "E" is the handrail round the condenser pit. The driver used to sit on this handrail to watch the pressure gauge, and the lever was arranged so that the operating wire passed down just clear of his back. Only a small portion of the lever projects beyond the wall into the open condenser pit, so its somewhat ungainly length is not noticeable.

The steam control device, with the development of which the author was closely connected, was fitted to a mixed pressure steam turbine some eight years ago, and has given complete satisfaction ever since. The turbine was arranged to take the exhaust steam from steam hammers, hydraulic pumps and feed pumps. A large low pressure steam receiver was fitted a few yards away from it, which to some extent took up the fluctuations in the supply of low pressure steam, but it was found that the rate of supply varied so much that it was necessary to keep a man at the low pressure starting valve to avoid wasting steam, or, what was worse, drawing air into the turbine. The obvious re-

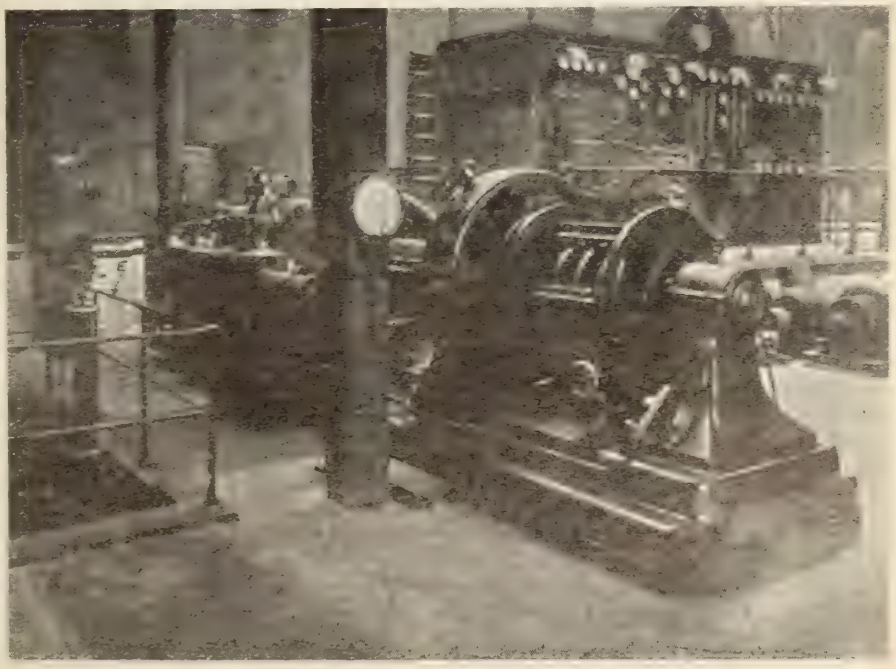


FIG. 1.

quirement was a very sensitive surplus valve which would shut when the pressure in the low pressure steam main was a little over atmospheric pressure, and would gradually open as the pressure rose, until it was full open when the pressure in the main reached 1 lb. per square inch. In connection with a somewhat unusual layout of boilers and steam mains the author had tested two high-pressure surplus valves, by well known makers, with such disappointing results that it was felt it would be useless to ask them for the very sensitive low-pressure valve required. The author's firm therefore decided to tackle the problem. The solution was staring them in the face, but the trouble to find it was much greater than would be supposed from a casual examination of the very simple gear which was evolved, and shown in Fig. 2. To an emergency stop valve normally lying idle in the turbine steam chest, we connected a float operated by a quantity of water lying idle in the steam receiver, and the job was done.

The turbine steam chest is fitted with an emergency trip stop "A" valve which closes upwards and whose spindle passes vertically through the bottom cover. This valve is of a piston type and is a duplicate of the governor throttle valve "B" fitted immediately above it. As arranged by the makers it was connected to its opening lever by a pair of short links "C." These links were replaced by some longer ones with a distance piece riveted between their ends to form a flat surface "D," and the bottom holes of the new links were elongated to allow the valve to be closed without raising the original operating lever. Under this against the wall of the condenser pit, was fitted a lever about 4 ft. 6 ins. long. At about 3 ins. from its fulcrum a vertical rod was jointed which passed through a suitable guide so that its end was just clear of the flat bottom of the new valve links, when the new lever was at the bottom of its travel. The end of the lever had to be raised about twelve inches to close the valve, and suitable guides and stops were provided to prevent all undue stresses. Owing to the 18 to 1 leverage provided, the effect of the friction of the valve and spindle was negligible at the end of the lever. The steam receiver "E," the shell of an old Lancashire boiler, had a syphon drain "F" connected to one end plate about 3 inches above the bottom of the shell. In consequence of the position of this drain there was always a quantity of water lying in the bottom of the shell, the surface of which measured roughly 3 ft. by 20 ft. At the other end of the steam receiver the old blow-off cock fitting "G" on the bottom of the shell had been blanked off. A 2½ in. cock was fitted to this blow-off cock branch one week end, and, working back from that the following week, we rigged up in a vertical position an old 7 ft. length of 8 in. cast iron pipe, and supported it from the floor by a length of 2½ in. pipe with a blank flange at the bottom. This pipe formed an excellent float chamber with sufficient head of water to seal the maximum pressure permissible in the receiver. Owing to the wide ratio between the surface of the water exposed to the steam on one leg of the submerged bend, and the surface of the water exposed to atmospheric pressure on the other leg of the submerged bend, about 60 sq. feet to 50 sq. inches, the rise of water in the float chamber was almost 2.3 ft. per lb. pressure in the receiver. A galvanized iron float was provided, 6 in. diam. by 12 in. deep, with a stretcher bar across its open top to enable it to be suspended correctly. This was filled with water and connected to the new lever by a flexible steel wire rope passing over two guide pulleys. Sufficient weight was then added to the lever to cause the float to be normally half submerged when the lever was clear of both stops.

The apparatus was now ready for a first trial. When the cock in the submerged bend was opened the pressure in the receiver was about 1½ lb. per sq. inch, and as the water rose in the float chamber the sag of the wire rope caused the light float to keep at the surface instead of becoming submerged. The float was then hauled out, a piece of rubber was spread over its bottom and sides, and about 3 lb. of iron punchings were put in as a make weight. An equal weight was added to the end of the lever and a second trial was made. This time the additional weight kept the wire rope taut and the float submerged if the water rose after the lever reached bottom (wide open) stop.

A curious fact in connection with the trip stop valve was now noted. This valve is of a piston type. It was assumed that it would not be affected by the pressure or the flow of steam and that its own weight would open it; it was found, however, that, while steam was passing through it, it would only open about an eighth of an inch when the new lever was depressed and that the lift rod then left the plain end of the valve links and travelled down without the valve. A slight pressure of the tips of the fingers was sufficient to open the valve, which rose again to its former position as soon as that pressure was removed. To get over this difficulty, that is to say, to enable the valve to be pulled open by the control gear and at the same time to avoid interference with its original function as an emergency valve, two pairs of spring clips were fitted to the top of the lift rod and were arranged to engage with slots in the edges of the links; as shown, enlarged, at "H"; two small cam washers were also fitted to the pin which passed through the original operating lever. As the new lever was depressed the spring clips now compelled the valve to follow it, and if the old lever rose the cam washers readily disengaged the spring clips from the valve links. The valve was thus enabled to perform in a very satisfactory manner both the work for which it was designed by the makers and the extra work for which it was desired to use it.

The steel wire rope used is about 3-32 in. dia. It consists of 42 strands of No. 34 s.w.g. wire and its breaking load is 560 lbs. Being very light and flexible it can be made to operate a throttle valve from a considerable distance. Recently a somewhat similar control device was fitted in which the throttle valve is operated, from a point over 150 yards away, by a similar flexible steel wire rope passing over 23 guide pulleys. The unbalanced pull on the wire rope when the lever is at rest, clear of both stops, is Zero. When the float is submerged, the lever presses with a force of 6 lb. on its bottom or "open" stop, and when the float is suspended in air through the water level in the float chamber falling below it, the lever produces a 6 lb. pull against its top or "shut" stop.

It is found that a displacement of only two inches of water above or below the centre of the float is sufficient to operate the valve, and that only a half pound variation of steam pressure is required to move the valve from "open" to "shut" or vice versa. It will thus be seen that a very simple solution of the problem was found. The value of this simplicity will perhaps be better appreciated when it is stated that the device has been in constant use for eight years and has not had a penny spent on it for repairs.

A part of the diagram is taken from a sketch supplied by the makers. It shows a portion of an end view of the turbine and a section through the valves in the low pressure steam chest. "A" is the emergency stop valve which is held open by the catch "I" while the spring "J" always tends to close the valve. The catch "I" can be knocked up by the driver in case of emergency, and it is knocked up automatically by a spring loaded trip bolt at the end of the rotor shaft if the turbine runs about 10 per cent. over speed. The other part of the diagram represents the steam receiver which is supported on piers about six feet above the floor level. It was raised above the floor partly to reduce the length of the steam pipes and partly to permit the introduction of the syphon drain "F" which is probably the most efficient form of low pressure steam trap in existence.

The exhaust steam from the hammers enters the receiver by the pipe "K" and passes out at "L" through a pipe which is not shown to the starting valve at the back of the steam chest. It then passes upwards through the two valves "A" and "B" and through a port which is not shown into the last expansion stage of the turbine.

The presence of the water in the receiver was entirely accidental. In preparing the diagram the author overlooked this point, but the end plate is flanged to fit inside the shell, consequently there is a considerable radius instead of the square end shown. When the syphon drain had to be connected to the receiver the fitter marked the hole just above this radius for convenience in drilling and tapping it.

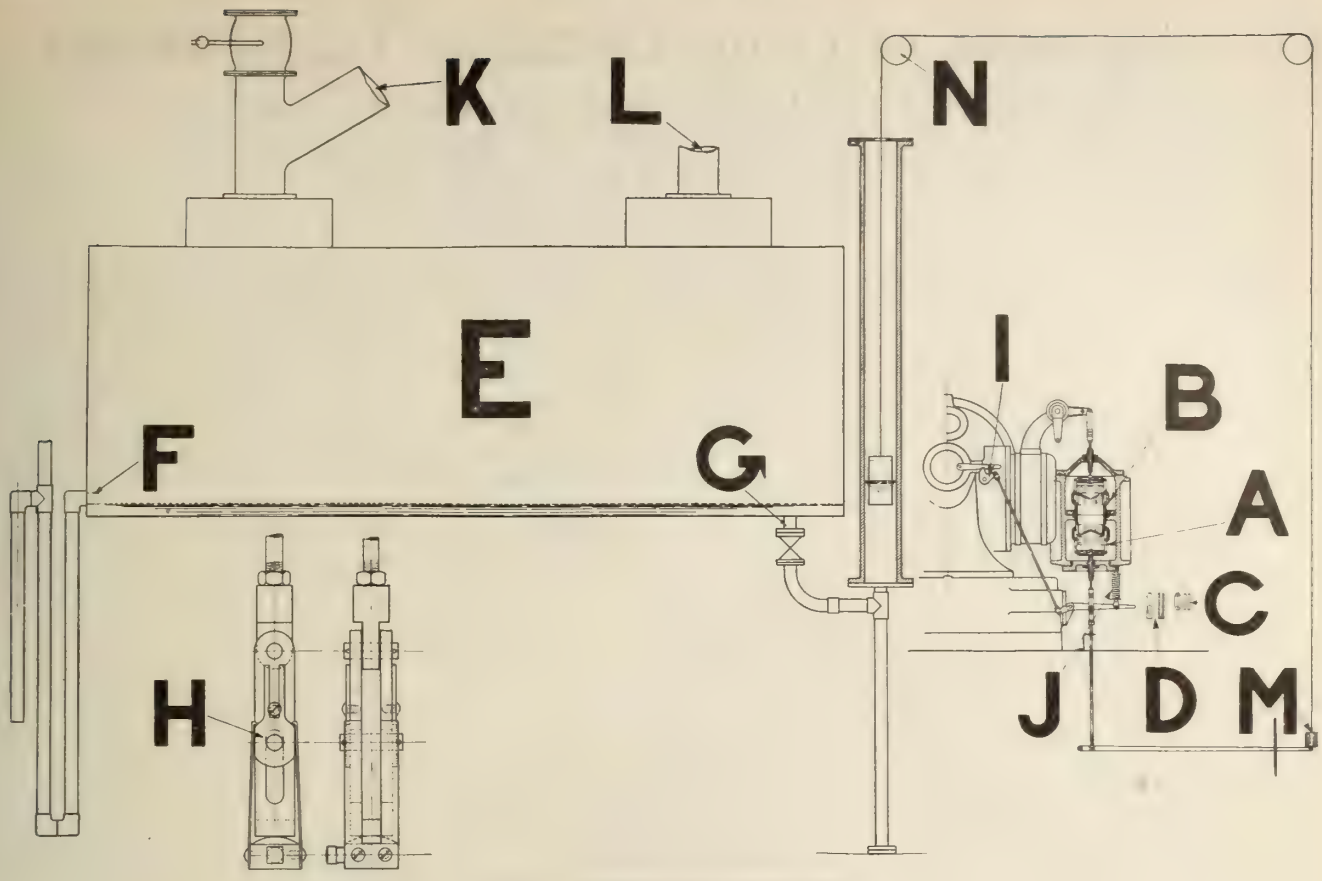


FIG. 2—DIAGRAM OF CONTROLLER.

It will be noticed that the middle of the syphon drain is long enough to seal about 3 lb. pressure and that the float chamber is long enough to seal rather more, also that an atmospheric relief valve is fitted to prevent this pressure being exceeded. It will be obvious, too, that neither the syphon drain nor the float control device can be conveniently used except at very low pressures.

Practically all variations of water level, due to pressure in the receiver, take place in the float chamber; one area of water is so large in comparison with the other that the slight variation of level which takes place in the steam receiver is entirely negligible.

In adjusting the weight "M" to cause the float to ride in the water half submerged, the pulley "N" was moved over a little so that the float could be lowered into a bucket instead of into the float chamber.

It was mentioned that the float failed to submerge when the water rose in the float chamber at the first trial. That was due to the sag of the horizontal wire between the two pulleys. The weight of the galvanized iron shell of the float is only about half a pound. The pull due to half a pound of iron submerged in water was not sufficient to keep the wire taut, but the pull of about three and a half pounds of iron submerged in water does it well. The float is always full of water, and the arrangement is capable of giving a six pounds pull in either direction at the end of the lever. This is a very liberal allowance for overcoming the slight friction at the various joints and wheels.

The fact that the flow of steam—the flow, not the pressure—will hold the valve "A" in suspension was quite a big trouble and nearly caused us to abandon the job. The simple little spring clips shown at "H" with the cam washers for releasing them, and especially the slotted projection and button-headed screw for keeping the cam washer upright, took the author fully a fortnight to evolve, and during that time the driver continued to perch on the handrail of the condenser pit like a huge sparrow, entirely destroying the harmony of the station.

Very slight fluctuations of pressure do not affect the float and there is always a small amount of lag in its movements. The water level has to be two inches above or below the centre of the float before it can overcome the inertia and friction of the gear, consequently under certain conditions within the range of this lever the pressure can fluctuate by an amount equal to 4 in. head of water without moving the float. Of course if the water rise after the lever reaches its bottom stop the float simply remains suspended under water, while if the water fall after the lever reaches its stop, the float simply remains suspended in air—nothing else happens.

The Sarco Company Inc., Woolworth Building, New York, are exhibiting steam traps, temperature regulators, recording gas calorimeters and CO_2 recorders, at the Chemical Exposition, New York.

The Sarco steam traps use the special Sarco tubular diaphragms and liquid expansion. They are claimed to be the only low price high-pressure type on the market and they cost about one third as much to make and market as traps of the ordinary bucket or float type.

The temperature regulators are specially designed for industrial purposes to regulate temperatures within a range of from 30 to 300 deg. Fahr., and are particularly suitable for chemical manufacturing operations, the canning industry, hot water service tanks, oil heaters, etc. The Sarco Company, Inc., although established only nine years, has made a very extensive study of temperature control for industrial purposes and has achieved a prominent position in this important and very promising field.

The Sarco recording gas calorimeter is of the type adopted by the Public Service Commission of New York. It burns gas in a finely regulated flame, the varying heat of which is recorded continuously in thermal units of the heat value of the gas. Gas engineering practice throughout the world favors the substitution of a heat value standard for a light standard for gas, and apparatus giving constant records is of great public as well as technical interest.

The Sarco CO_2 recorder gives a record of the carbon dioxide in flue gas from boiler furnaces. The percentage, subject to a few simple rules, is a definite indication of furnace efficiency and tells whether fuel is burned to advantage or to waste.

Development of Long Distance Transmission

In This Lecture Delivered Before the Johns Hopkins University as One of the John Aldred Lectures the Progress of Electrical Development is Reviewed from 1876 to Date.

By PAUL M. LINCOLN, Consulting Engineer, Cleveland

IN taking up such a subject as that to which I am to address myself this afternoon it is proper, first, to call attention to the extent of use to which electricity has attained in our modern life. Electricity is used in thousands of ways by the present-day human beings, and its use has had a marked influence upon the development of the present-day civilization.

It is doubtful, for instance, if our modern cities could have come into being without the aid of electricity. The modern city is typified by the congestion into a relatively small area of exceedingly large numbers of human beings, who each day must go and come to and from their daily work, be fed, clothed and generally ministered to for their infinite variety of daily wants. In all of these ministrations electricity has come to assume so important a part that I believe it is a safe assertion to say that without electricity our modern cities would be very different from what we find them today.

Take, for instance, the one item of transportation. Transportation is, of course, essential to our modern life, and with the rapid growth of our cities and the consequent congestion of large numbers of human beings into a relatively small space, the complexity of the transportation problem has increased to such a degree that it is doubtful if any other than electrical method of transportation could have solved the problem. The modern subway is made possible only by the use of electricity, and without the subway such cities as, for instance, the city of New York as it now exists would be impossible.

Not alone in transportation has electricity proved itself indispensable to our modern life, but in many other ways. For instance, as a source of light it is well nigh indispensable to take care of the congestion of large numbers of people into relatively small buildings such as we find in our modern cities. But its usefulness does not stop here. It ministers to us in thousands of ways. New duties are being found for it every day. In the household it assists the housewife; it cooks the meals, it washes and irons her clothes, it operates the refrigerator, it sweeps the floors and furnishes a cooling breeze that may make endurable an otherwise unendurable condition.

In industries its influence is even more important. Power is an essential to the modern industry. Power is as essential to our present-day industry as the air we breathe; it is absolutely indispensable.

In this matter of power and its influence on the industry, particularly in modern times, I think it is only proper to quote from a book—The New Epoch—written by Mr. George S. Morison, a noted civil engineer. This book was written more than twenty years ago, and the developments of the past twenty years have only confirmed the analysis and deductions made by Mr. Morison in his book. In this work Mr. Morison has pointed out the means by which man has progressed from a mere animal to his present position. In his rise from the condition of the beast the first thing that man acquired was the use of fire. This knowledge differentiated him from the beasts that surrounded him, and while still a savage, he was better off than the beast.

The second tool that man acquired in his climb from the condition of the beast to his present position was the use of the bow and arrow, and with its use another epoch began. With the invention of pottery and all that this implies—cooked food and greater permanence in place of residence—another epoch began and man passed out of the state of savagery and made a distinct advance toward the state of civilization. Still another epoch began when he acquired the ability to domesticate animals. He was thereby enabled to use a power beyond that of his own body and muscle. This ability gave him a distinct advantage. The final epoch of the savage or barbarous period began with the manufacture of iron, and finally with the acquisition of the written alphabet an epoch began which we now recognize as the epoch of civilization. With the ability to pass on the knowledge of one generation to the next, which the written language gave him, man acquired a power that was vastly important. I think I can do not better than to quote Morison's own language in further illustration of his points:

"The changes which mark the advances from period to period are all material improvements; in every instance they are characterized by some distinctive physical device which has enabled man either to utilize his own strength better than before, or to increase his power by adding other animate or inanimate force. The race that passed from one period to another acquired resources which it had not before: in the contests which characterized the life of primitive man, the men of a lower period fell before those who had risen higher. But though the devices were of a purely material character, they gave opportunities for mental and moral improvement which alone made further advance possible, till finally the written alphabet resulted in that preservative of knowledge which has made the intellectual efforts of thirty centuries available for ourselves. With the dawn of civilization the ethnical periods have been considered closed; subsequent growth has been the natural advance of civilization marked by the events which make written history.

"But there is no reason why the epoch which began with writing should be the last. It only needed a new capacity, radically unlike those which have gone before, to make an epoch in civilization as distinct as those in primitive society. Such new capacity has now been found; another epoch has begun. Fire, animal strength, and written language have in turn advanced men and nations; something like a new capacity was developed with the discovery of explosives, and again in the invention of printing; but the capacity of man has always been limited to his own individual strength and that of the men and animals which he could control. His capacity is no longer so limited; man has now learned to manufacture power, and with the manufacture of power a new epoch began. These words are used advisedly; creation, whether of substance or force, is not given to man; manufacture is not creation, but to change inert matter from one form to another in such a way as to generate power is to manufacture power. And this we do."

While I agree entirely with Mr. Morison in his analysis of the influence of power upon the development of the human race, I wish to point out that it is the electrical engineer, we ourselves, who have made its complete realization possible. The production of power is of itself not sufficient to bring about the new epoch which Mr. Morison has portrayed to us. To bring about the complete realization of this new epoch, power must not only be produced, but must be made available at points convenient for the use of mankind, in the household, in the shop, in the office; in fact, wherever man is he may need to use this power, and if we would realize to the full the benefits of power we must make it universally available. It is the electrical engineer who has made this realization possible by his ability to transmit and distribute power by means of electricity. It is my object in this brief address to set before you a brief history of the manner by which we have come to possess the knowledge and experience by which in turn we can today so easily transmit and distribute electrical energy.

An historical sketch of the develop-

ment of electricity usually begins with the amber of the ancients and passes in review the contributions of the various scientists to our knowledge of electricity. Such names as Gilbert, Volta, Ohm, Oersted, Ampere, Franklin, Davy, Faraday, Henry, Morse, Bell and many others, together with the labors and discoveries of each, might be set forth in detail. While this method may be interesting, it is already available in many historical reviews which have been written on the history of electricity. While the pure scientist, that is the man who seeks knowledge purely for the sake of knowing, is entitled to the utmost credit, the art of transmission and distribution of electricity as it is recognized today is an "applied" science, and it is the history of electric transmission and distribution as a commercial enterprise that attracts our attention first; it is this phase of the historical review to which I wish to draw your particular attention tonight.

Aside from the telegraph, the first commercial application of electricity was for lighting, and the first commercially successful electric lighting enterprise was that of an American, Charles F. Brush, of Cleveland. It was in 1876 that Brush produced his first successful dynamo-electric machine for the production of an arc-lighting system. At the time Brush began his work there was neither lamp nor dynamo—at least not in commercial form, and he had to attack the problem from both of these standpoints and solve not only the problem of the dynamo to produce electricity, but also the lamp in which the electricity was to be used to produce light. At the time Brush attacked this problem of electric lighting there were no commercially successful lighting systems. There had been produced a few isolated instances where electricity had been used for illumination, but these were isolated instances and were in no case successful from a commercial point of view. Brush, therefore, had a clear field before him. The attempts of Brush in the development of both the arc lamp and the dynamo to operate it were entirely successful. As indicated above, his first success was attained in the year 1876. The first lighting outfits which he made required the use of a separate dynamo for each lamp. Soon, however, Brush conceived the idea of operating his lamps "in significant series" so that the current from one passed in series to the next, and then to the next, and so on. At first the number of lamps operated in series was small, but later, as experience accrued, the number increased until, in some of his later machines, voltages in excess of 5,000 were common. The fact that Brush devised a series rather than a parallel or multiple connection for the purpose of operating more than one lamp from one machine had an important influence on the development of the art of transmitting and distributing electrical energy. This will be further developed as we proceed.

Although the first successful experimental arc machines were produced by Mr. Brush in the year 1876, the success of his enterprise as a commercial venture was not assured until about 1878. Beginning in 1878, Mr. Brush and the Brush Electric Co., which he formed and operated from that time on, proved highly successful from a commercial point of view. The Brush Company installed arc lighting outfits in many cities, towns and villages, and the success of his enterprises from a commercial point of view was complete.

By the year 1880 the commercial success of the Brush Company and its arc lighting system had become so pronounced that the industry began to attract competitors. One of the first American competitors to enter this field was the Thomson-Houston Company, of which the moving spirits were Mr. Elihu Thomson and E. J. Houston. These men developed both a dynamo and a lamp to compete with the one which Brush was using at that time. While there were a considerable number of detailed patents taken out during this period on both lamps and dynamos, there was nothing of sufficient fundamental importance to enable either the Brush Company or the Thomson-Houston Company to cover the method of arc lighting sufficiently to exclude competition. From then on the arc-lighting business continued to attract a considerable amount of attention, and still other companies entered the field. It is hardly necessary in this brief review to detail each of these companies, but it is important to point out that all companies used exactly the same method of distributing the electricity used for arc lighting as Brush previously had devised in 1876. While this method served very well for arc lights, it did not form the basis of the method of transmission and distribution of electrical energy in use today. This method did not come until later.

There was one outstanding objection to be noted in the arc-lighting systems, and this was that the unit of light was too large for convenient use indoors. While the arc lamp was made a very good street-lighting outfit, the light was so brilliant and so large an amount in a single unit that it was not applicable for indoor illumination. The problem of the day, therefore, was the so-called "divisibility" of the electric light. Among others, this problem was attacked by Mr. Thomas A. Edison, and in 1879 Mr. Edison produced his "incandescent" lamp. This "incandescent" lamp was built on an entirely different plan from the arc lamp of Brush, and constituted a very important advance in the electric art of that day. It accomplished the "divisibility" of the electric light, which was recognized as the foremost problem of the day. Edison's solution of this problem was one of the most brilliant achievements of modern times, and he is justly hailed as the foremost inventor of his age, and this largely on account of his accomplishments in the field of electricity.

It should be pointed out that Brush and Edison were working along two very different lines in so far as the method of distributing electricity was concerned. In Brush's arc-lighting system he used the lamps in series, and the same current passed in series from lamp to lamp. The voltage across one lamp was in the neighborhood of 45 to 50 volts, and each lamp in a circuit added its quota to the total voltage of the circuit. When, for instance, 50 lamps were used in series in one circuit, the total voltage across the entire 50 lamps approached something of the order of 2,500 volts, while the amount of current both in the dynamo and at any point in the lighting circuit was always the same, viz: about 9½ to 10 amperes. Edison attacked the problem of distributing his electricity on a very different principle. Instead of placing his lamps in series, as was the case with Brush, he placed his lamps in parallel, the voltage applying to the entire circuit being the same, each lamp adding its quota of current to that of the others. The method of distributing power was, therefore, fundamentally different in the case of Edison from that in the case of Brush, and this difference was to have a far-reaching effect in the development of electric power transmission and distribution.

Edison had to attack the problem not only of producing a lamp, but also of producing a dynamo to operate his lamps, and then of producing a distributing system for the purpose of taking the electricity from the dynamo to the lamps. There were, therefore, at least three problems which Edison had to solve—not one. Although Edison's first successful experimental lamp was produced in 1879, the other problems, that is, the problem of production of the dynamo and the problem of a distribution system, were not sufficiently advanced for nearly three years to enable him to put into operation an entirely successful electric lighting system. However, Edison persisted in his attempts to produce such a complete system, and in the year 1882 the first successful central station electric lighting system went into operation. The honor of the first successful Edison system goes to the little town of Appleton, Wis. This was followed a few weeks thereafter by the starting up of the well-known "Pearl Street Station" in the downtown part of New York City. The Pearl Street Station of the New York Edison Company operated for many years thereafter and has long been pointed out, not only as one of the first successful central stations, but also as the beginning of one of the most successful commercial enterprises of modern times.

Edison's achievement in producing first the incandescent lamp, second, the dynamo, and third, the distributing system for the taking power from his dynamo to his lamps, is to my mind one of the most brilliant achievements that has

ever been accomplished in the electrical field. He is entitled to the utmost credit for persevering under the many discouragements which he met in carrying to completion his great work in those early days. Edison's name is connected with many epoch-making inventions, but none of them shed more lustre on his name than does the electric lighting industry, so many units of which so appropriately bear his name.

In this connection it might be pointed out that the only use of electricity at this early date was for lighting. The use of electricity for power had not been seriously thought of. This is indicated clearly in the names of the various companies going into electrical enterprises in those early days. The term "Electric Lighting Company" was universally used for electrical enterprises in those days. The term "power" in connection with such enterprises was not used until many years after Edison started his first electric lighting system.

This was not because the ability to use the electric dynamo or generator as a motor was not known. This ability to use the electric generator as a motor was well known in the early days. In fact, it was as early as 1837 when the "reversibility" of the electric dynamo was discovered. But the first commercial use to which electricity was put was for lighting, and for many years lighting was its only commercial use. Then followed a period when electricity began to be used for power, but its use as a source of light rather than power was still predominant. As time went on lighting came to have a smaller and smaller relative importance in electrical enterprise until today the use of electricity as a source of power far overshadows its use in lighting.

During the decade from 1876 to 1886 the electric lighting industry developed tremendously. During the first five years of this period the development was entirely along arc lighting lines. With the advent of the Edison incandescent lamp in 1879, and the Edison dynamo and distributing system in 1882, a new method both of lighting and distributing electricity came into vogue. But neither the Brush nor the Edison method of distribution had within it the germ of a success as a complete transmitting and distributing system as we know that term today.

It should be emphasized again that these two systems were entirely different, one being constant current—variable potential—that of Brush—and the other being constant potential, variable current—that of Edison. The system as advocated by Edison lent itself to power distribution more readily than did that of Brush. This came about on account of the fact that the motors for use with the current which Brush was producing for the arc lighting dynamo could not be readily governed so far as speed was concerned. Motors, when operated from a constant variable potential source required a special kind of generator in order to make them regulate properly in the matter of speed. This restricted the use of motors when operating from that source to a very considerable degree. While this disadvantage was recognized, it was also recognized that in the matter of transmission the system which Brush had been using had a very considerable advantage in that the voltage that it carried was very much higher than that which Edison was able to use. The increased voltage gave the Brush system a very considerable advantage in the matter of the amount of copper conductor required to carry a given amount of power over a given distance. The series system of Brush was used to some extent, or rather an endeavor was made to use it for power purposes, but it did not meet with any very large degree of success. During the late eighties a copper mine in the Lake Superior copper district was equipped with a Brush dynamo and Brush motors, but their success was not sufficiently marked to indicate that it would have a very brilliant future.

Still another attempt to use the Brush method of generation and distribution of electricity during the eighties is worthy of note, as indicating that the problem of transmission was receiving careful attention. I refer to the endeavor of Sidney H. Short to develop the so-called "Short Series System" of railway operation during the late eighties. Short early recognized the difficulties that would be encountered if the Edison system of distribution was to be used to handle the relatively large amounts of power required by railways. He, therefore, devised a method of operating street railway cars so that all cars would at all times be in series—just as is the case of the Brush system of arc lighting. An attempt was made to put this system into operation in the city of Denver, Col., about the year 1886, and another attempt was made in the city of Columbus, Ohio, in the year 1889. Both these attempts were failures, and the complete success of Sprague with a modified Edison system of distribution in Richmond in 1887 caused Short to give up his attempt to develop the series system. However, let us give Short the credit of recognizing that the transmission problem was paramount and of at least trying to solve that problem along novel lines.

During the period from 1880 to 1885 the electric lighting industry developed by leaps and bounds. This was true not only of arc lighting with the Brush Company and the Thomson-Houston Company, as its principal advocates, but also it was particularly true of the Edison Company, as well as its competitors, which began to appear as soon as success was assured. It is only proper to point out again that neither of these systems was capable of development to a degree that could be called successful, as we know that term today. The art of transmission and distribution of electrical energy, as we know it today, requires ability to transmit quantities of power and over distances which are totally outside of the range of the systems which were adopted and used for electric lighting systems between the years 1880 and 1885. In the first place, the systems adopted by Edison were limited to comparatively low voltages. Edison started with the idea of using approximately 100 volts on his lamps. He soon recognized that this was not a sufficiently high voltage for distribution, even over the areas usually required in a normal city, and as a consequence, developed his "three-wire system" of distribution, in which the voltage doubled. The three-wire 110-220 volt system thereupon became the standard method of distribution for cities in the United States, and to a degree has remained so ever since.

In the second place, the system which was developed by Brush and his imitators was not capable of being developed into a general power distribution system—as we know that term today—for the reason that it was impossible to eliminate the element of danger due to high voltage from the method of distribution as soon as any considerable amount of energy was demanded. Incidentally, also, the inherent difficulties of operating motors and incandescent lamps on the Brush constant current circuits were much greater than with the Edison constant voltage system. Therefore, neither of the systems of distribution in use up to the year 1885 contained the germ of success for long-distance distribution of electric energy, as we know that art today.

It was the invention in 1883 of the "alternating current transformer" which gave the first hope of success for the system of transmission and distribution of electrical energy as we know that art today. The transformer was invented by a Frenchman named Gaulard, and an Englishman named Gibbs. The transformer was a development from the Ruhmkorf coil, which had been known for a number of years. It was during the year 1883 that Messrs. Gaulard & Gibbs disclosed their transformer. An account of this transformer came to the notice of Mr. George Westinghouse of Pittsburgh in 1885, and with this notice the era of transmission of electrical energy may be said to have begun.

At that time Mr. Westinghouse was already a marked figure. Sixteen years previously he had invented the air brake and had made not only a brilliant engineering success of that invention, but a brilliant financial success as well. But the air brake was only one of the many inventions which Mr. Westinghouse promoted. The transmission and distribution of natural gas was a subject upon which he had been devoting much attention during the period from 1880 to 1885. His ideas for compressing gas to high pressure for transmission over long distances and then reducing that pressure to a much lower point for distribution throughout a city had already taken form, and it is not unlikely that it was the analogy between the Gaulard and

Gibbs transformer and his own gas transmitting method that attracted him particularly to that idea. For several years previous to 1885 Mr. Westinghouse had been conducting experiments along electrical lines. He had been following the Edison method of generation and distribution, and had distinctly recognized both the shortcomings of the low voltage that Edison was using, as well as the danger attached to the high voltage, made necessary by the method of Brush. He recognized at once that the Gaulard & Gibbs transformer—if it were a success—would at once avoid both these difficulties. That Mr. Westinghouse recognized the great possibilities of the transformer is indicated by the fact that at once he dispatched an agent to Europe with instructions to purchase the Gaulard & Gibbs patents, no matter what the cost.

In the year 1883 Mr. Westinghouse had come in contact with Mr. William Stanley of Great Barrington, Mass. Mr. Stanley was also working on electrical matters, and Mr. Westinghouse put up to Mr. Stanley the problem of making the transformers into a practical device which could be used in the electric lighting industry. Apparently Messrs. Gaulard and Gibbs, in obtaining their patent on the transformer had the idea of using that device in a manner similar to the method in which Brush was distributing electricity to his arc lights. That is, the various transformers were connected in series, the primary current passing from one transformer to another, and the secondaries of these transformers were to be used for actuating the lamps or other devices. Apparently, the principal idea which Messrs. Gaulard and Gibbs had in mind was the avoidance of the danger to life which the arc lighting systems of that day entailed. By putting in transformers and operating lamps or other devices from the secondaries of these transformers the high potential of primary arc lighting circuit could be avoided and thereby the lamps or other devices made safe. It was apparently the Brush method of transmitting and distributing electricity that Gaulard and Gibbs had in mind when they devised their transformer, not the Edison method.

Mr. William Stanley at once recognized the serious shortcomings of this proposition of Messrs. Gaulard and Gibbs. He recognized, also, that it was possible to use transformers on a constant potential, variable current system similar to that which Edison was using, instead of the constant current, variable potential system which Brush was using. It was in the year 1886, and in the town of Great Barrington, in the western part of Massachusetts, that Stanley first used the alternating current transformer in the manner in which it is commonly used today. A short section of relatively high voltage, constant potential transmission line was operated in that town in March of the year 1886, and transformers were used to step down this high voltage to constant potential incandescent lamps operated on the secondaries. Thus, it was in March of the year 1886, in Great Barrington, Mass., that the first transmission of electricity by alternating current took place. While this in itself was an unimportant application, it had within it the germ of success for the alternating current distribution of power and light as we know that system today. Every element that today gives us the ability to transmit power over distances running up to hundreds of miles, and in quantities of hundreds of thousands of kilowatts, existed in that small experimental line first put into use in the year 1885 in Great Barrington. Modifications have, of course, taken place in frequency, in phase, in voltage and in distance of transmission, but these modifications are simply of degree, not of kind.

During the years 1885 and 1886 Mr. Stanley continued his investigations under the inspiration and at the expense of Mr. George Westinghouse in the city of Pittsburgh, and in the fall of 1886 the famous Lawrenceville experiment took place. In that experiment several hundred lamps were operated successfully in the little suburb of Lawrenceville, the source of power for those lamps being an alternator located in the old Garrison Alley Works of the Westinghouse Electric and Manufacturing Company, about two miles distant. The operating voltage of that transmission line was at first 1000 volts, and this was later increased to double that amount, or 2000 volts. During the earlier experiments the voltage on the lamps was 50 volts. This was later increased to approximately 100 volts. Transformers were used to step down the line voltage of 1000 or 2000 to the 50 or 100 volts on the lamps. Thus, in Lawrenceville, in the year 1886, an experiment in the transmission of power by alternating current was carried on which confirmed entirely the first experiences of Stanley in Great Barrington some months earlier. The success of the Lawrenceville experiment was complete, and the Westinghouse Electric Company, which had been organized in 1886, began the commercial exploitation of electric lighting equipment, incorporating this new idea of alternating current generation and distribution. The Westinghouse alternating current system began to be exploited commercially, therefore, in the year 1886, and during the next two years about 200 central station plants using this alternating current method of distribution were installed in the United States. The first one of these plants was installed in the little town of Greensburg, about thirty miles east of Pittsburgh. The second went into the city of Buffalo, N.Y. Both of these plants were installed during the latter part of the year 1886, and as indicated above, during the succeeding two years the systems attained very great popularity, some 200 being installed during the first two years.

At the time of its inception there seemed to be no prospect of using the alternating current system for anything but lighting. The alternating current motor had not yet arrived. It was not until the year 1888 that Nicola Tesla patented his "induction" motor. Although Tesla's original patents were issued in the year 1888, there was nothing commercially tangible from this idea until nearly five years later. I consider the conception of the alternating current induction motor by Nicola Tesla as one of the most brilliant conceptions that has ever taken place in the field of electrical development. Tesla was essentially a dreamer, and the road from the dream to the reality was a long and tortuous one. In the first place, all alternating current systems installed up to that time had been single phase, and consequently were not available for the polyphase motors that Tesla had devised. In the second place, the task of turning Tesla's brilliant conception into an actual working device was not a simple or easy one. This work was done by a group of brilliant engineers in the employ of Mr. Westinghouse, and it was in this period that a number of well-known names were first mentioned. Mr. Albert Schmid, of revered memory, was one of these pioneers who had a decided influence upon the electrical industry at this time. Others who are well known who did much towards developing the Tesla motor, and the auxiliary equipment which it necessarily brought with it, were Mr. O. B. Shallenberger, Mr. R. Bellfield, Mr. Charles F. Scott, Mr. L. B. Stillwell, Mr. B. G. Lamme and Mr. R. D. Mershon. As I indicated above, it required nearly five years from the time of the conception of the induction motor until a commercially successful alternating current "power distributing system" was placed on the market. The lapse of time was not entirely due to the development of the motor alone. It was largely due to the fact that up to this time electricity as a source of power was then considered entirely of secondary importance. As a consequence, up to the year 1889, or 1890, none of the alternating current systems which had been installed were of anything except the single phase variety. The induction motor being a polyphase motor and not being adaptable for use on single phase circuits, was, therefore, not adapted to use on any of the existing alternating current systems at that time. As a consequence, a new system of generation and distribution had to be developed and put into use before the new type of motor could be extensively used.

The polyphase generator and the polyphase distribution system did not attain a vogue of any noticeable degree until about 1892 or 1893, and at that time the polyphase motor, having been placed upon a basis where it was recognized as a successful device, the polyphase system, including, of course, the polyphase motor, began to come rapidly into general use.

(Continued on page 38)

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

HAVING studied the method of calculating the various types of riveted joints used in building boilers, we can now return to the boiler we were considering in earlier articles. This was to be a 100 horsepower boiler at the standard rating of 34½ lbs. water evaporated from and at 212 degrees. We arrived at the leading dimensions, which were 72 inches diameter and 18 feet long, with a working pressure of 125 lbs. per square inch. We can now proceed to find the necessary thickness of shell to carry the required steam pressure.

We saw when studying the bursting pressure of a sphere that the result arrived at was that f, the stress, was equal to the pressure multiplied by the diameter and divided by twice the thickness or, expressed as a formula,

$$f=\frac{pd}{2t}$$

When we wish to apply this to an actual boiler, we have some variations to introduce, these being the least percentages of longitudinal joint, and the factor of safety. Neglecting these for a moment, we will show how to find any one of the factors from the others. For instance, to find the pressure the formula would be

$$p=\frac{f2t}{d}$$

To find the thickness we would have

$$t=\frac{pd}{2f}$$

While to find diameter the formula becomes

$$d=\frac{2tf}{p}$$

The formula to find the working pressure of a boiler is

$$WP=\frac{S\times\%\times2t}{d\times F}$$

where S = tensile strength of material, % = least percentage of longitudinal joints, t = thickness of plate in inches, d = diameter in inches, and F = factor of safety.

We have already set the required working pressure, and as we are to get a boiler of good workmanship and material we can assume 4.5 as a factor of safety. We will use a triple-riveted double-strap butt joint with an efficiency of 86% for the longitudinal seams, so that all that remains is to find the required thickness of shell. We must, therefore, substitute the known figures in the formula, and thus find the unknown. We have then

WP = 125,
d = 72,
S = 60000,
F = 4.5,
% = 86.

Putting in the figures, we get

$$\frac{60000\times.86\times2t}{72\times4.5}=125.$$

It is easier to use all fractions instead of decimals, so

$$\frac{60000\times86\times2t\times2}{72\times100\times9}=125.$$

By cancelling out we get

$$\frac{50\times86\times2t}{3\times9}=125$$

$$2t=\frac{125\times27}{50\times86}$$

$$t=\frac{125\times27}{100\times86}$$

$$t=.3924.$$

The nearest fraction to this is 25-64, but as the plates are not made in variations closer than 1-32, we will call it 3-8 inch and see if that will give the desired result. If not, we will increase it 1-16.

Then

$$\frac{60000\times86\times2\times3}{72\times100\times9\times4}=WP.$$

Cancelling

$$\frac{50\times86}{9\times4}=119.$$

This gives only 119 lbs., so we must take 7-16 as the size of plate, and try again.

$$\frac{60000\times86\times2\times7}{72\times100\times9\times8}=WP.$$

Cancelling

$$\frac{25\times43\times7}{6\times9}=139.$$

This gives us 14 lbs. more than we require, but as plates in this country are not rolled to dimensions of thirty-seconds of an inch, we must use the 7-16 plate. This is a good fault, as it allows a margin against corrosion, and makes practically no difference to the heat conductivity. It also allows a bigger factor of safety. This will now be, assuming the pressure is carried at the figure first set

$$\frac{60000\times86\times7}{72\times100\times F\times8}=125.$$

Then

$$F=\frac{60000\times86\times7}{125\times72\times100\times8}$$

Cancelling

$$F=\frac{86\times7}{5\times24}$$

$$F=5.$$

Designing the Joint

We have now got the diameter, length and thickness of plate of the boiler, and now we will determine the particulars of the joint.

First, as we have seen in the articles on riveted joints we will determine the pitch of rivets in the outer row. Then

$$\frac{P-D}{P}=.86$$

$$P-D=.86P$$

$$D=.14P.$$

Now we have 7-16 plate, we will have a 15-16 inch rivet, and if the diameter is .14 of the pitch, the pitch will be

$$\frac{.9375}{.14}=6.69 \text{ or say } 6\ 11\text{-}16.$$

Let us see how close this will come to the required percentage.

$$\frac{6.6875-.9375}{6.6875}=85.98\%.$$

This is sufficiently close for all purposes. We will now try the rivet strength, using the pitch found. We

shall have four rivets in double shear and one in single shear, making eight rivet areas in all. Then by formula, using .7 as the constant for steel rivets in steel plates

$$\frac{a \times n \times C}{p \times t} = \%.$$

Then

$$\frac{15 \times 15 \times .7854 \times 8 \times 70 \times 16 \times 16}{16 \times 16 \times 107 \times 7 \times 100} = \%.$$

Cancelling

$$\frac{9 \times .7854 \times 20}{107} = 132\%.$$

This gives a much higher percentage of rivet strength than plate strength. By reducing the rivet diameter to ⅞ inch we get a higher plate strength, and a lower rivet strength, thus

$$\frac{7 \times 7 \times .7854 \times 8 \times 70 \times 16 \times 16}{8 \times 8 \times 107 \times 7 \times 100} = 111.3\% \text{ rivets}$$

and $\frac{6\ 11\text{-}16 - ⅞}{6\ 11\text{-}16} = 86.9\%$ for plate.

This is more in proportion, and the smaller size rivets will reduce the cost of manufacture.

We will now see if we are within the limits of the maximum pitch as allowed by the Ontario regulations. The maximum pitch is found by using the formula

$$PM = (C \times T) + 1⅝$$

where PM = maximum pitch,
C = Constant,
T = Thickness of plate in inches.

The constant C varies with the type of joint as follows:

No. of Rivets in one pitch	Constant for Lap joint	Constant for Double butt Strap joints
1	1.31	1.75
2	2.62	3.5
3	3.47	4.63
4	4.14	5.52
5	....	6.00

As there are five rivets in a pitch, we must use the constant 6. Then

$$PM = (6 \times .4375) + 1.625$$
$$= 2.6250 + 1.625$$
$$= 4.25.$$

Although the regulations omit to state this, in a joint with every alternative rivet omitted in the outside row, this formula should be multiplied by 2, and in this case the maximum pitch for the outside rivets is therefore 8¼ inches, and we are well inside this dimension. The combined efficiency of plate and rivets must be found from the formula given in the regulations:

$$\frac{(A \times C) + (P - 2d)T}{P \times T}$$

This, as can be readily seen, is the shearing strength of one rivet, multiplied by the constant, and added to the net section of the plate between the outside row of rivets, divided by the unit section. Substituting figures we get

$$\frac{\left\{\frac{7 \times 7 \times .7854 \times 70}{8 \times 8 \times 100}\right\} + \left\{6 - \frac{11}{16} - 1¾\right\} \times \frac{7}{16}}{6\frac{11}{16} \times \frac{7}{16}} =$$

Combined Efficiency.

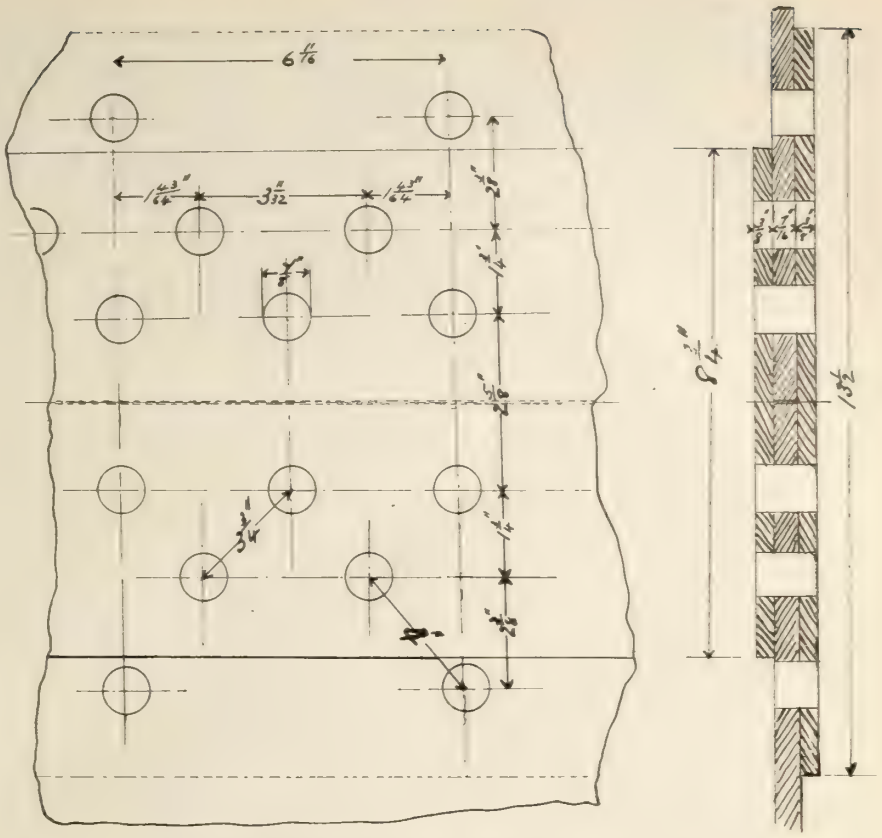
Reducing to decimals it becomes

$$\frac{.42 + 2.16}{2.92} = \frac{2.58}{2.92}$$

$$= 88.3\%,$$

which is higher than the plate strength as determined.

We must now determine the distance between the rows of rivets, and the exact allowable arc definitely decided by the regulations. Of course one could arrive at this distance by calculating the section of metal to be left to secure the necessary strength, but for the purpose of those passing examinations it will be better to work out the formulae set down by the Ontario board. The minimum distance between the outer and middle rows is found by the following expression, where V = the minimum distance:



TREBLE RIVETED DOUBLE UNEQUAL STRAP JOINT.

$$V = \sqrt{[(11\text{-}20P + d)(1\text{-}20P + d)]}$$

In order to make these clear we will show the various steps in full. Substituting figures we get

$$V = \sqrt{[(11\text{-}20 \times 6.6875 + .875)(1\text{-}20 \times 6.6875 + .875)]}$$
$$= \sqrt{[(.55 \times 6.6875 + .875)(.05 \times 6.6875 + .875)]}$$
$$= \sqrt{[(3.6781 + .875)(.3343 + .875)]}$$
$$= \sqrt{(4.5531 \times 1.2093)}$$
$$= \sqrt{5.4793}$$
$$= 2.33$$

Therefore 2.33 inches is the minimum distance between outer and middle rows. For the distance between inner and middle rows we have

$$\sqrt{[(11P + 8d)(P + 8d)]} \div 20$$

Substituting figures

$$\sqrt{[(11 \times 6.6875 + 8 \times .875)(6.6875 + 8 \times .875)]} \div 20$$
$$= \sqrt{[(73.5625 + 7)(6.6875 + 7)]} \div 20$$
$$= \sqrt{[80.5625 \times 13.6875 \div 20]}$$
$$= \sqrt{[1102.69 \div 20]}$$
$$= 33.2 \div 20 = 1.66.$$

Then 1.66 inches is the minimum pitch between the inner and middle row.

For the minimum diagonal pitch between inner and middle rows the formula is

$$P = (3P + 4d) \div 10$$
$$= (3 \times 6.6875 + 4 \times .875) \div 10$$
$$= (20.0625 + 3.5) \div 10$$
$$= 23.5625 \div 10 = 2.35.$$

And for outer and middle rows

$3\text{-}10P+d$
$=.3\times 6.68875+.875$
$=2.00625+.875$
$=2.881.$

Of course these dimensions are all the minimum allowable, and if we exceed them it will not matter.

For the thickness of the metal forming the straps we have

$$\frac{5\times T\times (P-d)}{8\times (P-2d)} = \text{Thickness.}$$

Then

$$\frac{5\times 7(6\ 11\text{-}16 - \frac{7}{8})}{8\times 16(6\ 11\text{-}16 - 7\text{-}4)}$$

$$\frac{5\times 7\times 93\times 16}{8\times 16\times 16\times 79}$$

$=.321$ inches.

This is practically 5-16, but it would be just as well to use ⅜ plate, and thus have a margin over size to allow for wasting, and to make a better caulking edge.

The dimensions for the joint will therefore be:

Pitch outside row, 6 11-16 inches.

Pitch inner rows, 3 11-32 inches.

Diameter of rivets, ⅞ inch.

Thickness of straps, ⅜ inch.

Minimum distance between outer and middle rows, 2.33 inches.

Minimum distance between inner and middle rows, 1.66 inches.

Minimum diagonal pitch between inner and middle rows, 2.35 inches.

Minimum diagonal pitch between outer and middle rows, 2.88 inches.

The width of straps will be the sum of the distance between the three rows of rivets, plus 3 diameters, multiplied by 2.

The accompanying dimensioned sketch shows all the particulars.

WORLD-WIDE COAL SHORTAGE A MENACE TO INDUSTRY

As a result of the coal shortage which menaces the world, only the United States and Great Britain are assured of sufficient fuel to operate their industries at capacity during the coming winter, according to Joseph A. Broderick, vice-president of the National Bank of Commerce in New York. In an article on the International coal trade in the October issue of Commerce Monthly, the bank's magazine, he points out that although eventually a balance will be reached between demand and production, this cannot be hoped for in the near future. Neither shipments from new and remote fields nor the increased use of fuel oil and other substitutes will solve the problem for the present.

The article indicates that at the present rate of monthly receipts not a single importing country in Europe or South America is receiving a supply which is even approximately adequate. France is now receiving coal at about two-thirds the rate which would be necessary to assure operation of French industries at capacity; Italian receipts are about three-fifths of the estimated necessary amount; Netherlands is receiving only one-third the amount of coal required by its industries, and Norway is receiving approximately one-half. The situation is no better in the case of the other chief European and South American buyers in the international market.

"Only two countries of the world, the United States and the United Kingdom, to-day have reasonable assurance of sufficient coal to operate their industries at capacity during the coming winter," Mr. Broderick says. "In order to attain this security a definite limit has been placed upon the amount of British coal available for export, and in the United States exports have been automatically held in check by measures taken to assure domestic supplies. The fuel problem is the foremost question facing the industry of every country of Western Europe, except the United Kingdom. It is also to the fore in a number of countries outside Europe, chiefly those countries of South America which have heretofore been dependent on imported coal.

"The international coal trade is entirely dominated by the United Kingdom, Germany and the United States. Not only is the coal supply of importing countries now dependent upon the mines of these three countries, but there is no prospect for years to come of important additions from other sources to the amount of coal available for the export market. The recent emphasis placed upon small shipments from new and remote coal fields has been entirely out of proportion to their relation to the issue. A similar over-emphasis has also been placed on the proposed use of substitutes. Regardless of what the more remote future may hold, the present fuel problem will not be solved by the substitution of fuel oil for coal. The production of electricity from water-power necessitates elaborate installations at a time when capital is costly and difficult to secure, and extensive water-power projects require years for completion. Wood and peat are but poor substitutes for coal, and for many uses lignite likewise is highly unsatisfactory. Modern industry has been built on coal, and it is dependent on adequate supplies for its maintenance.

"The total shortage of coal in the international market is only a small part of the difference between actual production and probable output had the war not occurred, but when measured in terms of the effect on the countries which are suffering this shortage it is acute, and the only hope of meeting it lies in the productive capacity of the United Kingdom, the United States and Germany.

"No comment can add emphasis to the facts. British exports for the year cannot exceed 25,000,000 tons with an additional 13,500,000 tons for bunkerage of vessels in foreign trade. Exports from the United States much in excess of exports for previous years, that is, gross exports of 25,000,000 tons, and 7,000,000 tons for bunkerage, might result in a corresponding shortage for American consumers. Required German coal deliveries are probably in excess of the surplus which Germany would have available for export if German industry were to operate without a handicap.

"The degree to which industry and the routine of ordinary daily life are disorganized in these countries is determined in part by the seriousness of their coal shortage and in part by the extent to which they are industrialized. The north European countries are the worst sufferers. Ultimately a balance will be attained between consumption and production, but it does not appear that this can be hoped for in the immediate future. The international coal shortage is one of the most serious results of the wastefulness of war."

BRANTFORD NEEDS MORE POWER NOW

The shortage of coal, the scarcity of wood in the civic yards there were augmented when the Brantford city council was informed by the local Hydro-Electric Commission that this city was now carrying a load of 200 more horse-power than it was getting, and that the situation would get worse instead of better with the approach of winter, with lessened supply and greater demand. The only ray of hope was shed when the Gas Committee reported that with new fields opening up and available because of increased prices, the Dominion Natural Gas Company would be in a position to give assurance that a greater supply of better quality gas would be available for Brantford this winter.

Although no deposits of anthracite or bituminous coal have been found in Ontario, the province has considerable beds of lignite. This substance is more fibrous than common coal, and though it can be used as fuel, its heating power is much inferior. It also has an exceptional amount of soot and ashes. What we have been needing is some cheap method of converting it into marketable fuel. According to report this method has been found and a plant erected in the State of Victoria, Australia. It was designed and built by Roy N. Buell, of San Francisco. The means employed reduces the moisture in the lignite from 25 to 40 per cent., and an apparatus is used to draw the soot and dirt out by suction. Under test the boiler efficiency of the fuel was 80 per cent. and the furnace 78 per cent. If the process operates successfully, as claimed, the new invention will mean much to the manufacturers of the United States and Ontario.

Oil Firing Installations for Land Boilers

The Following Points on Burning Oil Under Land Boilers Are Reprinted from "The Practical Engineer" and Contain Many Valuable Hints and Suggestions.

By G. F. WARD

WITHIN the last six months much has been said regarding the introduction of liquid fuel for marine purposes. A great number of papers have been written and in some cases they have touched on the application of oil firing for land boilers.

To apply successfully oil firing to, say, a Lancashire boiler, is very different from the application to a large marine water-tube boiler. I do not wish to infer that the same plant would not be successful in working in each case. Such a statement would be erroneous. My point is simply a question of initial cost together with efficiency obtained.

It is, perhaps, more a question of the type of installation to be used: the oil pressure jet system as used for marine work against the cheaper air and steam jet systems.

There is still a great deal of prejudice against the use of liquid fuel for land boilers, chiefly on account of present-day market price of oil. In a great many cases high-grade oil is chosen for comparison. The writer has successfully burnt mixtures of pitch and creosote and the by-product from Mond gas plant, which before the war was worse than useless refuse.

Steam and Air Jet Burners

To deal efficiently with the heavy types of liquid fuel, the steam and air jet systems are much to be commended, more especially for low-pressure boiler plants.

With the steam jet burner, the oil is atomized by the steam pressure and at the same time inducing a quantity of air into the burner, spraying the mixture into the furnace at a high temperature. With this system, between 3 and 4 per cent. of the total steam raised is required for jetting and recovering about 70 per cent. of the calorific value of fuel used.

In large installations the use of air at about 4 lb. pressure is much more economical, and test results have shown that nearly 76 per cent. of calorific value of fuel is recovered in actual work. The additional plant required for air jetting is a small air compressor. Heated air is supplied by leading air pipe alongside flues of boiler, and in the case of the Scotch boiler through smoke-box at boiler front.

Installation

The writer has often noticed that sufficient care is not exercised in the installation, more especially with regard to pipe lines and position of tanks. Main storage tanks should not be less than 40 feet from boiler-house, and, if possible, fixed below the ground level. The advantage of this arrangement is that the supply oil may be quickly discharged into a tank from barrel or railway tankers, and in the latter case does not necessitate keeping expensive rolling stock idle while the oil is being pumped out—often a long and tedious operation.

Suitable heating coils are arranged in storage tanks to assure easy passage of oil to pump, and then to gravity tank. A good plan is to entrench the steam pipe to the heating coil alongside the main oil discharge to pump, thereby ensuring oil being kept at an even temperature from tank to boiler-house.

A small oil pump is required to raise the oil from storage tank to gravity tank. Oil tanks are frequently placed immediately above the boilers, a practice not to be commended on account of danger of the oil dripping upon hot surfaces. A head of about six feet should be allowed from gravity tank to burners.

The question of filtering the oil is often troublesome, owing to oil filter of inadequate capacity being used. The writer has found a large box filter made of iron gauze well fitted in a wire cage to be the most suitable. This is fixed in the gravity tank, the oil supply being let into it and filtering through the gauze into the tank. It is essential that the filter should be kept clean, especially when using very heavy oil. Irregularity in oil supply at the burner is often due to filter trouble.

For both steam and air jet burners, the temperature of oil should be between 135 degrees and 150 degrees Fahrenheit, depending on the density of the fuel. This is best regulated by means of a thermometer placed in a pocket containing water and suspended in the oil gravity tank, the steam supply to the heating coil being adjusted to suit the required temperature. On no account should the oil exceed the temperature of 150 degrees Fahrenheit.

Heating coil joints are better brazed or welded together to eliminate water leaking and mixing with oil fuel. Any accumulation of water in the gravity tank should be drawn off by means of drain cock on bottom of tank.

The best position for the oil delivery pipe connection to burners is about six inches from the bottom of gravity oil tank so as to allow ample room for any sediment to gather which may have escaped oil filter. Whenever possible, straight lengths of oil piping are to be preferred, and should be of ample diameter to allow a free flow of oil and easy cleaning of pipes.

The usual form of furnace front equipment for both steam and air jet systems consists of a large cone-shaped fitting attached to the furnace, the fire-bars being removed. Suitable air ports are cut in the sides of this fitting for the admission of extra air, and the burners are fitted immediately in front of the furnace.

Care must be taken in adjusting extra inlet ports. Admission of an insufficient quantity of air will produce a blood-red smoky fire. The correct flame should be transparent and of an intense white color, or approaching a pink when using light oils.

The writer has seen burners fitted to Lancashire and Scotch boilers with little or no alteration to the boiler fronts giving excellent results. Expensive and complicated boiler front fitting will often give trouble unless a really reliable boiler attendant is in charge.

It is sometimes advisable to line the furnace with fire-bricks a few feet from the front to avoid the oil spray coming in contact with cold plates before complete combustion takes place. A good back bridge of fire-brick is essential, so that the flame will beat against it, and thus avoid striking cold surfaces.

Variations in the boiler load should be met by variations in oil jetting and air control. It is often thought quite unnecessary to regulate the boiler damper when firing the oil. To many there are only two positions for the damper—full open or closed. The attendant acts upon the theory that draught is made to be used, and as much as possible should be used. A little care in this direction will do much in maintaining combustion efficiency.

Burning Solid and Liquid Fuel Together

We are told that large quantities of low-grade fuel are daily placed on the dump heap as being useless. Indeed, it is said that nearly fifty million tons per annum of low-grade fuel is wasted. At the pit head this is termed unsaleable fuel, and is made up of mine sweepings, residues from colliery washeries and such like. Many attempts have been made to burn this fuel in boiler furnaces, but difficulty is always experienced in maintaining the full boiler load, owing to the low value of the fuel.

By the introduction of, say, 15 per cent. of liquid fuel to burn in conjunction with the solid fuel, a great saving in the weekly fuel bill will be effected.

In the case of a Lancashire boiler, a small burner may be inserted immediately over the fire-door at an angle, pointing slightly towards the fire-bars. The oil will then burn immediately over the solid

fuel and will materially assist in obtaining complete combustion.

A similar arrangement may be applied to water-tube boilers, and in the case of generating stations will be found useful in order to enable a sudden demand for extra power to be met. The question of oil firing for land boilers is to be considered in spite of the present high cost of liquid fuel. It has many advantages over coal firing, and, providing care is taken in the work of installation and proper adjustment, little or no trouble will be experienced in operation.

The Construction of a Bell Ringing Transformer

By ROBERT G. FLAVIUS

Copyright. All Rights Reserved.

BY following the instructions herein given, a transformer suitable for a primary voltage of 110 and a secondary voltage of 10 volts can be constructed. The secondary circuit has a capacity of about 1 to 1½ amperes. This device can be applied for any of the services for which bell ringing transformers are ordinarily used. It will ring vigorously an ordinary vibrating signal bell or will light a 10-volt tungsten lamp requiring about half an ampere and producing four candle power. It can also be used for driving such small electrical toys and motors as will operate on alternating current. The secondary winding is provided with a 50 per cent. tap, so that a pressure of five volts can be obtained therefrom.

It will be found that if the transformer is constructed in accordance with the directions its exciting current will be negligible, that is, when it is connected to a source of 110 volts and no current is being drawn from its secondary, practically no current will flow through the primary winding. Such a transformer will not take enough current to operate a watt-hour meter when the secondary of the transformer is open.

Fig. 1 shows the transformer assembled in its case complete. One of the stampings from which the core is built up is shown in Fig. 2. The core mounted on its supporting studs with the winding in position is diagrammed in Fig. 3. Fig. 4 shows the temporary core form upon which the winding is served and in Fig. 5 is illustrated the winding complete. Fig. 6 details the sheet iron case, and Fig. 7 illustrates other details of the device.

In making the instrument, the first move is to cut the sheet iron pieces which will comprise the core. One of these pieces is shown in Fig. 2. The sheet iron from which these core pieces are cut should be as thin and as soft as possible. Any soft sheet iron thinner than 1-32 in. either tinned or plain, will do. However, probably the most desirable material is No. 27-gauge sheet steel, which is about 0.017 in. thick. In any event, enough pieces like that of Fig. 2 should be cut to make a pile of ¾ in. thick. If No. 27 gauge steel is used, about 45 pieces will be necessary. These 45 pieces can be cut from a sheet 18 in. square.

The pieces can be cut with an ordinary tinner's shears. Note that a cut C is made at the upper end of the tongue of each piece. This cut is necessary to provide for the insertion of the pieces in the form wound coil to be described later.

After a sufficient number of pieces have been cut, they are clamped into a pile ¾ in. thick. Then a hole ⅛ in. in diameter should be drilled, in the location shown in Fig. 2, in each of the four corners of the pile. These holes are to accommodate the supporting studs shown in Fig. 3. The supporting studs should not be inserted at this time.

*Copyright, all rights reserved.

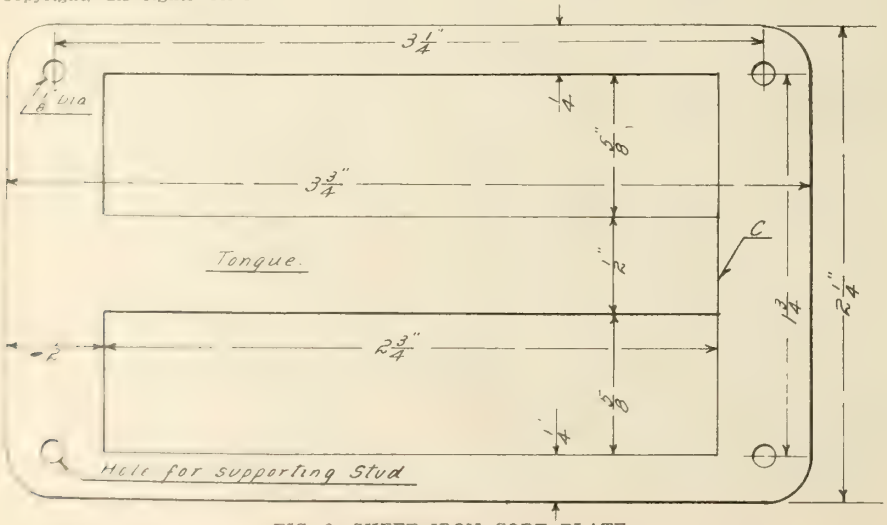


FIG. 2—SHEET IRON CORE PLATE.

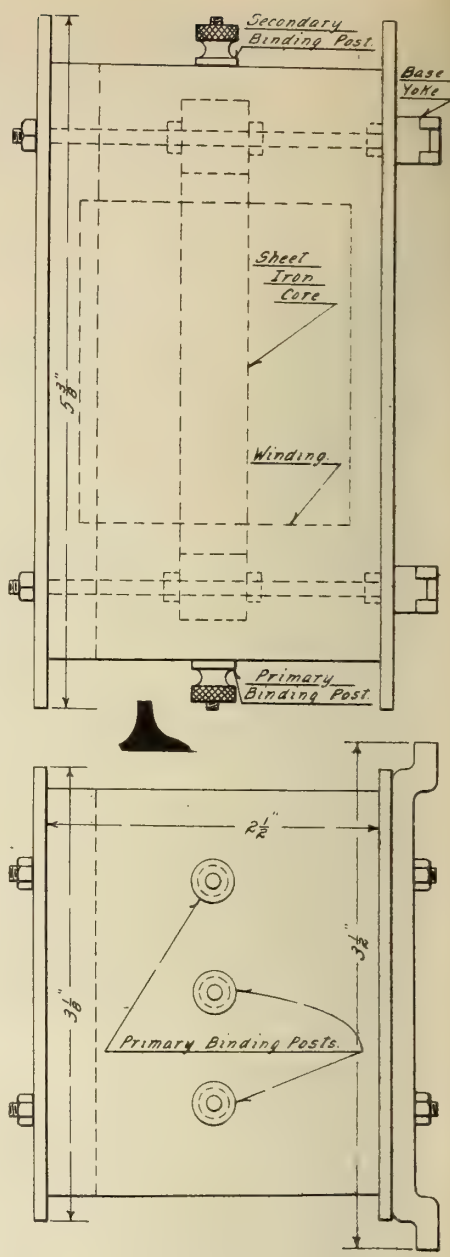


FIG. 1—TRANSFORMER ASSEMBLED.

The next step is to wind the coil. To do this a form is prepared as shown in Fig. 4. This form consists of a prism of wood ½ in. x ¾ in. x 4 in. Its ends should be arranged for centering in a lathe or some other winding device so that it can be rotated. A serving of about a dozen layers of heavy paper is wound around the wood prism, but should not be cemented to the prism. Then a strip of oiled linen or friction tape should be placed at each face of the prism over the paper wrapping. Each of these strips should be about 5 in. long and will project about ½ in. at each end of the block. Now a small wooden block B (Fig. 4), is fastened to each face of the prism with wood screws. These blocks should be so located that there is a clear space lengthwise of 2½ in. between them. In this space, between the blocks, a couple of layers of shellacked paper and four layers of oiled muslin or friction tape should be wound for insulation. The form is now ready to have the windings put on it.

The primary winding should now be served around the form. This should consist of about 3,000 turns of No. 34 wire. Enamelled copper wire should be used if it is available, but if not, double cotton-covered wire can be used instead.

Since the insulation on the cotton-covered wire is thicker than the enamelled insulation, the transformer will be bulkier if it is used. Between every four or five layers of the wire, which should be served on evenly and regularly, a sheet of oiled linen should be inserted for insulation. After all of the turns of the primary winding are in place five layers of oiled muslin should be wound around it and cemented in place with shellac.

Now the secondary winding can be made. This is wound directly over the primary and should consist of about 290 turns of No. 24 enamel-covered copper wire. The same condition obtains with the secondary as with the primary winding, that is, if enamel-covered wire is not available, double cotton-covered wire can be used, but it will require more space for the same number of turns. After half of the secondary winding is in place, a tap about six in. long should be looped out from it to constitute the five-volt tap referred to in the first paragraph.

The winding being completed, it should be tested for grounds between the primary and the secondary and within the primary and secondary. If faults are discovered it will be necessary to rewind the coil to eliminate them. If the windings test clear, the blocks B (Fig. 4), are removed and the ends of the cloth strips S are pulled back to the winding and turned over it tightly. Then the whole winding is served with a couple of layers of friction tape to hold the layers and the ends of the cloth strips in place. This friction tape serving also constitutes a protection for the winding. Now drive the wood prism P, upon which the windings were served, out of the coils. This can be done by tapping on it gently with a hammer.

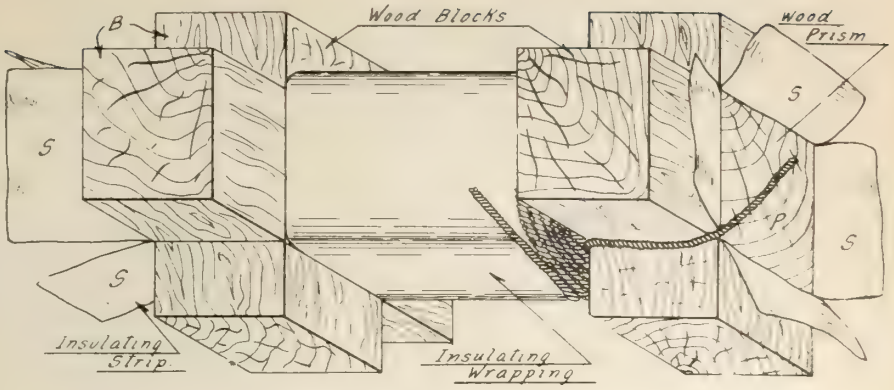


FIG. 4—FORM BLOCK PREPARED FOR WINDING.

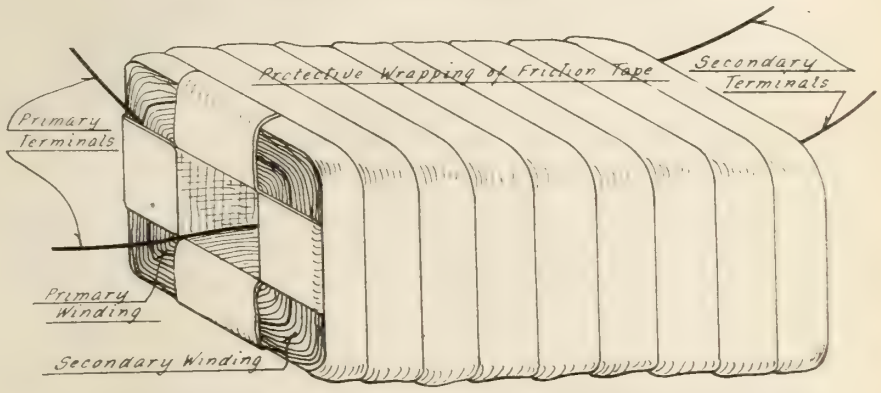


FIG. 5—WINDING COMPLETE.

The coil is now finished and will appear about as shown in Fig. 5. It should be painted a couple of coats of shellac to cement the tape in place and to provide additional insulation.

The core pieces, Fig. 2, can now be assembled in the coil. This is effected by bending the tongue of each strip until it stands at right angles to the balance of the strip. The tongue is then inserted into the hole in the coil and the remainder of the strip bent down until it lies in the same plane as the tongue. This process is repeated with each of the core pieces. In inserting the core pieces, the cuts C, should be staggered, that is, if the first piece is inserted from the right hand end of the coil, the next piece should be inserted from the left hand end, and so on until the pile is built up to the required thickness of ¾ in.

The supporting studs shown in Fig. 3 are made by threading four ⅛ in. x 3 in. round rods. Two nuts are run on each rod after it has been pushed through the core, and then these nuts are set up tightly, binding the core plates firmly in position. Sheet iron, either galvanized or painted, is used for making the case which is detailed in Fig. 6. Three binding posts are set in one end of the case, as shown in Fig. 7-II, for the secondary terminals, and two binding posts for the primary ter-

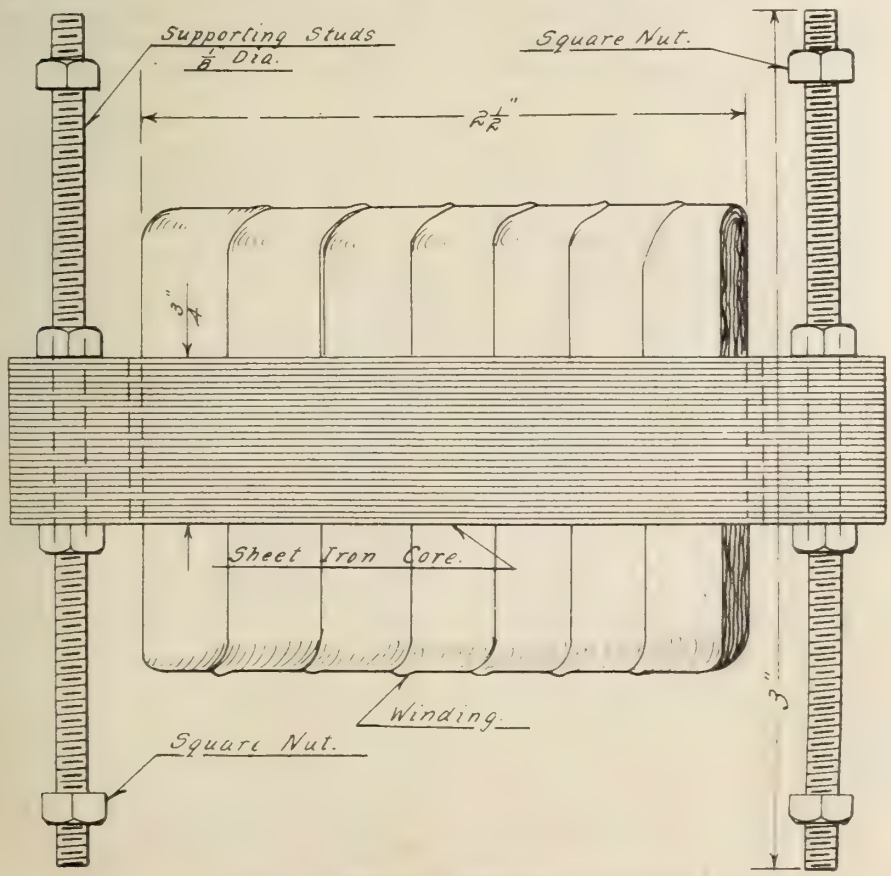


FIG. 3—WINDING ASSEMBLED ON CORE.

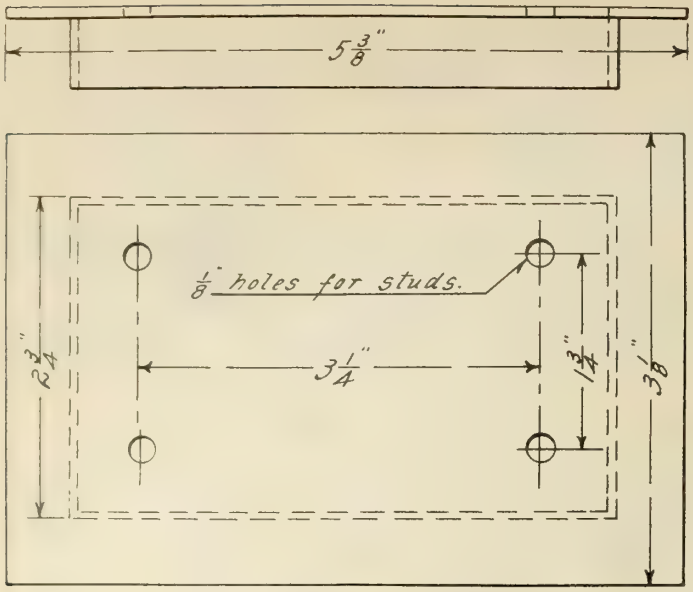


FIG. 6—DETAILS OF COVER.

minals are arranged on the other end of the case. The punchings for these binding posts should be made in the sheet for the case before it is bent into its final contour. The cover for the case shown in Fig. 6 is also of sheet iron. To provide support for the transformer and case, two yokes are bent from strap iron as shown in Fig. 7-I. The two holes in each of these yokes, 1¾ in. apart, are for the accommodation of the supporting studs which are clamped therein with a couple of nuts. The remainder of the construction of the device will be apparent from the illustrations. The two wires from the primary winding should be connected to the primary binding posts. The outside ends of the secondary winding should be connected to the two outside secondary binding posts, and the five-colt tap should be connected to the middle binding post.

These binding posts must be carefully insulated from the case with fibre or mica washers as shown. The stud of each binding post is wrapped with tape where it passes through the metal, which constitutes an insulating bushing.

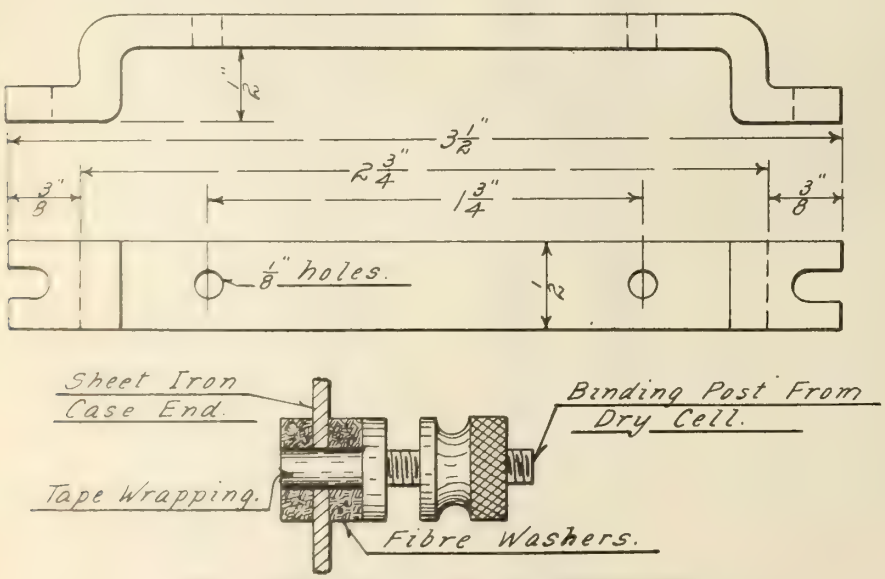


FIG. 7—DETAILS OF YOKE AND BINDING POSTS.

HYDRAULIC NEVER TO REPLACE COAL

Interesting Figures Brought Out by Authority in United States Field

Dr. Charles P. Steinmetz, chief consulting engineer of the General Electric Company, New York, warns against a too general belief that the power of our water may ever completely replace the use of coal and oil for power purposes.

The maximum possible hydraulic energy of the nation, he estimates at the tremendous figure of 370,000,000 horsepower, which is little more than the total energy which we now produce from coal, and is about equal to the present total energy consumption of the country, including all forms of energy.

"This is rather startling," said Dr. Steinmetz. "It means that the idea that when coal once begins to fail we may use the water power of the country as the source of energy, is, and must, remain a dream, because if all our potential waterpowers were developed and every raindrop used, it would not supply our present energy demand.

"Thus hydraulic power may and should supplement that of coal, but can never entirely replace it as a source of energy. This probably is the strongest argument for efforts to increase the efficiency of our methods of burning coal.

"Obviously, of course, we can never hope to develop more than a part of the maximum potential energy of the water, and I merely cite these figures to show that our water power resources, if developed, to theoretical perfection, would still fall short of meeting the energy demands of the country to-day."

The total present developed water power in the United States exceeds 7,000,000 horsepower with 19,000,000 still undeveloped, and potential water power capable of development amounting to 31,000,000 horsepower.

The present use of water power saves the country from upward of 33,000,000 tons of coal annually.

TRADE ANNOUNCEMENT

Announcement is made by the American Steam Conveyor Corporation of a change in their corporate name to the "Conveyors Corporation of America."

The change in name is due to the rapid growth of the corporation, the addition of new lines of business and the purchase at South Bend, Indiana, of a large and completely equipped machine shop to which foundry facilities will be added.

The new name more nearly describes the present business of the organization. Their line includes steam jet conveyors for handling ashes, soot, combustion ash, etc.; trolley carriers for handling coal, limestone, sand, gravel, and like loose, bulky materials; ash pit doors; flood oil bearing sheaves and other conveyor supplies.

The acquisition of a new machine shop at South Bend, Indiana, will afford unusual prompt service and will meet the strictest requirements of the customers.

There is no change either in the personnel or policy of the company.

PORTABLE PROJECTOR

The Graphoscope Development Co., 50 E. 42nd St., New York City, have issued a moving picture apparatus especially designed for the use of salesmen. This complete unit, ready for operation, is packed in a case of about the same size as an ordinary suitcase. It is equipped with a motor drive and is of simple construction. The machine uses standard films and will project a picture 10 feet square at a distance of 35 feet.

EXPLOSION OF A SCOTCH MARINE BOILER

From "Travellers Standard"

Boilers of the Scotch marine type are widely employed in Great Britain, where they are considered to be reasonably safe and economical. They have never been extensively used in American land practice, although they are by no means unknown in this country, and in some sections they are frequently met with. Occasionally one of them fails, and the accompanying illustrations show some of the damage that resulted when an accident of this kind occurred recently. The fireman, who was the only person about the boiler house at the time, was killed, and the property loss amounted to about $7,000.

THE RUPTURED FURNACE.

The boiler that exploded was No. 2 of a battery of two boilers of similar type and size, which were installed in the plant of the Detroit Creamery Co., at Owosso, Mich. Each boiler was 90 inches in diameter and 13 feet 3 inches long. Each had a single furnace, 47 inch in diameter and 12 feet 10 inches long, composed of five sections of steel plate, each ⅜ of an inch thick and about 30 inches long. The furnaces were of the plain type—that is they had no corrugations or stiffening rings or flanges—and the girth and longitudinal seams in the furnaces were of the single-riveted lap-joint type.

The explosion occurred at about 5.30 p.m. on June 17. The furnace of the boiler failed by collapsing throughout its entire length, and by rupturing the first girth seam. About half of the rivets sheared, and the metal in the plates pulled away from the rivets in the remaining part. The rupture extended about 39 inches around the top of the seam, and the upper part of the front course of the furnace was pushed down and forward.

WHERE THE BOILER LANDED.

The fireman was blown across the river and against the wall of an old packing plant—a distance of 500 feet or more. The boiler was thrown some 600 feet in the opposite direction, and struck the rear end of a residence. It moved the house at least a foot on its foundation, crushed a woodshed, and damaged two other houses and a nearby automobile. The boiler house was destroyed, and boiler No. 1 was moved out of position. The steel stacks on the boilers were tipped over upon the creamery building. The boiler shell was not materially injured, and can be put in service again after new tubes and a new furnace have been installed. Examination of the boilers after the accident led the investigators to believe that low water was the primary cause of the explosion. The metal showed evidence of overheating, and there was also testimony to the effect that water was being introduced into the boiler at the time of the accident. The mode of failure also tends to confirm the low-water theory, because the first girth seam, which was in the hottest part of the furnace, would be first affected.

The boilers were constructed and installed in 1913, and at that time plain furnaces were quite commonly used. This construction is not favored at present, however, and would not be accepted for the pressure under which these boilers were operated (namely, 85 pounds) in localities where the A. S. M. E. code, or some other similar code, is in effect. In fact, the A. S. M. E. code limits the diameter of an unstayed furnace of this kind to 38 inches.

NEW BULLETIN

The Hays automatic CO_2 and draft recorder is described in a new bulletin just issued by the Jos. W. Hays Corporation, Michigan City, Indiana. The bulletin describes fully the unpacking, erecting, pipe layout, and operation of the recorder. It is well illustrated, and a diagram of spare parts, numbered to correspond to a spare part index, is included. This is a very useful little book for all users or prospective users of these instruments.

George W. Cole, Ltd., Toronto, have issued a new bulletin descriptive of their steam traps and steam trap installations. Diagrams and illustrations of actual installations are given, and line drawings of the operating features of the trap included. The bulletin also illustrates heaters, check valves, radiator valves, etc., handled by the firm.

CATALOGUE

The Armstrong Cork and Insulation Co., Pittsburgh, have issued catalogues descriptive of their Cork Tile for flooring purposes, also their Linotile floors These catalogues are well illustrated in colors, and the different applications of the flooring specified.

Dominion Motor Castings, Ltd. Incorporators: Clifford Albert Ripley, manufacturer; and others, all of Detroit. Capital $250,000. Head office, Windsor.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)

A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.
UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.
GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, OCTOBER 5, 1920 No. 19

PRINCIPAL CONTENTS

A Simple Low Pressure Steam Control Device 437
Development of Long Distance Transmission 440
A Course of Instruction 444
Oil Firing Installation For Land Boilers 447
Construction of a Bell-Ringing Transformer 448
Explosion of a Scotch Marine Boiler 451
Editorial 452
Development in New Equipment 454

Selecting Coal by the Microscope

AT the recent meeting of the Iron and Steel Institute in England, a paper was read by Mr. A. L. Booth of Manchester, in which he drew attention to a method of selecting coal, which is of great interest. After pointing out that though many methods of ensuring fuel economy in the burning of the fuel had been advocated and tried, but little attention had been paid to the selection of the right class of coal for the service required. While a good deal of dependence was placed on analysis where it is used, Mr. Booth claims that this is a very unsatisfactory means of determining the value of a coal. He points out that two kinds of coal may give the same analysis and look practically the same, and yet give totally different results when used in the furnace. Most men who have had much experience in the burning of fuel under boilers will agree with this statement. The conditions under which the test is made in the laboratory, and those under which the coal is burned in the furnace, are so vastly different that there is little wonder that fuels often fail to give the results which might be expected from their chemical classification.

The author of the paper claims that in order to select coal intelligently, it is essential that a knowledge of its formation should be possessed by the person selecting. He is, of course, dealing with British coal seams, and gives the various formations as follows: At the bottom occur leaves, small stems, broken-down wood tissue, etc., from ferns, horse tails and cordiates; and above, the main bulk of the coal is made up of the remains of Lycopods, which include the great Lepidodendrons, Sigilarias, the spore bearing trees, and above these again the "Cannels," which are a class apart. These fossil remains therefore form three types of coals: the "Humic" composed of leaves, stems, and brokendown woody tissues, together with some spores; "spore" coals, in which both "micro" and "Meg" spores predominate, and "Cannel" coals. These coals are not found in absolutely separate and distinct layers, but run into one another, the "Humic" coals often containing a large amount of spores, while the "Spore" coals become more and more "cannelized" as the yellow bodies which are characteristic of cannel merge with the spores. It is due to this condition that the author claims microscopic examination becomes necessary to determine what work a particular sample of coal is most fitted for.

The usual method of classifying coal from the chemical standpoint is by the relation between the carbon and hydrogen, and the relation between carbon and oxygen. These comparisons are, according to the author of the paper, open to objections. He points out that in the "Humic" coals a large amount of cellulose is present, and if this remains even in a small degree in the coal as finally mined and ready to burn, it will have a very marked influence on the hydrogen and oxygen content of the coal. The following tables show this effect. The first table is a chemical analysis of Humic coals, calculated on ash and sulphur free dry coal. These coals swell and coke in the furnace. The second table covers Spore coals, which do not swell or coke, and the third table shows the ratios of C:H and C:O in the two classes of coal.

TABLE NO. 1.

Carbon per cent.	Hydrogen per cent.	Oxygen per cent.
88.0	5.96	5.65
83.2	4.78	11.16
82.6	5.83	10.5
87.6	5.12	5.8
87.0	6.22	5.2

TABLE NO. 2.

Spore Coals

Carbon per cent.	Hydrogen per cent.	Oxygen per cent.
88.0	5.72	5.14
88.1	5.54	5.32
86.0	5.16	7.5
81.8	5.39	11.74
83.2	5.56	9.34

TABLE NO. 3.

Humic Coals.		Spore Coals.	
C:H.	C:O.	C:H.	C:O.
14.7	15.55	15.4	17.1
17.4	7.5	15.9	16.5
13.9	7.9	16.7	11.4
17.1	15.1	15.2	6.96
14.0	16.7	14.8	8.9

The author of the paper points out that on the strength of these analyses the coals would be classed as bituminous, and in his opinion any system that would class these two kinds of coal together is useless. It was due to the unsatisfactory nature of the chemical classification that the microscopic method has been adopted in England in the selection of 250,000 tons of coal per year.

The microscopical examination showed that there were three main types of coal, each suitable for a particular class of work. Further work showed how far it was possible to go from the particular type without getting a coal that would give unsuitable results. The microscopical examination is used together with a chemical analysis, and the following points are necessary to help in making a decision:

Approximate analysis. 2. The percentage of total sulphur. 3. The percentage of sulphur in the ash. This is necessary to get the amount of sulphur that will be carried

away in the products of combustion. 4. An analysis of the ash itself. This is necessary in order to form some idea of the tendency to form clinker. The author points out further that the laboratory determination of the fusion point of ash is not reliable, as the size of coal, and the the presence or absence of steam influences the point of fusion to a great extent. If powdered coal is to be used, it will be necessary to determine the percentage of phosphorus.

The microscopic examination, it is stated, is useful in determining whether or no it pays to wash coal, and will often explain why a good clean appearing coal will often have a high ash content.

It is also useful in case where there is shortage or a particular class of coal cannot be obtained, in determining the best substitute. The author admits that this method of selecting coal is beyond anyone but the large consumer, but suggests that a number of firms or collieries might combine to perform the work. He holds out the hope that it may some day be possible to buy coal by specification as steel is now bought. He brings out the interesting fact that coal cut from the same seam, at intervals of twelve years, was shown to be of the same type under the microscope. In the published paper are sixteen colored photomicrographs showing the various types of coal, and the text gives their numbers and descriptions of each one. We unfortunately cannot reproduce these photomicrographs.

Although this may seem perhaps to be of only academical interest to many users, it does explain very satisfactorily what has been a cause of wonder to many engineers and coal purchasers. It is quite a usual experience to buy coal which shows a certain heat value by analysis, and find it gives a very much lower value when burned beneath the boiler. This is particularly the case with the very small sizes of anthracite, such as No. 3 and No. 4 bird's-eye, which acts altogether differently in actual practice than in the laboratory. It has a very high ash content by analysis in many cases, but even where the analysis gives a reasonable ash content, the actual amount of ashes pulled from the fire is usually much greater than would be expected. This is due to the low fusion point of the ash, and it has been the cause of many heated arguments and dissatisfaction on the part of plant managers with the man in charge of their plant, and much discouragement to the unfortunate individual who is supposed to get results from it.

The full paper can be obtained from the secretary of the British Iron & Steel Institute, or from the printers, Spottiswoode, Ballantyne & Co., Ltd., Colchester, London and Eton, England.

A Great Natural Resource

THE value of science and scientific research to a country's development was strongly emphasized in a recent speech made by Professor McLennan, of the University of Toronto. It will be well known to many of our readers that Professor McLennan was a very valuable member of the Board of Naval Inventions, presided over by Admiral Fisher during the late war, and it was he who was largely responsible for many of the most successful methods devised to combat the submarine menace, and for the wonderful means of guiding ships through a mine field by means of a submerged cable. In his speech the Professor stated that in the daily press, and in daily conversation, and in daily thought the natural resources of Canada were greatly exaggerated. We had at one time possessed wonderful natural resources, but these had been dissipated and thrown away with a prodigal hand, and we were now faced with the problem of making the best of what was left. Here was the place that science could prove its value. For instance, the great nickel deposits had been denuded of the best of their ore, and the problem was now faced of getting nickel from low grade ore, which was a problem for the scientist. The same thing applied to iron ores. Agriculture was carried on in what seemed to him a most wasteful fashion. Instead of using artificial manures or fertilizers to get an increased yield from the land, a larger area of land was cultivated, which, in these days of high wages and scarcity of labor, added materially to the cost of production. At Niagara Falls was a plant producing cyanide which was a basis for artificial fertilizer, and this was all shipped to the U. S., as there was no sale for it in Canada. The great lignite fields of the Western provinces would soon be available for commercial use, thanks to the achievement of scientific research and experiment. Professor McLennan insisted that the greatest natural resource that Canada possessed was in the intellects of the young men who were growing up now, and he regretted the fact that the most brilliant young men that were turned out at the university were lost to the country. They were taken by firms in the United States who knew the value of scientific research, and opened up possibilities for these young men that were too attractive for them to refuse. Here was another case where our resources were being thrown way. Canada trained these young men and then when they were trained and ready to be of use to their country they were allowed to take their brilliant intellects and capacity for good work away from the country of their birth, which needed them most. This was something for employers and manufacturers in general to think over, and something that is of interest to all Canadians. Prof. McLennan stated that the most brilliant intellects that had come under his notice in recent years were to be found in the large engineering and industrial firms of the United States, who came to Toronto year after year in search of just such material. This is a state of affairs that should never be allowed to continue in a country that prides itself on its wide vision and general business acumen to the extent that Canada does. Professor McLennan's remarks should receive the widest publicity, the more so as they come from a man whose scientific abilities have been devoted to work in the last few years that had a material effect on the ultimate victory of the Allied forces.

Pays Tribute to Business Press

"THAT, in the opinion of this Congress, it is desirable, with a view to the encouragement of closer trade relations within the Empire, special efforts should be made to secure the wider distribution of trade journals throughout the Empire, and that more favorable postal facilities should be accorded by the various governments to the end."

The above is copy of resolution unanimously passed at the meeting of the British Chambers of Commerce held in Toronto. It was moved by Mr. Symonds of the London, England, Chamber of Commerce, and seconded by Sir Thos. Mackenzie, former Prime Minister of New Zealand.

This important resolution stands out in bold contrast with the effort put forward by Mr. E. Nicholls, Director of National Publicity for the Government at Ottawa, to legislate the trade and technical papers out of business. In spite of the opposition of M. E. Nicholls and J. E. Atkinson of Toronto Star, the Chambers of Commerce of the entire British Empire composed of many of the best trained business and technical experts have seen fit to pass this resolution emphasizing the great importance of the specialized business and technical press to those who would better understand conditions in the various parts of the Empire. The incident again shows the need of our governments selecting men of clear-sighted vision to look after the country's welfare.

Progress in New Equipment

PUMPS FOR CORROSIVE LIQUIDS

The development of the chemical industry continually makes demands upon the engineer for apparatus of a special kind, which, furthermore, is required to operate under conditions which call for properties entirely outside the ordinary characteristics of mechanical equipment.

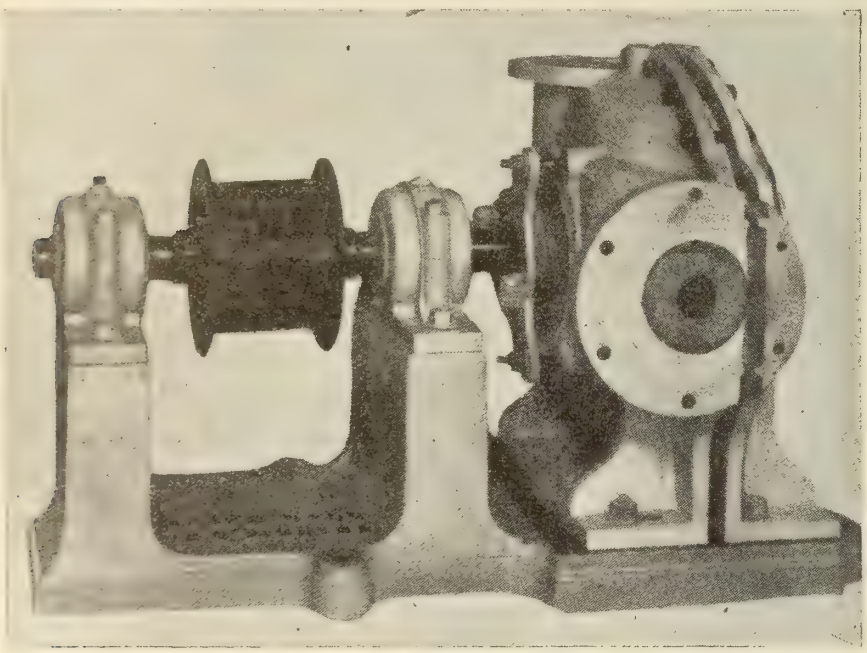


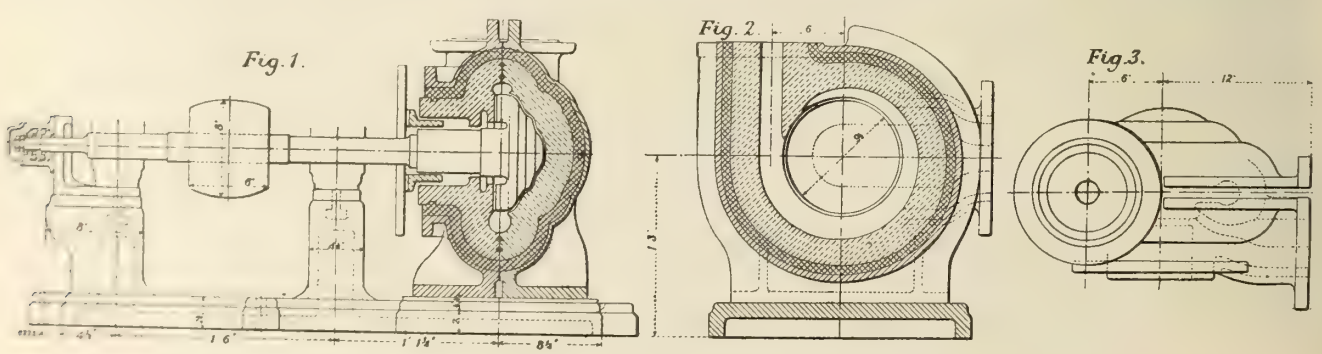
FIG. 4.

Strongly corrosive liquids have to be pumped and stored, often at a high temperature and considerable pressure, and not only must this be done with complete safety to the operators, but the apparatus must be neither dissolved, corroded or eroded in the process. Should the pumps, piping or vats, etc., be attacked by the substance in contact with them, their rapid destruction might be the least of the trouble. Any such attack would necessarily contaminate the chemicals with the dissolved material, and might easily be serious enough from this point alone to render the process impracticable.

When the conditions are very severe, pumps of the reciprocal type are out of the question, as the centrifugal pump with its natural simplicity of construction, its absence of internal rubbing surfaces and its freedom from valves possesses obvious advantages. Centrifugal pumps, therefore, are widely used for pumping corrosive liquids, and they are made of various materials. Ferro-silicon will resist some acids, but cannot be used for hydrochloric acid or in processes where contamination with iron must be avoided. Lead and regulus metals are also used for pumps but are unsuitable for some acids and for solutions containing metallic salts. Ebonite pumps have been built, but these naturally will not withstand hot liquids, while certain chemicals will attack them. Moreover, ebonite is a bad material for the rubbing surfaces of the glands.

The substance which is most generally suitable for resisting the action of corrosive liquids is some kind of silicious ceramic material, as this can be obtained in forms which are quite insoluble in almost any liquid. Ceramic material is also of a very hard nature, so that it is practically unaffected by erosion. Hence, in spite of its intractable disposition and somewhat unsatisfactory mechanical purposes, it has been brought into use for many purposes. A new acid-ware, called ceratherm, was prepared during the war under the necessity of finding some substance suitable for apparatus for the condensation of large quantities of acid gas. Like silica-ware, it can be plunged when red hot into cold water without cracking, and its good heat conductivity permits of a rapid equalization of temperature in vessels of which it is made.

A modified form of ceratherm, having a higher tensile strength, and possessing the further advantage of being more easily manufactured to accurate dimensions, has been adopted by Messrs. Guthrie & Co., of Accrington, in the manufacture of their acid-proof pumps and other articles. The material is entirely unaffected by almost every chemical solution and may be brought into contact suddenly with either hot or cold liquid without any danger of cracking. The use of this material has enabled Messrs. Guthrie & Co. to put on the market a line of pumps which mark a distinct advance in design and construction over the German made apparatus which was used in this country before the war. The general nature of the ceratherm acid-proof pump will be understood from Figs. 1 to 6. The acid-proof material,

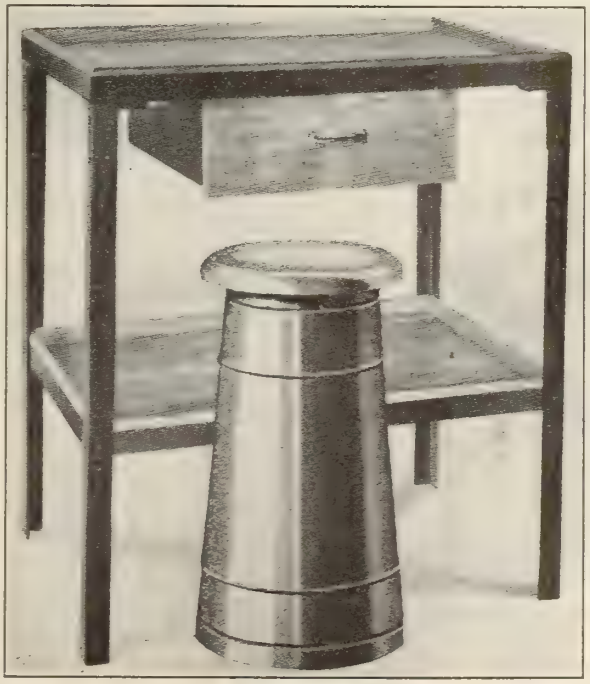


FIGS. 1, 2 AND 3.

FIGS. 5 AND 6.

forming the body of the pump is very thick and strong and is cemented into an iron casing. It is so arranged that it is only subjected by the bolts to crushing stress. The gland through which the spindle passes is usually on the suction side, so that it is relieved from pressure and the stuffing-box is packed with a small quantity of wool, usually soaked in paraffin wax. Various types of impeller are used, according to the duty required. Figs. 5 and 6 show open and closed types in position in the half-casing of the pump. In Fig. 5, the gland is on the pressure side. In all cases the impeller shaft is continued right through the gland and the internal metal spindle is screwed into a cementing material which fills the interior of the shaft and is also held by screw threads formed in the latter. When the impeller is mounted it is ground and balanced on its own spindle. The thrust of the impeller when working is taken up by a ball bearing at the end of the spindle far removed from any danger from acid. The requirements of the chemical industry usually call for a pump designed for lifting comparatively small quantities, say, from 20 gallons to 100 gallons per minute, against a head of anything up to 120 ft. Comparatively high efficiencies are claimed for these little pumps, although when the total power absorbed is so small the question of efficiency would not seem a serious matter. Ceratherm pumps have been built for a head of 300 ft., which corresponds to a pressure of 130 lb. per square inch in the pump casing. Four-inch pumps are constructed to deliver 400 gallons per minute at a head of 90 ft. when running at 1,000 r.p.m. The range of sizes built by Messrs. Guthrie & Co. runs from deliveries from 10 gallons to 5,000 gallons per minute, and comparatively slow rotational speeds are adopted, so that the usual factor of safety of the impellers is about 15 at the normal speed of the pump. They have been used successfully for some years on a commercial scale for pumping sodium peroxide, both hot and cold solutions, a substance which is very troublesome to pump and for which a metallic pump would be useless as the slightest particle of metal passing into the process would do considerable damage. Other awkward liquids such as hydrochloric, nitric and acetic acids, both hot and cold, are also being handled successfully by pumps of this type, and, in fact, the makers claim that they have not yet found any liquid which the ceratherm pump will not deal with successfully.

In addition to the use of ceratherm for the construction of pumps Messrs. Guthrie & Co. employ the same material for valves and for the linings of acid eggs and large vats, etc., as its smooth surface and indestructible qualities make it valuable for many chemical purposes. The firm also specialize in chemical engineering plant of other kinds and manufacture large grinding pans, mixers, hot-drying plates, etc., so that the British chemical industries can now be equipped with the most modern kinds of plant without the necessity of recourse to Continental makers.—"Engineering."



VIEW OF THE STOOL AND THE TOOL STAND.

TOOL STANDS, RACKS AND STOOLS

The old days when a manager would discharge a man for sitting down to his work have passed. It has been proved that for certain classes of work the workman can become more effective by sitting, and the same holds good insomuch that men are no longer allowed to waste time running all over the shop to find tools. Nowadays tool stands, drawers and benches are always handy to the various machines, or at least such is the case in the real up-to-the-minute plants.

The National Engineering Co., Ltd., Sarnia, Canada, are firm believers in all the above statements and to follow out their belief have placed on the market a varied line of time savers. These include tool stands of various nature and sizes, some being supplied with drawers and some without. They also market an all steel storage rack which can be built in any number of sections and combinations for use against a wall, or placed back to back. Such racks are especially useful in warehouses, or in the cut off department.

In addition to the above mentioned lines they make a shop stool of novel design. This stool is depicted in the illustration standing alongside one of the tool stands as made by this concern. The stool is so simple, yet efficient, that it requires no explanation except that it is made in three heights, 24-ins., 27-ins. and 30-ins.

The A. R. Williams Machinery Co., Toronto, are handling this line and will be pleased to give all information regarding the same upon application.

Owing to the Seamen's Union calling out the crews of all Canadian vessels in harbor, to enforce their demands for increase in wages that amount to 25 per cent., seven Canadian ships are tied up in Fort William harbor. There is no indication as to how long the strike will last as the whole walk out is operated from headquarters in Toronto.

COAL OIL LAMPS

The Standard Meter Co., Ltd., 10 Morrow Ave., Toronto, Canada, have placed on the market a very interesting line of lamps which are described herewith. At Fig. 1 is shown what is known as

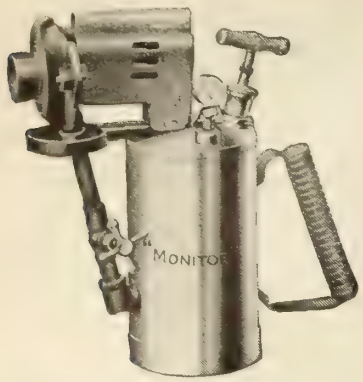


FIG. 1—SHOWING BRAZING LAMP.

the Monitor high power coal oil brazing lamp. This lamp is used for brazing and work of similar nature on a large scale and can be used in any position. It is said to be both portable and powerful. They are made in 2, 4, and 5 pint sizes.

The next type of lamp shown at Fig. 2 is known as the Monitor high power coal oil blow lamp. This style of lamp is both wind and rain proof and is used extensively by millwrights, plumbers, electricians and hot water engineers. This lamp is made in 2-3 pint, 1 pint, and ½ pint sizes.

Another type of lamp carried by this concern is known as the Petropark high power inverted incandescent coal oil lamp. The latter style lamp is used as portable light for country railroad stations, farm buildings, fair grounds,

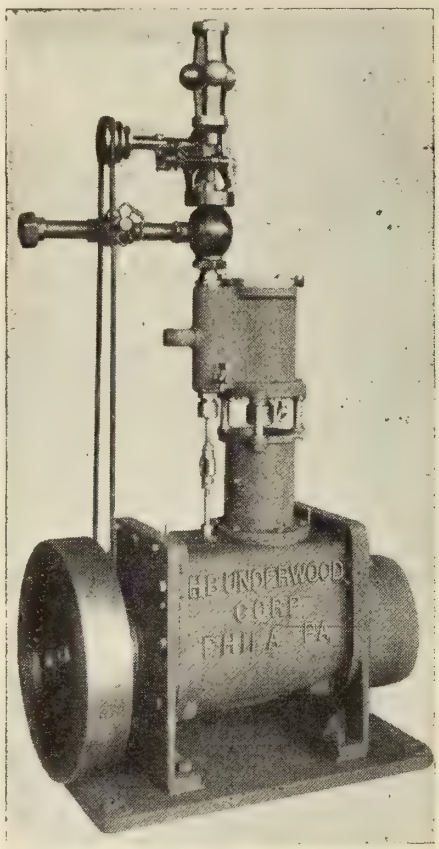
FIG. 2—SHOWING BLOW LAMP.

large workshops, wharves and other innumerable places where portable lights are desired.

AIR OR STEAM ENGINE

The H. B. Underwood & Co., 1015-1025 Hamilton Street, Philadelphia, Pa., have placed on the market what are known as their 3 and 5 h.p. steam or air engines. These engines are built in the two sizes above mentioned, and the illustration herewith gives one a good idea of their general appearance. They are used and designed for driving portable tools such as boring bars, valve seat rotary planers, drilling machines, etc., and are constructed to use either compressed air or steam.

All working parts are enclosed in an oil tight case, which is formed in the base of the engine, making it dust



GENERAL VIEW OF THE ENGINE.

proof, and reducing wear to a minimum. The cylinder of the 3 h.p. engine is 3½-inches diameter and of the 5 h.p., 4½-inches diameter, both engines having 3 1-2-inch stroke. The design of the piston valve used is said to reduce friction and wear to a minimum.

The crankshaft is a solid forging-finished 1½-inches diameter. The engine is well balanced, uses 70 to 125 pound pressure, and runs at 250 r.p.m. This engine should particularly interest railroad shops.

The floor space required is 12-in.x 21-inches, and the height from base to extreme top of governor 46 inches. The net weight is 270 pounds.

Word has been received that Sir Walter Runciman, who recently sold the Moor Line, has formed the Runciman Steam Navigation Co., with a capitalization of one million pounds.

H.P. PER TON REFRIGERATION

Question.—Would you kindly answer through your valuable paper the following: What horsepower will be required per ton of refrigeration with 50 lbs. suction pressure and 185 lbs. head pressure?

Answer.—With the suction pressure at 51 lbs. gauge and the head pressure at 185 lbs. gauge for each ton of refrigeration, 1.8 cubic feet of gas per minute must be pumped. With suction pressure at 15 lbs. and the same condenser pressure about 3.8 cubic feet must be pumped. The mean pressure of the indicator diagram in the first case will be 81.02 lbs. per square inch, and in the second case 68.82 lbs. per square inch. The horsepower required in the first case is .6398 per ton of refrigeration, and for the second case 1.1467.

The following formula for the i.h.p. per ton of refrigerating capacity is by Professor Lucke, of Columbia University, a recognized authority on heat engines:

a = Area of piston in square inches.
p = Mean effective pressure, lbs. per square inch.
L = Length of stroke in feet.
n = Number of compressions per minute.
Ec = Apparent volumetric effieiency. The ratio of the volume of ammonia apparently taken in per stroke to the full displacement of the piston.
Wc = Weight of 1 cubic foot ammonia vapor at the back pressure, as it is in the cylinder at the beginning of compression.
Lc = Latent heat of vaporization available for refrigeration.
288,000 = B.t.u. equivalent to one ton refrigeration.
T = Tons refrigeration per twenty-four hours.

$$\frac{\text{I.H.P.}}{\text{T}} = \frac{\text{plan} \div 33{,}000}{\dfrac{\text{La} \times \text{Ec} \times \text{nWc} \times \text{Lc} \times 60 \times 24}{144 \times 288{,}000}}$$

$$= \frac{.87}{\text{Wc} \times \text{Lc}} \times \frac{\text{p}}{\text{Ec}}$$

The volumetric efficiency varies between 73.5 per cent. and 84 per cent., according to experiments made by Professor Denton.

Refrigerating machines work at their highest efficiency when the range of temperature is a minimum, so that a low head or condenser pressure, with a high suction or evaporator pressure, is the condition to aim at.

A peculiar incident took place when an ocean going vessel for the first time since the completion of the Quebec bridge had to step one of her masts in order to pass under the structure. The vessel was the Grand Duchess Maria Mikoldevna, a full rigged, three masted sailing ship, and the first of its type to visit Montreal for a long period. The vessel belongs to the Russian Volunteer Fleet.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 35
Plates, ¼-in. up	6 50	6 60

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.00	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
4½-in. and larger, 10%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	27½
Palacine	30½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82½
Cylinder Oil, Acme	70
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	10
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, squpare blank	add $ 2 00
Nuts, square, tapped	add 2 25
Nuts, square blank	add $ 2 00
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 35
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	16 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 38
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl.	4 50
Sandpaper, B. & A. list, plus	43%
Emery cloth list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	49 00	48 00
Copper sheet, tinned, 14 x 60, 14-oz.	52 00	48 00
Copper sheet, planished, 16-oz. base	56 00	55 00
Braziers', in sheets, 6 x 4 base	48 00	46 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$54 00	$55 00
Spelter	9 00	10 50
Lead	9 50	9 50
Antimony	9 50	12 00
Aluminum	36 00	37 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$11 50	$14 50
Sheets, 3½ lbs. sq. ft.	11 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	11 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

DEVELOPMENT OF LONG DISTANCE TRANSMISSION

(Continued from page 443)

There is one feature of the electrical history of that time which, while disagreeable to contemplate, in retrospect should not be overlooked.

With the entrance of Mr. Westinghouse into the field of electric lighting, beginning in the year 1885, there began a controversy between the alternating current system as championed by Mr. Westinghouse, on the one hand, and the direct current system, as championed particularly by Mr. Edison and his coterie, on the other hand. This controversy became exceedingly bitter. When the alternating current system first appeared the direct current system was the established system and the advocates of the direct current system used every possible means to retard the development of the alternating current system. One of the results, for instance, of this controversy was the decision on the part of the State of New York—unquestionably instigated by some ill-advised advocates of the direct current system—to use electricity for the purpose of executing criminals. Naturally, alternating current was employed for this purpose, and it was brought about that a Westinghouse alternator was secured for this purpose, and the fact that it was Westinghouse was advertised far and wide. Another phase of the controversy was the introduction of a bill in the legislature of the State of New York making it unlawful to use alternating current voltages in the public streets of above a certain specified maximum, which was placed at such a point that the alternating current system could not have continued to exist had the bill passed. Fortunately, the bill did not pass and the alternating current system passed a critical point in its history of development.

The controversy which took place between the systems did no good to either. It unquestionably retarded the development of the electrical art for many years. The advocates of each system sought almost as much the discredit of his competitor's system as he did the advancement of his own. I believe that I am right in saying that most of the gentlemen who were responsible for the initiation and continuance of this controversy lived to see the error of their course and to regret very much that the controversy ever started. They now recognize that the art was retarded by the controversy and that no permanent advantage was gained by either side.

One of the unique phases in the history of the development of power transmission and distribution is that the first installation of a power transmission by alternating current — which was carried out in the year 1890 — was carried out not by means of the polyphase alternating current system, and the induction motor, which we know so well to-day, but by means of a single phase synchronous motor which was operated by a duplicate machine, running as a synchronous generator and driven by the prime mover. This development was carried out in the mountains of Colorado during the year 1890. The voltage of the transmission was 3,000, the distance was approximately three miles and the amount of power was approximately 100 h.p.

As indicated above, the motor and the generator were identical single phase machines, except that the generator was separately excited, whereas the motor was a self-excited machine. While the Tesla motor had been invented about two years previously, it is significant to note that it was not used in this case; however, a Tesla motor was used for the purpose of starting the main single phase synchronous motor. A small Tesla motor was started up as a split phase motor on a single phase circuit, and its pulley was then brought into contact with the main pulley of the synchronous motor, and by this friction drive the synchronous motor was brought up to speed. After being brought up to speed it was synchronized in the usual way and thrown in on the transmission line. The system was then ready to operate. In this day of the universal use of the induction motor it is interesting to look back and see that the first power application of the alternating current system was carried out not by the use of the induction motor, but by the use of the synchronous motor.

It is also interesting to note that the power development for this time later developed into the well known Telluride Power Company. The Telluride Power Company later became a very prominent factor in the development and transmission of power throughout the Central West, covering much of Western Colorado, Central Utah and Southern Idaho. The chief spirit in the promotion of this power company was Mr. L. L. Munn, and he, together with his brother, Mr. P. N. Munn, became the moving spirits in the Telluride Power Company.

The mining industry in Colorado and other Western States was a very profitable industry at that time. Many of the mines, however, required power in considerable quantities in order to make them pay. Before the advent of electric power it was customary to use steam power, generated from fuel which had to be hauled to the immediate vicinity of the mine. In many cases the expense of hauling fuel was prohibitive, and as a consequence rich mines had to be abandoned on account of the fact that the cost of the necessary power was prohibitive.

(To be continued)

TRADE NEWS

The Jeffrey Manufacturing Co., of Columbus, O., have opened a new branch office in Buffalo, at 1108 Marine Trust Building, with Mr. H. W. Scott in charge. Mr. Scott is very conversant with the Jeffrey products, which are well known to engineers, and cover elevating, conveying, pulverizing and portable loading machinery.

Warren Webster & Co., of Camden, N.J., for whom Darling Brothers, Montreal, are the Canadian agents, have issued several bulletins covering their product, contained in a neat binding on the loose leaf principle. The bulletins describe the heating systems, heaters, separators, radiator traps, etc., made by the firm, which can all be procured from Messrs. Darling Bros., Montreal and Toronto.

FOR SALE—ENCLOSED LIQUID FUEL COMbustion apparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented October 8th, 1918. Can be inspected at and for sale by H. W. Petrie, Limited, 131 Toronto St. W., Toronto. (p1h)

Bruce Macbeth Gas Engine 100 H.P. Natural Gas 80 H.P. Producer Gas—Attachments for both—New Clutches—Floor Stands, Shafting and Pulleys, $2,000. Immediate shipment from Central New York.

SYRACUSE INDUSTRIAL GAS CO.,
208 McCarthy Building,
Syracuse, New York.

WANTED—EXPERIENCED BOILER DESIGNer by large manufacturing plant in Ontario. Apply Box 92120, Power House.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 TO 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

FAIRBANKS-MORSE

Helping Canada's Great Railways

The industrial development of Canada is measured by its great railroad systems. Thousands of miles of steel, extending from coast to coast, reaching out from the big manufacturing centres, have been pioneer steps in the country's advancement. And The Canadian Fairbanks-Morse Co., Limited, has been a factor in this development.

Wherever construction gangs have followed surveyors, Fairbanks-Morse railway equipment has been used because of its dependability—dependability that made it worthy of its part in this pioneer work.

From the smallest drill to the electric locomotive—the stand pipes and water tanks that feed the great transcontinental engines—Fairbanks-Morse railway supplies render a service backed by the organization's high efficiency.

The 100% quality seal that marks all Fairbanks-Morse railway equipment is the ideal of the Fairbanks-Morse institution—the mark that symbolizes a standard of equipment and service.

Make this mark your guide in buying.

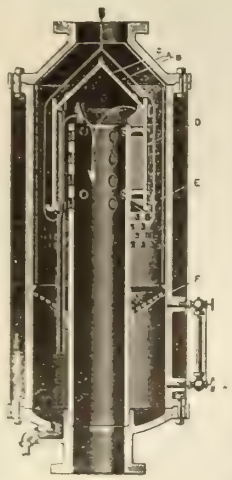
The Canadian Fairbanks-Morse Co. Limited

Canada's Departmental House for Mechanical Goods

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, St. Catharines, Windsor, Winnipeg, Saskatoon, Regina, Calgary, Victoria

10

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

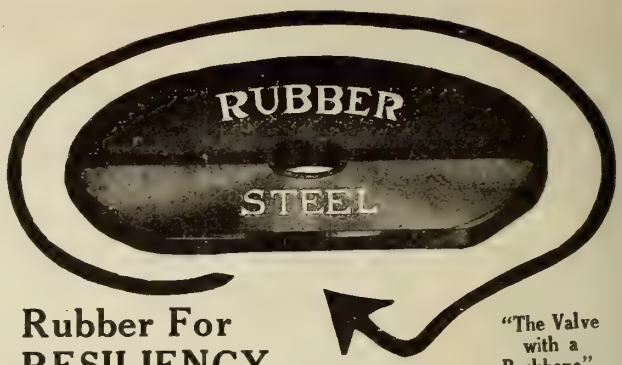
II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



"The Valve with a Backbone"

Rubber For RESILIENCY
Steel For STRENGTH

A combination that forecasts the perfect valve service. Neither the all-rubber valve with its tendency to dish and blow through under pressure nor the all-metal valve with excessive weight can, efficiently, meet to-day's demands.

Voorhees Rub-Steel Valves

unite the virtues and eliminate the objectionable features of both. By a new process tough, resilient rubber and a strong, rigid steel plate are securely attached, creating a valve that will not warp, buckle, crumble or clog the pipe line.

Made in four grades.

The Canadian Fairbanks-Morse Co., Ltd.
Exclusive Canadian Agents for
Voorhees Rubber Mfg. Co., Jersey City, N.J.

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

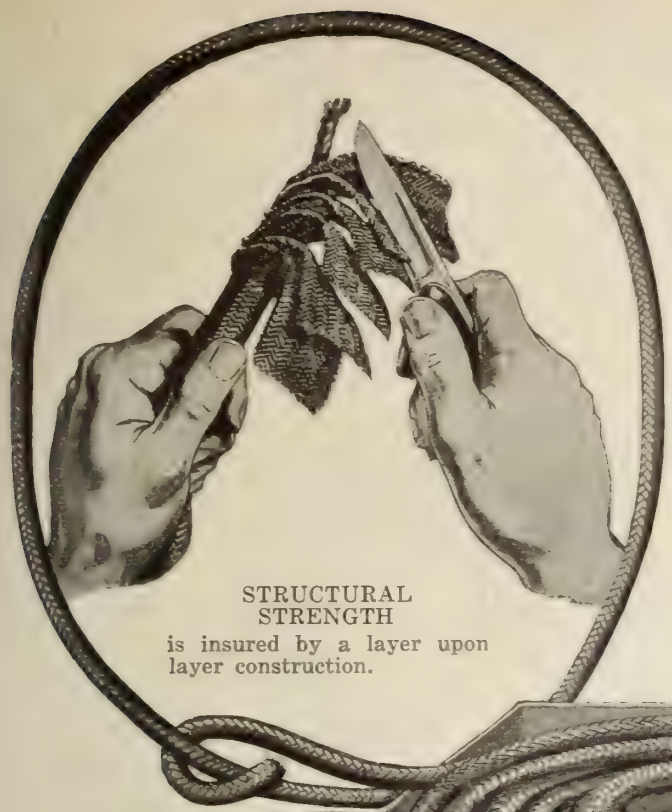
Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

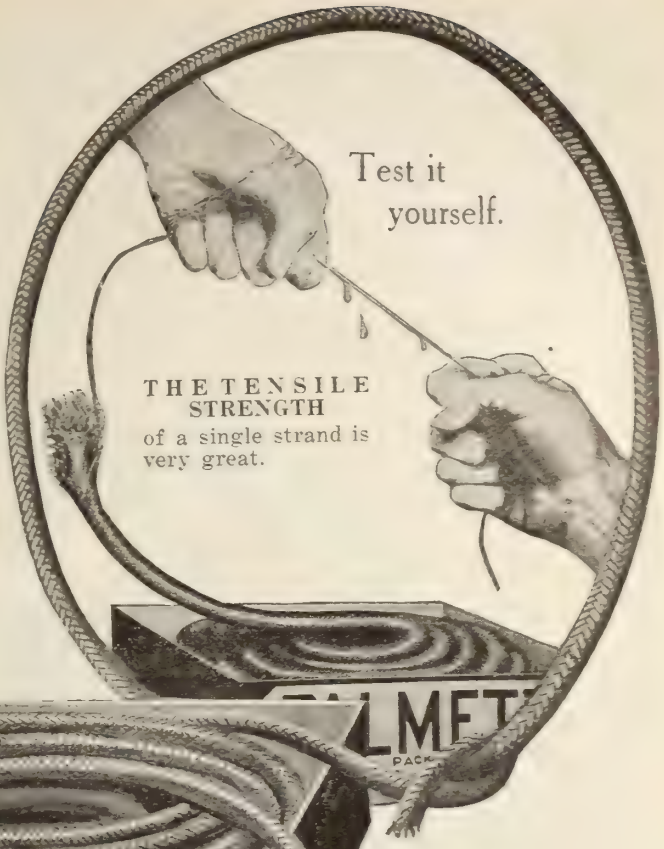
DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA



STRUCTURAL STRENGTH
is insured by a layer upon layer construction.



Test it yourself.

THE TENSILE STRENGTH
of a single strand is very great.

Three Reasons why "PALMETTO" PACKING

is superior for high pressure, superheated steam and compressed air.

It gives longer service than other packings and is therefore more economical.

Let us send you a working sample to test under your own conditions—no charge.

GREENE, TWEED & CO.

Sole Manufacturers
109 Duane St., New York

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary Saskatoon, Victoria, Vancouver.

Its graphite grease lubricant prevents friction.

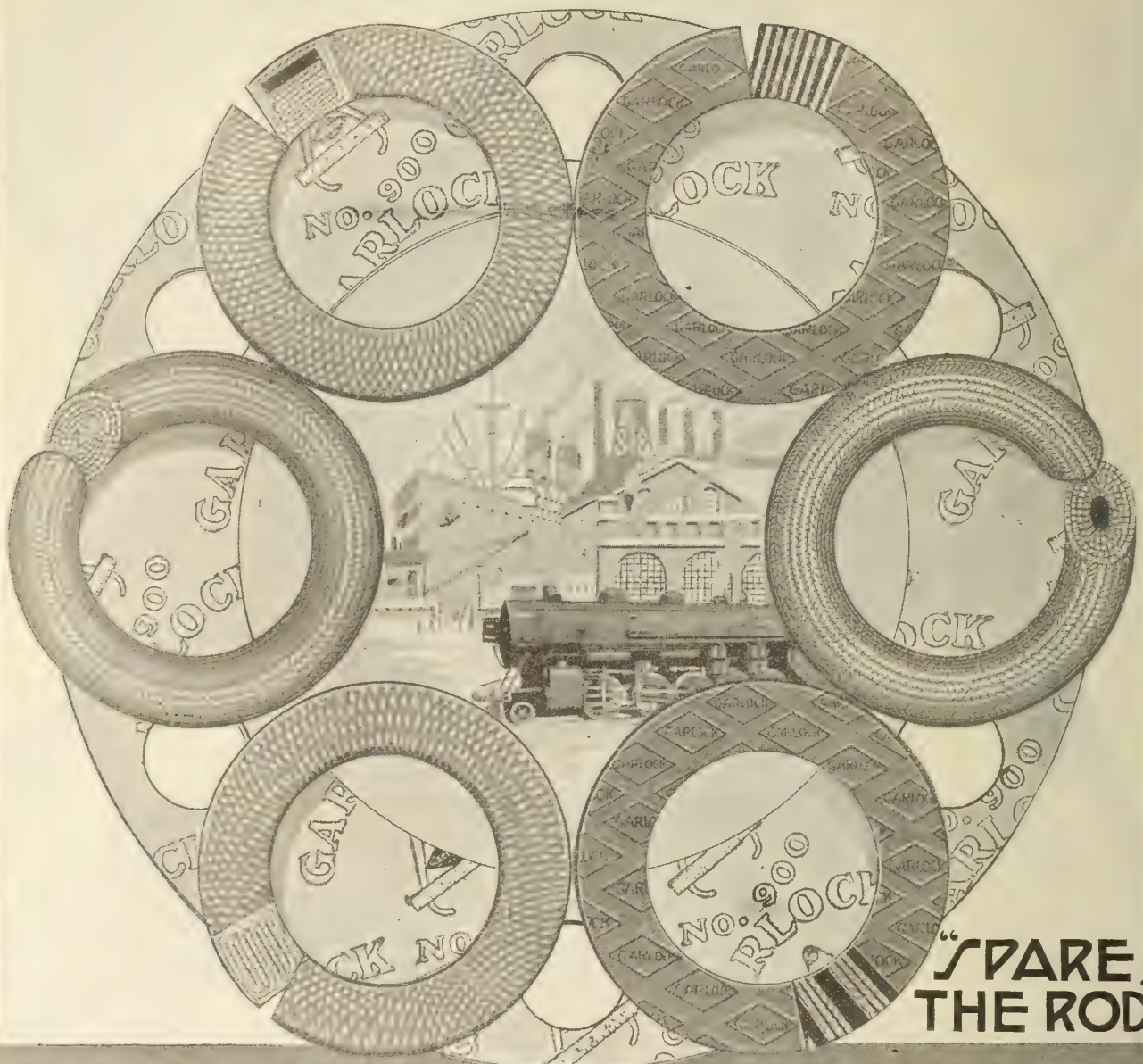
Lubricant is forced into each single strand before braiding.

IN ENGINEERING CIRCLES

It is the operating engineer who most appreciates reliability.

Hours spent renewing rod packing and replacing gaskets, often in inaccessible places, have proved to him the fact that quality is the main consideration when purchasing packing. Added to this is the saving due to minimum rod friction and leakless joints.

On your next order specify GARLOCK, the packing of world-wide reputation and known reliability.



GARLOCK PACKINGS

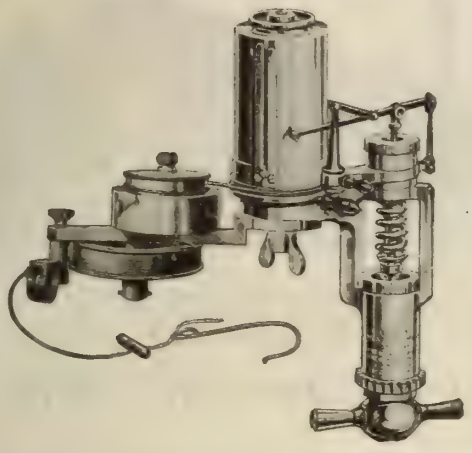
THE GARLOCK PACKING COMPANY
HAMILTON, ONT.

Branches:

Montreal, Que. Toronto, Ont. Winnipeg, Man.
Calgary, Alta. St. John, N.B. Vancouver, B.C.

Mr. Engineer!

DO YOU OWN AN AMERICAN THOMPSON IMPROVED INDICATOR?



You owe it to yourself to purchase one of these NOW and secure all the benefits it makes possible. The price is right snd easy terms can be arranged.

Write us.

Our Canadian Agents:

Canadian Fairbanks-Morse Co., Ltd.

St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria

American Steam Gauge & Valve Mfg. Co.

New York Chicago BOSTON Atlanta Pittsburgh

P&C CO

Gate Valve Check Valve Asbestos Packed Cock Globe Valve

What the Pratt & Cady Trademark Means to *You*

The P. & C. Trademark is a bona fide guarantee that every product bearing this mark will give absolute satisfaction. It is the tangible evidence of our obligation to make the product that bears it measure up in every respect to the high standard that has been scrupulously maintained in all products that have left our factory during our half century of business. It stands for an organization in which every member is actuated by a single idea or ideal—to jealously guard and constantly preserve the well-established Pratt & Cady reputation for integrity, responsibility and quality of product.

May we send you a catalog?

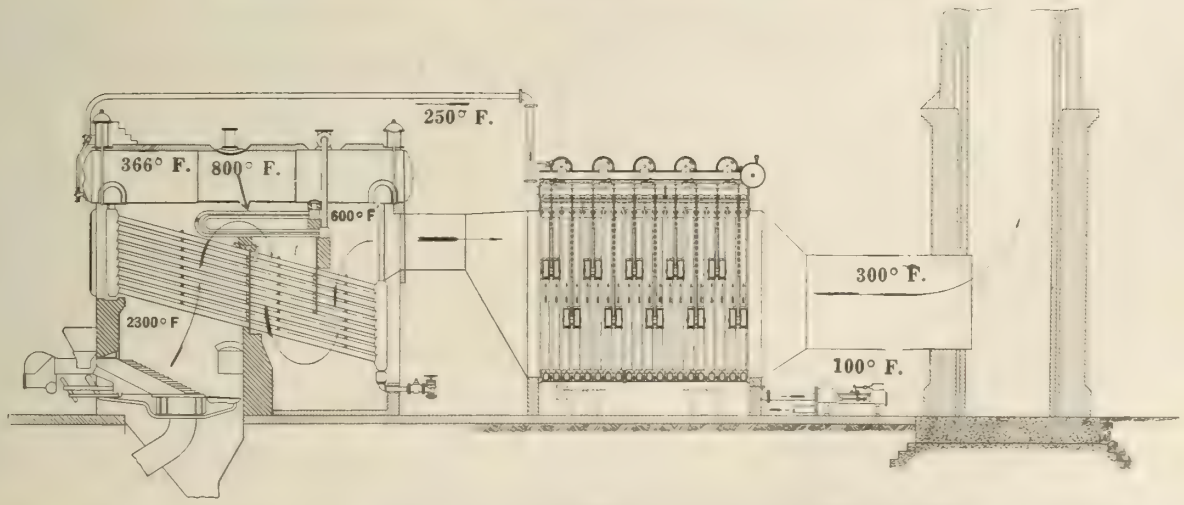
Pratt & Cady Co., Inc.

Factory: Hartford, Conn., U.S.A.

The Canadian Fairbanks-Morse Co., Ltd.

PRATT & CADY PRODUCTS

GREEN'S ECONOMISERS



A Saving of 13.6%

Green's Economiser "installation temperature diagram," showing a rise of 150° in feed water temperature above that of the feed water heated. This is not an unusual case, and under these conditions would show a saving of 13.6% based on 1% saving for each 11° increase in feed water temperature.

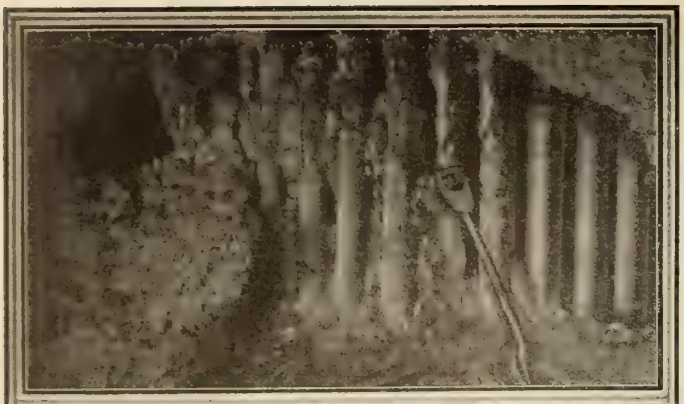
Modern economic operation of boiler plants demands that your boilers be operated above normal rating. This means higher exit temperatures of the flue gases.

Green's Fuel Economisers utilize this heat in the flue gases to heat the feed water under boiler pressure, which accounts for the fuel saving and also allows you greater boiler capacity.

Ask our engineers for data on economisers for your plant.

GREEN'S ECONOMISER, LTD.

TORONTO



Can YOU Afford It?

Soot and ash deposits on the fire surface of boilers cause a loss of millions of dollars annually.

Your proportionate share in this loss depends upon the number of boilers you operate, the cost of coal, and the degree of cleanliness obtaining.

Suppose you have four 500 H.P. boilers. Normally these will require 4 tons of coal per hour, or 20,000 tons of coal per year on a 5,000 hr. basis. At present prices, this coal probably will cost you $100,000 per year.

If you customarily allow your boilers to get in the condition shown in the picture before cleaning them, your loss is anywhere from $10,000 to $20,000 or more per year.

If you clean your boilers regularly and conscientiously with the hand lance, your loss is from $4,000 to $8,000 per year, depending upon the skill of the fireman.

If you clean your boilers with Diamond Soot Blowers you incur no loss, but get value received in steam (within the limitations of your furnaces and boilers) for every dollar spent for coal.

Best of all, Diamond Soot Blowers cost but a fraction of the annual saving.

Ask for Bulletin 280.

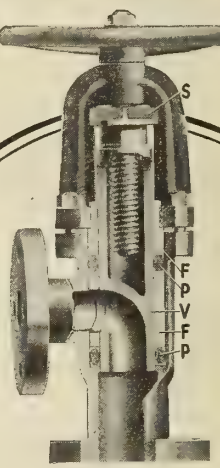
DIAMOND SPECIALTY COMPANY
Windsor, Ont.

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

YARWAY

Seatless Blow-Off Valves



Operation: Shoulder S on plunger V engages the loose follower gland F, compressing packing P above and below the port, and making an absolutely tight valve.

In Connecticut—

In the plant of the United Illuminating Company at Bridgeport, twenty-one **Yarway Seatless Blow-Off Valves** are rendering highly satisfactory service.

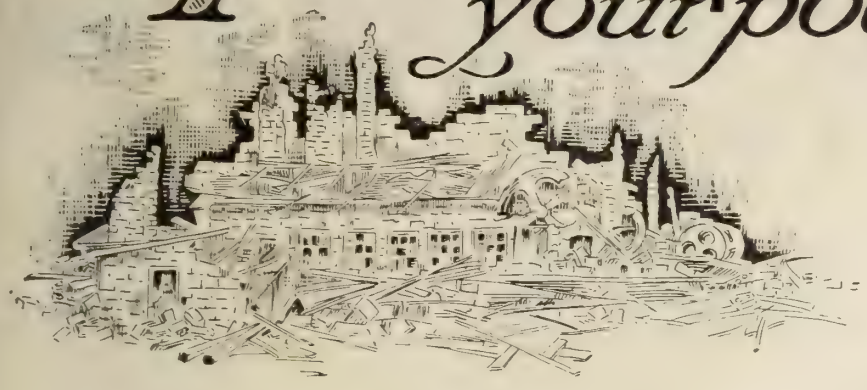
The percentage of re-orders—83 1-3%—from prominent concerns speaks conclusively of the success of Yarway Seatless Blow-Off Valves in the hardest of all valve service.

Full details and list of well-known users will be sent on request.

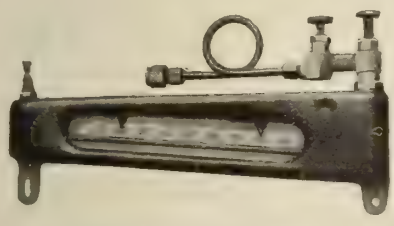
Yarnall-Waring Co.
7604-20 Queen St.
Chestnut Hill Philadelphia
Representatives in all principal cities.

"No Seat to Leak"

If the wind wrecked your power plant

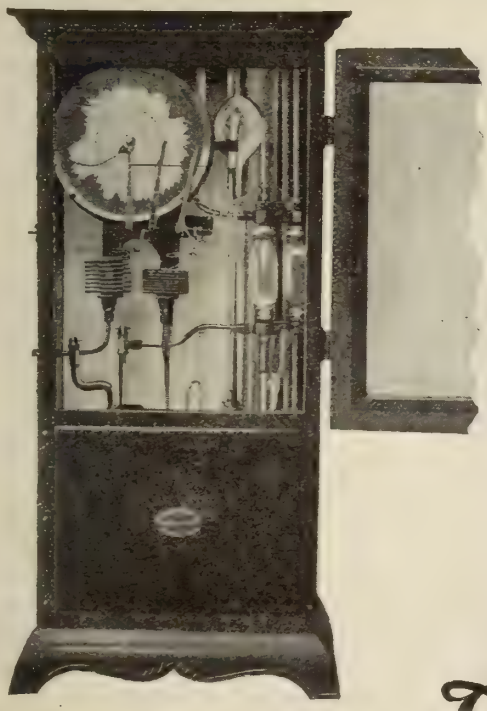


You would know there had been a big loss on account of too much draft. The insurance might partly cover the damage, but you would be able to see the terrible waste and know the reason for it.



HAYS DRAFT GAGE

The everyday losses resulting from too much draft over the fire in your boiler furnace, may go on undiscovered because unseen. Every time the wind changes or the resistance of the fuel bed varies, the draft changes. Excess air taken in, reduces furnace temperatures, burns up your expensive fuel that is so hard to get and causes untold waste that is not covered by ordinary insurance. Accurate knowledge of conditions is the only insurance that will rid you of this large overhead cost.



HAYS AUTOMATIC CO_2 AND DRAFT RECORDER

Awarded Certificate of Merit by the Franklin Institute

Your fireman should have up-to-the-minute information about the draft and the condition of his fires; you should have a daily chart record from the HAYS AUTOMATIC CO_2 AND DRAFT RECORDER to point out the otherwise hidden wastes that swell your fuel bills.

When you consider Hays Apparatus you automatically assign "Hays Service" to cut down the high operating costs of your Power Plant.

Descriptive literature on request. Have you received your copy of the booklet "Fuel"?

The Jos. W. Hays Corporation

Combustion Efficiency Appliances

Michigan City, Indiana

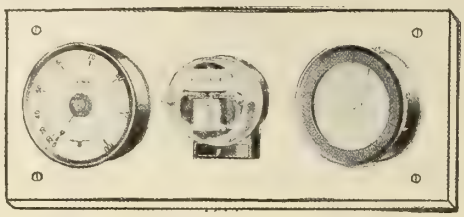
Republic TWINS

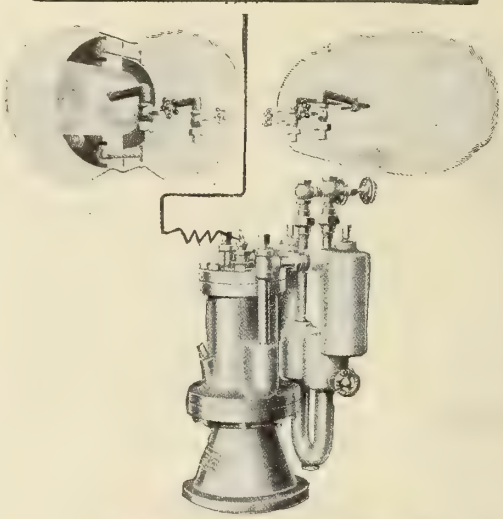
Trading Flow Meters for Boilers

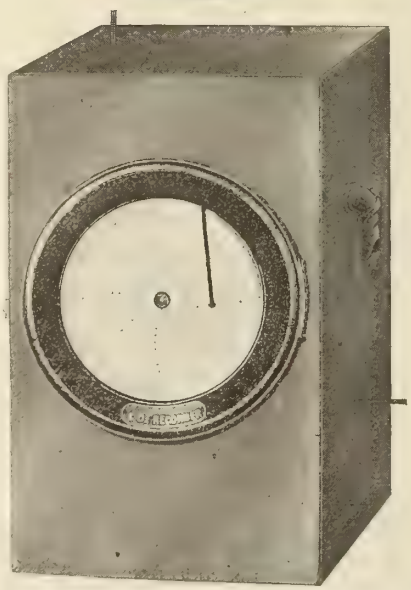
BY installing Republic Flow Meters on a battery of six boilers, a well-known traction company avoided ordering two additional boilers to take care of its peak load. Not only was the cost of the boilers avoided, but also the continual expense of keeping additional boilers banked under light load during the off-peak part of the day. This Company traded Flow Meters for boilers at a tremendous profit.

When you consider that a saving like this is merely incidental to the many economies brought about by tracing erroneous conditions during the regular operation of the boiler room, you begin to realize how really indispensable an installation of Republic Flow Meters IS.

In every-day operation the Republic is a constant guide to furnace efficiency—a continual indication of the performance of individual boilers—an indisputable record of power costs by Departments.







Trading CO_2 Recorders for COAL

COMBUSTION means a combination of carbon with the correct amount of air. If too much air is admitted then coal is wasted. The only method of checking continuously and correctly is by the use of a CO_2 RECORDER. If a CO_2 Recorder is installed, the amount of air cut down, then the amount of coal is lessened; in fact, you have traded CO_2 Recorder for coal.

With coal at the prevailing prices, a CO_2 Recorder is a very good investment under such conditions.

Also by the use of a CO_2 Recorder **Black Smoke is avoided.**

Republic CO_2 Recorders have no valves, no glass (tubing or otherwise), only two moving elements, no complication of mixtures, absolute absorption insured by long travel of gases through absorbent.

Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

145 Wellington Street West
TORONTO

WHY DO YOU ADVERTISE

When You Are Behind In Deliveries ?

THIS seems to be a very natural question, and the answer involves the discussion of a vital policy of this business—a policy that is fundamental.

If we were building a business for to-day our policy would vary from day to day with the temporary changes with which every business has to contend.

But we are building for the time to come and we hope that this business will become many times greater than it is to-day. Without the proper foundation it would undergo violent changes dependent upon temporary national, local or even imaginary conditions.

If we should permit ourselves to become inflated with self-confidence when business conditions are favorable, restricting our selling and advertising activities, and go down in the dumps when conditions are not so favorable, this business would not amount to any more than the existing conditions would make of it.

We say right now, without reservations, that we hope, regardless of how aggressive and efficient our manufacturing department may be, that it will never be able to catch up with our selling organization.

If our efforts should be halted in the middle of the road in times of liberal buying to wait on the manufacturing department, there might come a time when the manufacturing department would have to suspend operations while waiting on the sales organization.

With such a policy we would be running around in a circle, disorganizing one day and reorganizing the next.

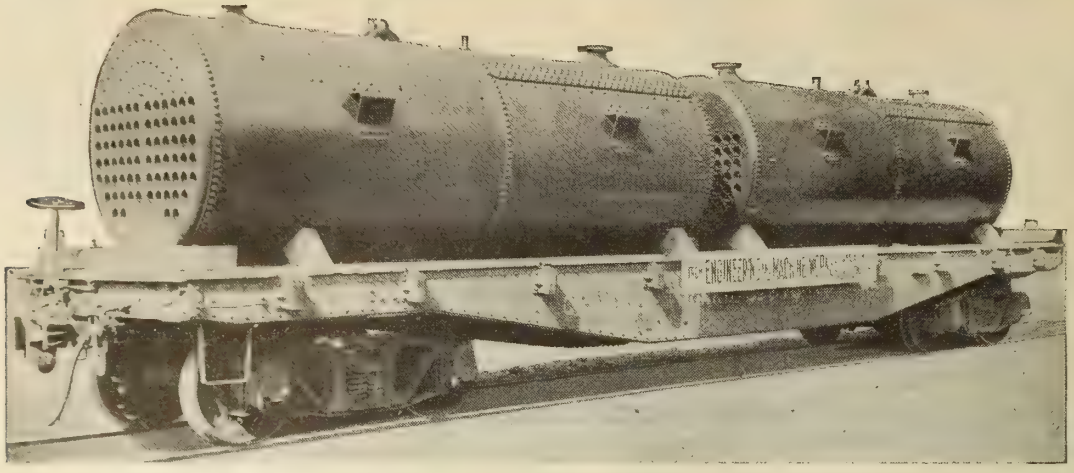
The greater the demand for our product, the quicker the turnover for merchants; and the more frequent the turnovers, the larger is the volume of profit.

In this business advertising is a sales policy—the same as our policy of maintaining a sales organization—and we might as well consider the elimination of one as the other. Neither will be eliminated, as this business needs both if we are building for the future.

We hope the idea will never creep into this organization that there will be any let-up in aggressive methods, which might suggest that when business is good there is no occasion for work and when business is poor it is too hard to get.

We constantly have in mind that the American people are much more concerned in their own affairs than in ours, and if we should restrict our selling and advertising activities they will begin to forget us—and this would be our fault.

We are going ahead with the idea of increasing the present momentum in favor of our goods; and if conditions should turn face about, our dealers and ourselves will be in a better position to hurdle obstacles than if we originated a policy for each condition as it arose.



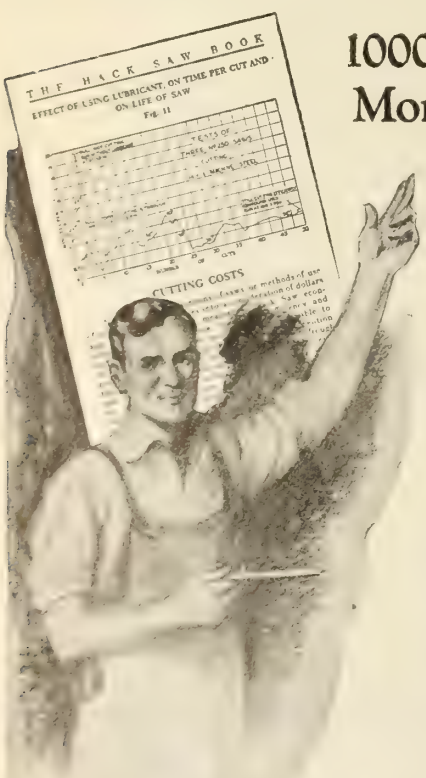
Prompt Boiler Deliveries – Now

Our workmanship and quality considered—the following offerings are exceptional. Subject to prior sale of materials we offer prompt delivery of the following sizes—72 in. x 18 ft., 72 in. x 16 ft., 66 in. x 16 ft., 66 in. x 14 ft. Smaller sizes, too, can be quickly handled.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



1000 Percent More Work

That's what lubricant does for hack saw blades.

Look at the chart above. Three identical blades cutting the same piece of stock. Two of them were run without lubricant—and in each case failed in less than five cuts. The third made over 50 cuts and was still cutting when the test was stopped,—because it was flooded with lubricant.

—That's just one of the charts in "Hack Saws and Their Use". There are more of them in this new Starrett Book, showing the effects of different cutting speeds and weights. There's also the Starrett Hack Saw Chart.

If you use hack saws, you need "Hack Saws and Their Use". Write for a free copy and for Catalog No. 21 "CD"

THE
L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Mfrs of Hack Saws Unexcelled
ATHOL, MASS.

42-65

Use Starrett Hack Saws

COAL

IF IN JULY A SHORTAGE

IN DEC., JAN., FEB., MAR.

?

Why not a Sterling gasoline engine for breakdown emergency?

No change in transmission: operates at centrifugal pump and generator speed. Nominal cost; high efficiency. A battery of these engines will enable you to

KEEP UP PRODUCTION

STERLING ENGINE CO.

BUFFALO, N.Y.

DEPT. C-4

12 to 300 H.P. high duty gasoline engines.

For standby fire service and emergency.

DOMINION RUBBER SYSTEM
CANADIAN CONSOLIDATED RUBBER CO. LIMITED
AND ASSOCIATED COMPANIES

Industrial Rubber Goods For Every Purpose

No matter what you may need, or what its size or shape, *if it's made of rubber,* we either have it in standard stock goods, or will produce it to meet your requirements.

We carry in stock at all our branches, standard sizes of Belting, Packing, Gaskets, Fire Hose, and supplies, Moulded Goods, and every rubber need for mill, factory, mine, lumber camp, shipbuilding, marine, or other industry.

Dominion Rubber System Products

are carefully inspected and tested to insure our high standard.

We maintain a Special Service Department of technical experts who will be glad to analyze your requirements, and specify the correct product to prevent waste, lower upkeep, and maintain maximum production.

This service is yours, without charge, and requires only a phone call or wire to our nearest service branch.

Dominion Rubber System Service Branches

Halifax	Toronto	Fort William	Edmonton
St. John	Hamilton	Winnipeg	Calgary
Quebec	London	Brandon	Lethbridge
Montreal	Kitchener	Regina	Vancouver
Ottawa	North Bay	Saskatoon	Victoria

BELTING

Transmission: "Dominion," "Keewatin."
Conveyor: "Rockproof," "Canadian," "Hiheat."
Elevator: "Dominion," "Rockproof," "Endurance."
Agricultural: "Lumber King," "Star."
Grain Elevator: "Metcalf Standard," "St. Lawrence," "Grain King."

HOSE

Air: "Kushion Kover," "Para," "4810 Airtite."
Steam: "Indestructible," "Rockproof," "Para."
Water: "Indestructible," "Kushion Kover," "Para."
Suction: "Para," "Star," "Trade."
Garden: "Canadian," "Dominion," "Star."

PACKINGS

Sheet: "Join-Tite," "Star," "Importers."

Rod: "Cabestos," "Valve-Bestos," "Canadian."

Valves: "Montreal," "Commercial," "Canadian."

MISCELLANEOUS

Mats, Matting and Flooring, Plumbers' Specialties, Rubber-covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rubbers, Moulded Goods.

"MEAD-MORRISON"

CANADIAN MM

Material Handling Machinery

Made in Canada

Grab Buckets
Steam Hoists
Electric Hoists
Coal Handling Machinery
Bridges
Crushers
Conveyors

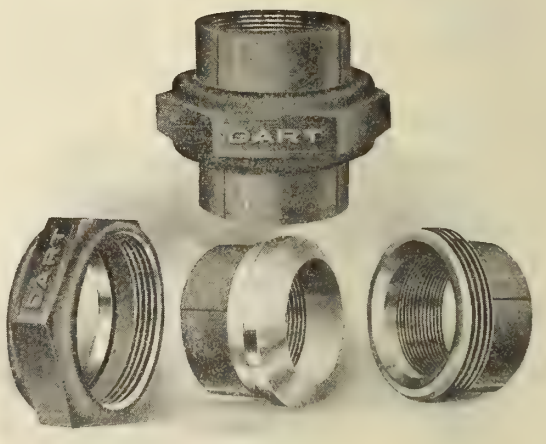
Dependable Service

Agents :
HARVARD TURNBULL, TORONTO
KELLY POWELL, WINNIPEG
ROBERT HAMILTON, VANCOUVER
FERGUSON & PALMER, LONDON, ENG.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WELLAND ONT.

DART

Unions



CANNOT LEAK

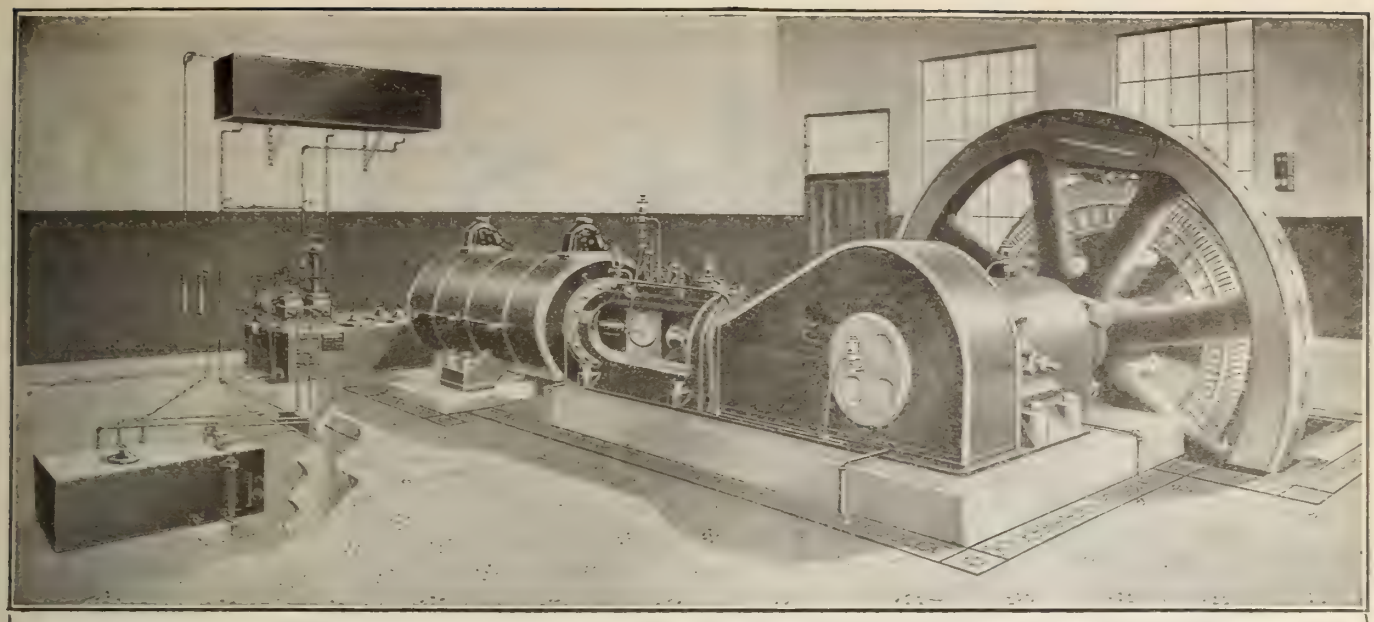
With Dart Unions attention or replacement are wholly unnecessary, and there's never any damage from leaks.

Bronze to Bronze at the Joint
No Deterioration

Dart Unions can be used over and over again — they're always efficient.

Heavy Iron Parts
Will not stretch nor pull apart under strain or heavy pressure.

Manufactured by
Dart Union Co., Limited, Toronto



CONSERVATION OF OIL

Above picture shows a practical application of a Bowser 6-F. Oil Filtering and Circulating System. It can be used with engines and other machinery where the filtration of dirty oil is essential.

Write for our Booklet on Oil Filtration.

The consumption of mineral oil products is increasing faster than the production. Consequently engineers are beginning to realize how important and necessary it is to conserve these oils.

A Bowser Oil Filtration System will assist you in doing this.

By filtering oil with a Bowser System it can be used over and over again—or indefinitely. The installation of a Bowser Complete Oil Filtering and Circulating System generally results in a saving of over 50 per cent. on your oil bill.

S. F. BOWSER & COMPANY, INC

FORT WAYNE, INDIANA, U.S.A.

S. F. BOWSER & CO., OF TEXAS
DALLAS, TEXAS

S. F. BOWSER CO., LTD
TORONTO, CAN.

OFFICES IN PRINCIPAL CITIES OF THE WORLD

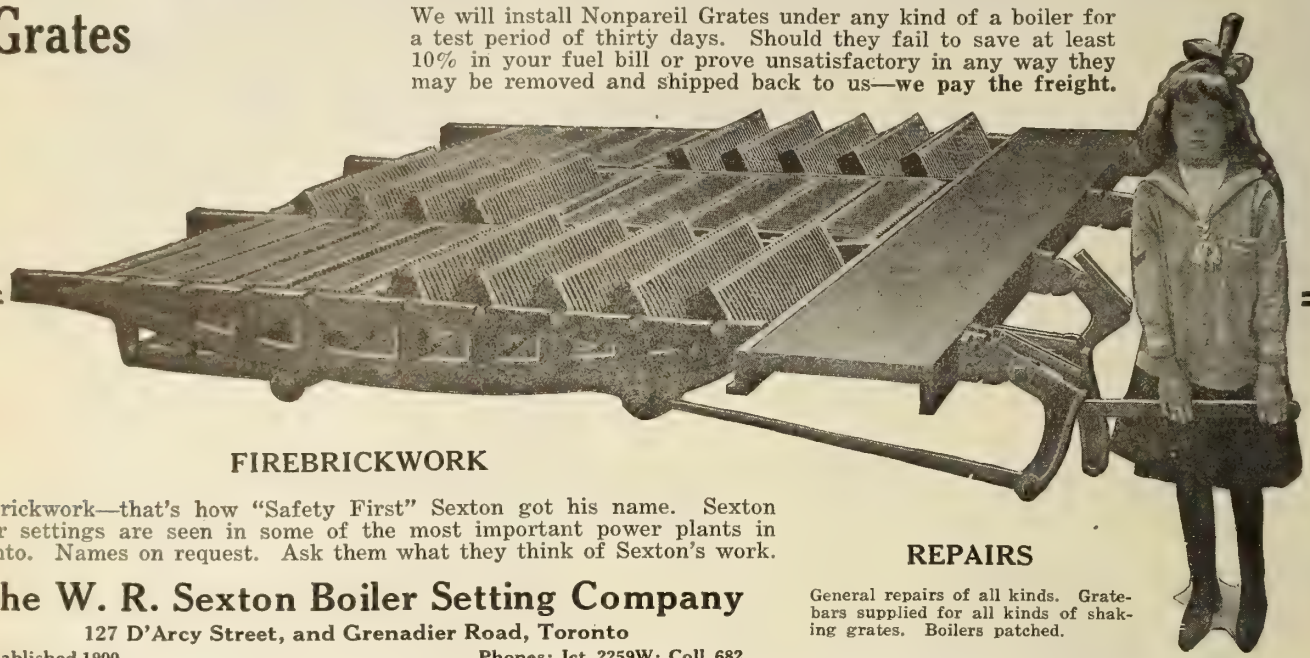
The Cowan Co. Install Nonpareil Grates

Many of Canada's largest and most successful manufacturing establishments have adopted **Nonpareil** Shaking and Dumping grates. The Cowan Company, Cocoa and Chocolate manufacturers, Toronto, is one of the latest to be listed as Nonpareil users.

Be guided by the experience of others—adopt Nonpareil Shaking and Dumping Grates. In your specification say Nonpareil!

Now is the time to get Nonpareil Grates under your boilers.

We will install Nonpareil Grates under any kind of a boiler for a test period of thirty days. Should they fail to save at least 10% in your fuel bill or prove unsatisfactory in any way they may be removed and shipped back to us—**we pay the freight.**



FIREBRICKWORK

Firebrickwork—that's how "Safety First" Sexton got his name. Sexton Boiler settings are seen in some of the most important power plants in Toronto. Names on request. Ask them what they think of Sexton's work.

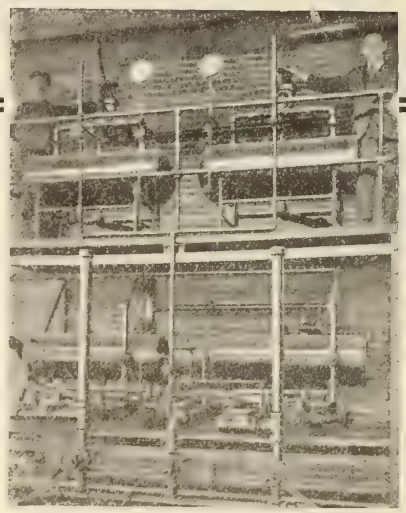
The W. R. Sexton Boiler Setting Company

127 D'Arcy Street, and Grenadier Road, Toronto

Established 1900 Phones: Jct. 2259W; Coll. 682

REPAIRS

General repairs of all kinds. Gratebars supplied for all kinds of shaking grates. Boilers patched.



This Battery of COLE Automatic Boiler Feeders feeds four 250 H.P. each Water Tube Boilers at the plant of The Canadian National Railway, Leaside, Ont.

Our Return Type Machines are installed throughout the plant on Heating System and Main Steam Headers returning all condensate to Boilers via COLE Automatic Boiler Feeders.

IS YOUR PLANT EQUIPPED "THE COLE" WAY?

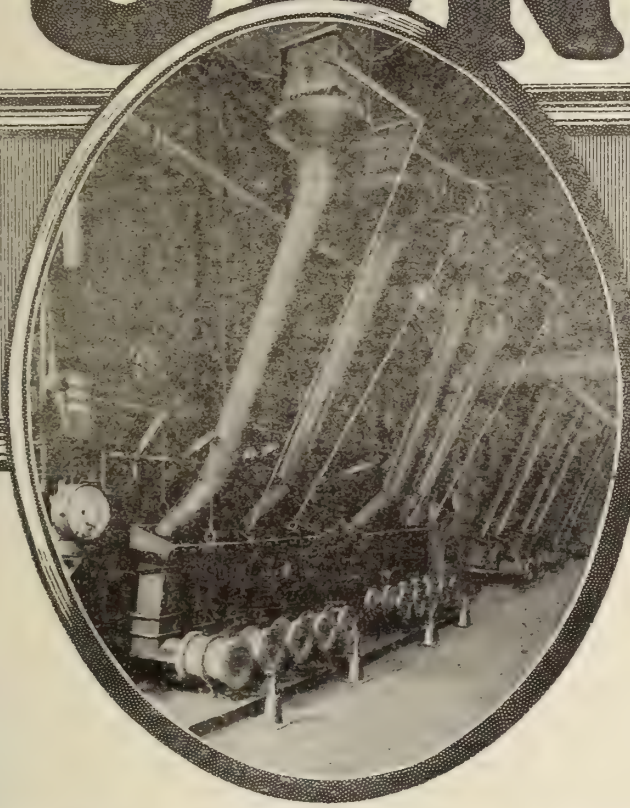
Our new catalogue is just off the press and it is yours for the asking.

Shipment of COLE Traps to above plant.

Geo. W. Cole Limited 2002 DUNDAS STREET WEST, TORONTO, ONTARIO

Represented in MONTREAL, QUE. WINNIPEG, MAN. VANCOUVER, B.C. NEW GLASGOW, N.S.

JONES



"A-C"

(Automatic-Cleaning)

STOKERS

Burn Any Available Coal at High Efficiency

WHEN the stoker is limited to one grade of coal, the plant is at the mercy of the mines and railroads. To-day, ability to burn the available coal means ability to burn any one of a number of coals. The Jones "A-C" (Automatic-Cleaning) Stoker will burn practically any coal from lignite to semi-anthracite.

In one plant Jones "A-C" Stokers are burning three parts coke-breeze to one of coal at 150% of boiler rating. "Bone coal," and war coal running 8,000 to 12,000 B T.U. as fired, is being burned at good efficiency in Jones equipped plants.

The Jones "A-C" burns a wider range of lowest grades of coal at highest efficiency because of the basic under-feed principle, originated by this company and given greater advantages by distinctive features found only in the Jones "A-C."

Simplicity and rugged construction, slight inclination of retorts, accessibility of parts, individual control of retorts and prevention of clinker on side and bridge walls, are some of the reasons why the Jones "A-C" will broaden your fuel market.

Manufactured by an old-established Canadian Stoker Manufacturer, newly re-organized to render a greater engineering service to Canadian power users. Write for extensive catalogs.

The Under-Feed Stoker Co. of Canada, Ltd.

18 Victoria St., TORONTO

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freigh Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

CRANE FLANGED FITTINGS

CRANE

LIMITED

HEAD OFFICE & WORKS

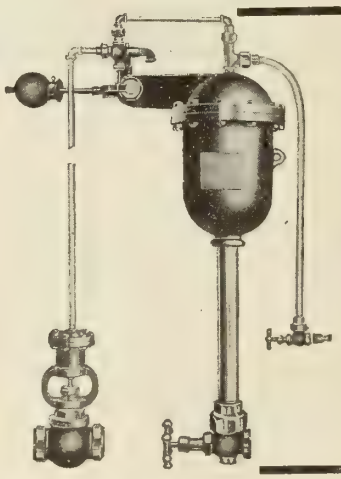
1280 ST PATRICK ST

MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.

SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

When Writing to Advertisers Kindly Mention this Paper



Make Sure of Constant Level and Stop Worrying

Eliminate the danger of boiler explosion due to low water or a wre ked turbine or engine due to high water by feeding your boilers automatically with

Vigilant Water-Feed Regulators

They hold the water level constant at middle gauge—the safest and most logical point—that insures better economy and protects the boiler against excessive expansion and contraction.

A paying investment for any plant.

Write for Catalogue now

The Chaplin-Fulton Mfg. Co.

28-34 Penn Avenue, Pittsburgh, Penna.

Also Manufacturers of the Fulton Pump Governor

THE EMPIRE STEAM TRAP IS A WONDER

WRITE FOR CATALOGUE

THE E. S. MANNY Co

27 COTE St. MONTREAL, QUE

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR
Ontario Government

Minister: Hon W. R. Rollo — **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

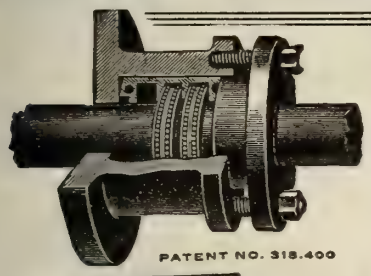
All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordanee with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.



PATENT NO. 318,400

PAT. NO. 500,899 " " 534,104 " " 602,328 " " 654,541 " " 654,542 " " 725,368 " " 774,490 " " 775,193 " " 775,194 " " 791,300 " " 805,669

PAT. NO. 829,118 " " 830,530 " " 856,103 " " 878,238 " " 894,537 " " 895,791 " " 898,066 " " 905,108 " " 934,629 " " 979,206 " " 1000,75

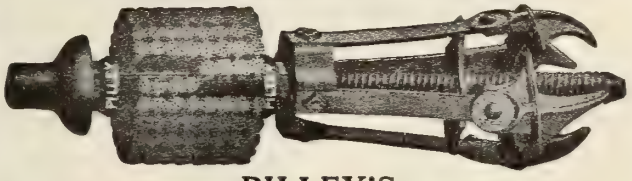
Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing
Is Guaranteed 3 Years

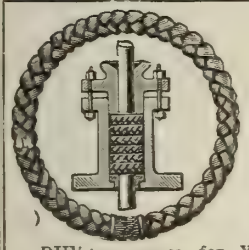
Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.
Incorporated 1897

The Simplest and Best Cleaner on the market is



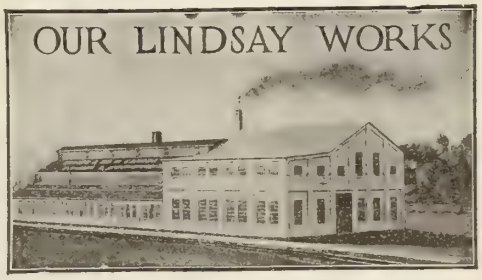
PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



DUVAL'S METALLIC PACKING
for
ALL CLASSES OF ENGINES
and the
Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.
"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.
SOLE AGENTS FOR CANADA
LAURIE & LAMB
Board of Trade Building, Montreal

Water Turbines, Hydraulic Governors, Centrifugal Pumps

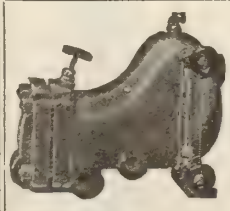


Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

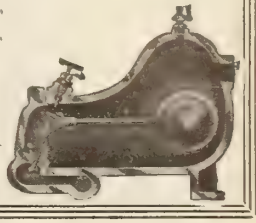
The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.
Why not get acquainted through a trial order? Ask for our catalogue.
JOHN MONCRIEFF, Ltd., Perth, Scotland
Canadian Representative:
W. J. WALL, 134-136 Bleury St., Montreal



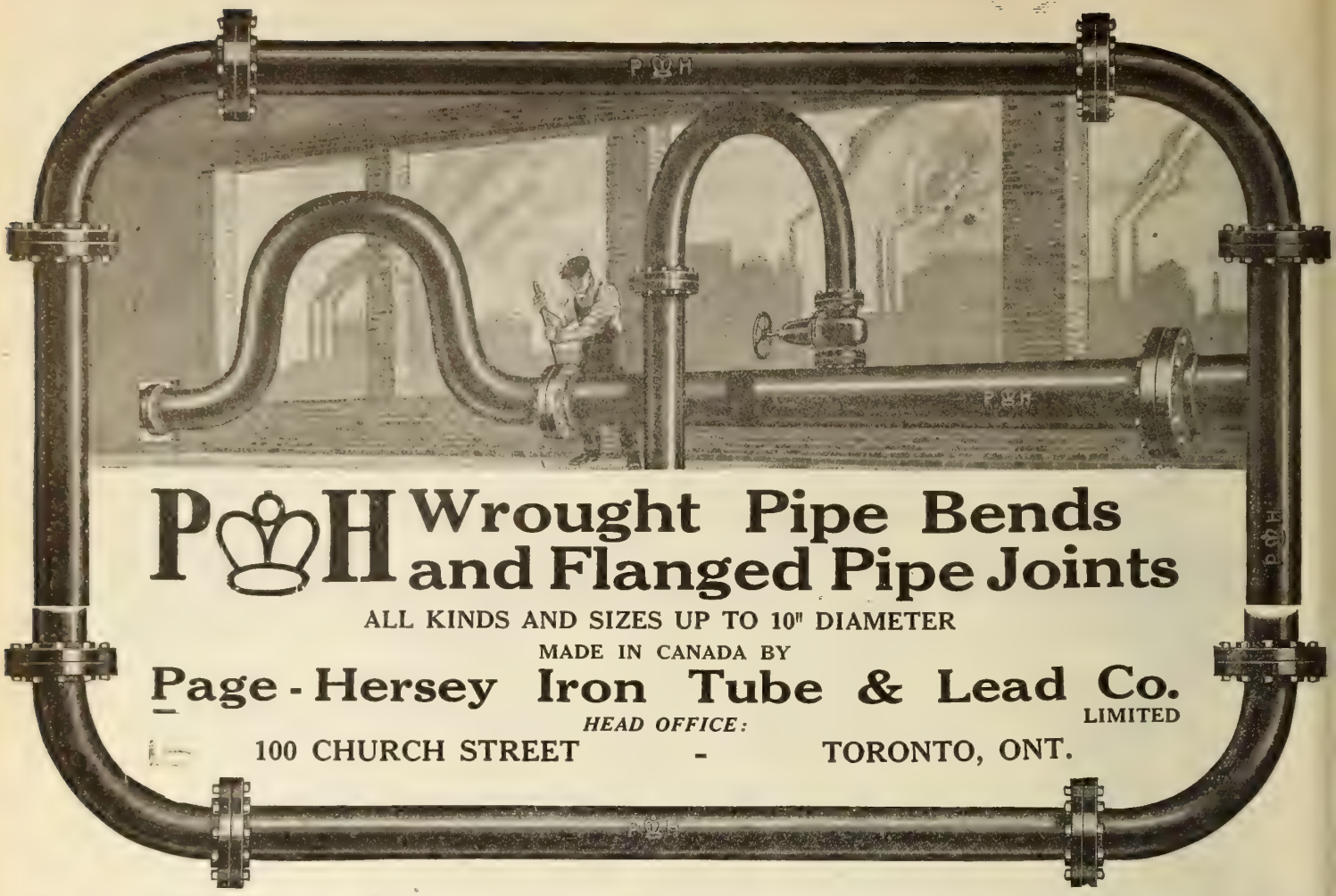
McDANIEL IMPROVED STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.
SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th Street. PHILADELPHIA, Pa



P&H Wrought Pipe Bends and Flanged Pipe Joints

ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

Page-Hersey Iron Tube & Lead Co. LIMITED

HEAD OFFICE:

100 CHURCH STREET - TORONTO, ONT.

TRIMO

THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company

Roxbury (Boston,) Mass., U.S.A.

UEHLING
CO2 Recording CO2 Equipment
CO2 Recorder For Office of Chief Engineer
CO2 Indicator for mounting on Boiler Front

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent. of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office
Fireman's CO_2 Guide on Boiler Front
Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet
"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers
2008 EMPIRE BLDG., NEW YORK

Showing ease with which Plibrico G is laid in place.

Use PLIBRICO

In Building Your Boiler Furnace Lining

It will outlast any fire brick. An ideal material for front door arches, side walls, combustion chamber linings, bridge walls and baffles. It's Jointless. Makes your furnaces **Airtight** and **Saves Coal.**

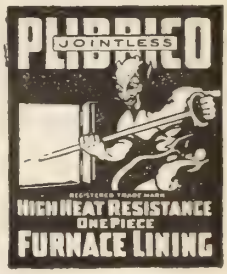
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Write for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

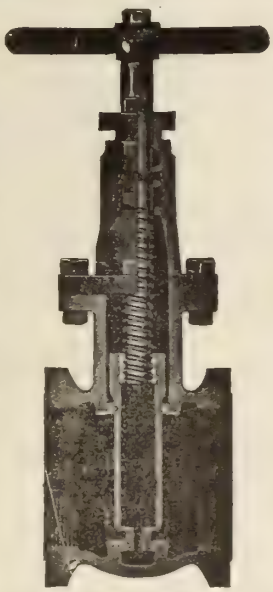
Beveridge Paper Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

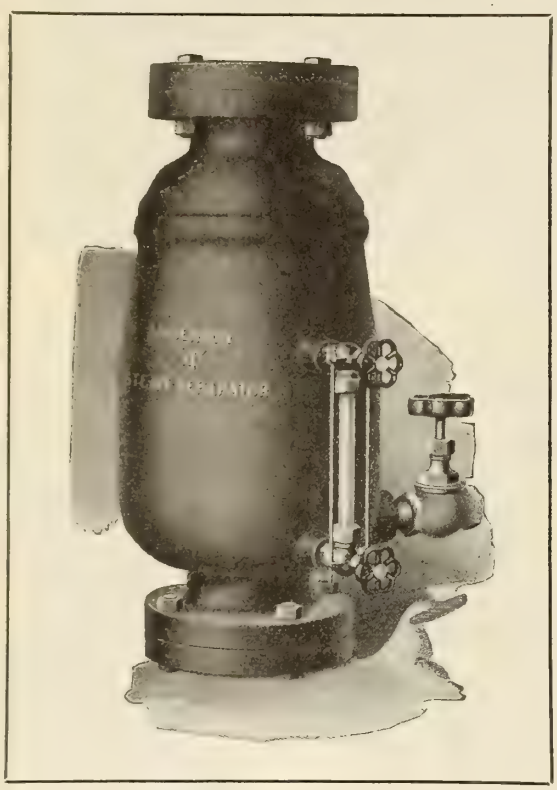
AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

ANDERSON
Steam Separator



Make Breakdowns Things of the Past!

Time and labor are too expensive to stand idle. You can't afford to have any engine breakdowns due to accumulated moisture in engine cylinders and turbine casings.

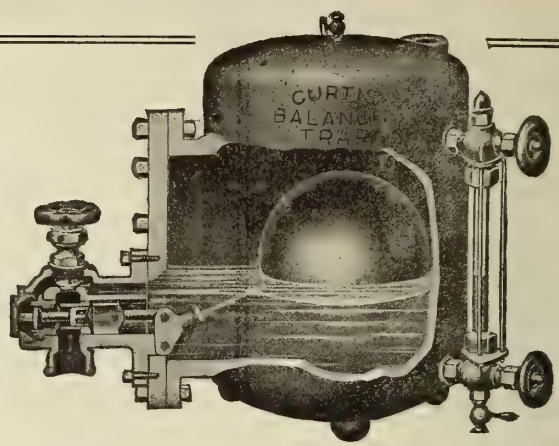
Breakdowns of this nature can be counted as things of the past in your plant when you install the Anderson Steam Separator.

The Anderson delivers **dry steam** under all operating conditions. The moisture is completely separated by the combined action of centrifugal force and the sudden reversal of high velocity steam current—and the moisture cannot be picked up again, when once separated.

A copy of catalog fully describing all Anderson Power Plant Specialties will be forwarded upon request.

The V. D. Anderson Co.
1935 W. 96th St. - Cleveland, Ohio

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties. Canadian funds are accepted at par at Montreal.

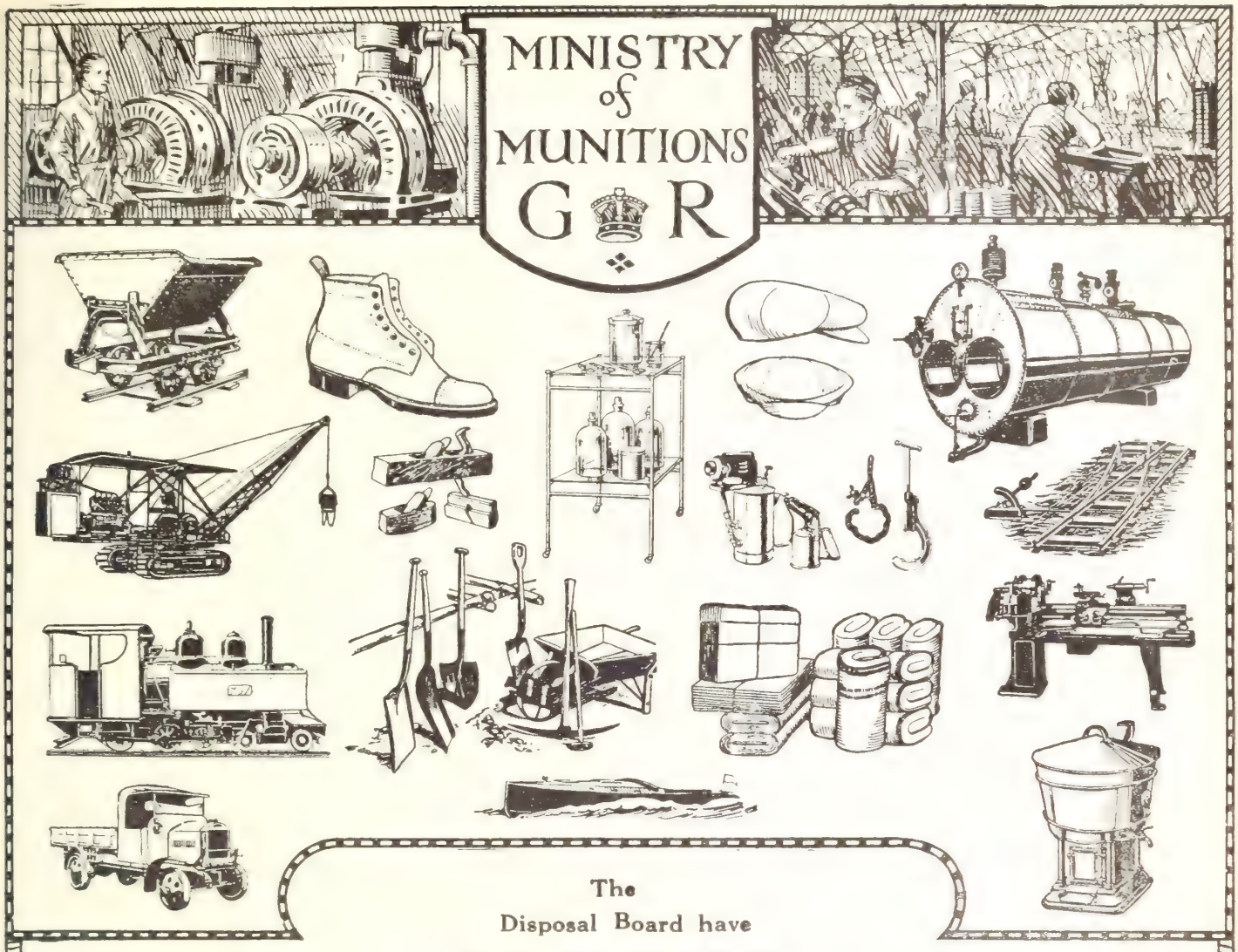
JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.
Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

Homestead Valves

You can save yourself many a breakdown and many a shutdown by using Homestead Valves. They are guaranteed unconditionally and are rendering more than expected results to thousands of satisfied customers who back up their experiences by ordering more Homesteads whenever they require tight, efficient, durable, positive-acting valves.

Benefit by the experience of others. Use Homestead Quarter-Turn Valves, and secure permanent satisfaction!

Homestead Valve Mfg. Co.
PITTSBURGH -:- PA., U.S.A.
Works: Homestead, Pa.



The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with D. B. 8 Canadian Export Department, Ministry of Munitions, Whitehall Place, S.W.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

REGISTERED
COPPUS
U.S.PAT.OFFICE

In Public Buildings

Municipal engineers **demand** efficiency—and **insist** on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the **highest** standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save **you** money." Write for Blower Catalog.

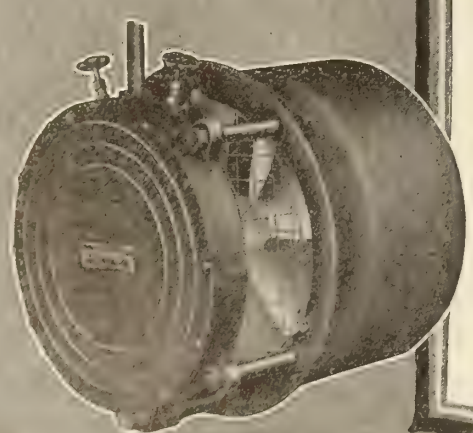
"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block.
Calgary, Alberta.



COPPUS TURBO BLOWER

The Fuel Situation!

How to Meet It!

With a coal famine staring us in the face, and the clean grades of coal almost off the market, it is essential that your boilers be equipped so that you can burn any grade of coal which you may have to use during the coming winter.

With COPPUS BLOWERS you can burn those cheap grades of fuel which it is impossible to burn with natural draft, and in addition, you can burn them more efficiently than you can the better grades of coal with natural draft. If, however, you have on hand a large supply of high-grade coal, COPPUS BLOWERS, by producing more complete combustion, will burn these grades of coal with a saving of at least 10% of your fuel. COPPUS BLOWERS, supplying forced draft under the grates of a hand-fired boiler, produce practically the same conditions of combustion which are secured in large Power Plant installations where expensive forced draft stoker equipment is installed.

On the other hand, consider the saving which can be secured by burning the cheap grades of fuel with COPPUS FORCED DRAFT as compared with the cost of burning the high grades of fuel by natural draft.

For example, if you are now burning ¾ Lump Bituminous Coal it will cost you to-day $14.75 per ton on the cars at Toronto. By installing COPPUS BLOWERS you can burn 80% of Birds-eye or Anthracite screenings at $6.00 per ton and the remaining 20% of Bituminous Slack at $13.50 per ton, so that the average cost to you would be $7.50 per ton for the mixture, OR A SAVING OF $7.25 PER TON, as compared with the cost of burning straight ¾ Lump Bituminous coal.

Some users of COPPUS BLOWERS

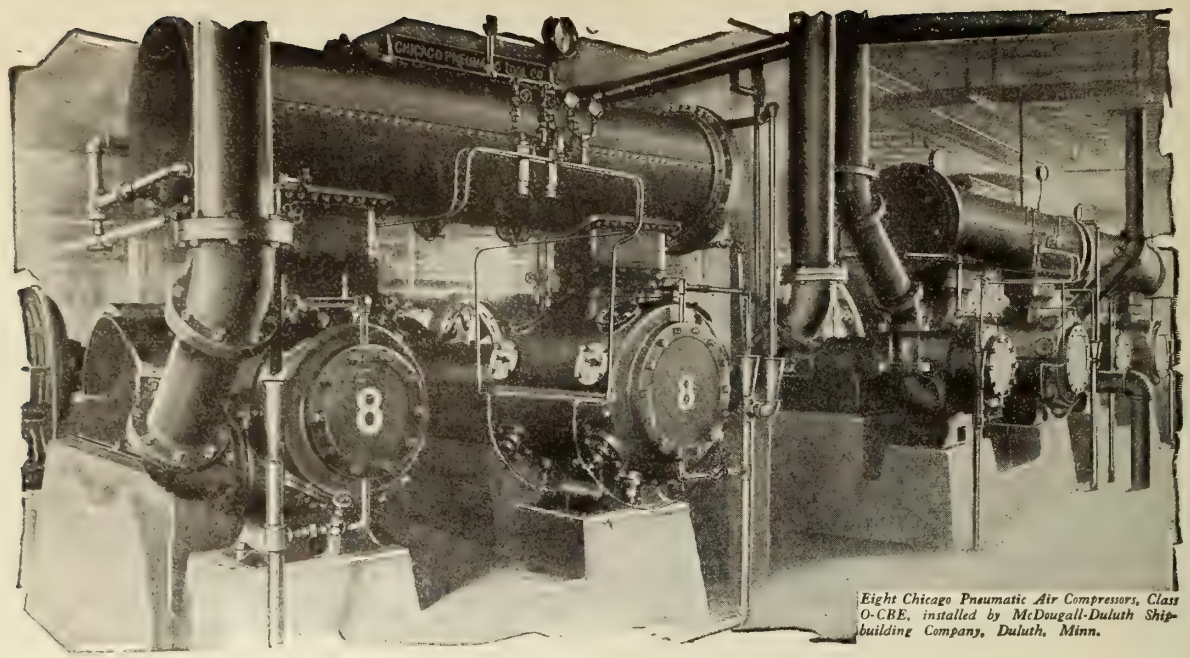
The T. Eaton Company Ltd., Hamilton.
Canadian National Rys., Leaside, Winnipeg.
Farmers' Dairy Co., Toronto, Indian River.
Lever Bros., Toronto.
Simpson Knitting Co., Toronto.
St. Michael's Hospital, Toronto.
Davis Leather Co., Newmarket.
Municipal Abattoir, Toronto.
Davisville Hospital, Davisville.
Orthopaedic Hospital, Christie St., Toronto.

Let us send you your copy of the Coppus catalogue.

The Arthur S. Leitch Co.

1001-2 Kent Building

TORONTO



Eight Chicago Pneumatic Air Compressors, Class O-CBE, installed by McDougall-Duluth Shipbuilding Company, Duluth, Minn.

Real endurance is *continuous* performance

"Napoleon would often, when on a campaign, remain for days without taking off his clothes"

COMPARED to Napoleon's energy on the plains of Champagne, is the unyielding endurance of Chicago Pneumatic Air Compressors.

Many Chicago Pneumatics, after serving *continuously* over periods of five to fifteen years, are still delivering *dependable* air power.

Contributing to this faithful performance is the Simplate flat-disc indestructible valve. Over 500,000 Simplates in use have delivered unfailing service since the day they were assembled at the Company's plant. Their simple, fool-proof, rugged yet light-weight construction is responsible for this record.

Other C-P economy-features are: Exceptionally large bearing surfaces, totally enclosed frame construction, automatic lubrication, automatic regulation under varying loads, and modern construction throughout on all sizes and types of the complete line.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-75-H

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

TURBO UNITS

60 CYCLES

K.W.	Volts	Make	R.P.M.	Lb. Pressure	K.W.	Volts	Make	R.P.M.	Lb. Pressure
30	240	Westinghouse-De Laval	1200	135 lb.	500	2300	General Electric-Curtis	3600	175 lb.
37½	220	Crocker Wheeler	1200		625	440	British Westinghouse	3000	
50	240	Westinghouse	1200	180 lb.	700	4400	General Electric-Leffel	300	
60	240	Westinghouse-De Laval	1200	135 lb.	750	2300	General Electric-Curtis	1800	150 lb.
75	250	Westinghouse	1200	100 lb.	800	480	Allis-Chalmers	3600	175 lb.
100	2300	General Electric-Curtis	3600	150 lb.	870	158	Westinghouse-Parsons	3600	
100	2300	Allis-Chalmers-Kerr	3600		1000	2300	Westinghouse-Parsons	3600	175 lb.
125	480	Burke-Kerr	3500	70 lb.	1200	240	Allis-Chalmers-Parsons	3600	150 lb.
150	2300	Westinghouse	900	125 lb.	1500	4000	General Electric-Curtis	900	150 lb.
187	2400	Westinghouse-Parsons	3600		2000	600	Allis-Chalmers	1800	150 lb.
200	2300	Allis-Chalmers-Kerr	3600		4000	4150	Allis-Chalmers	1800	185 lb.
250	2300	Westinghouse-Parsons	3600	150 lb.	2500	5500	Westinghouse	1200	200 lb.
300	2300	General Electric-Curtis	1800	110 lb.	5000	13200	General Electric-Curtis	720	175 lb.
375	4150/2300	Westinghouse-Parsons	3600		9000	6600	General Electric-Curtis	720	
400	2300	Westinghouse-Parsons	3600						

MacGOVERN & COMPANY, Inc.

285 Beaver Hall Hill, Montreal

Offices: New York, Pittsburgh, Seattle — Plants: Lincoln, N. J., and Linden, N. J.

Buyers and Sellers of New and Used Machinery

POWER HOUSE SOLVES THE PROBLEM

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Insist Upon Having the TRADE CAOUTCHOUC TRADE MARK Packing Bearing Our MARK

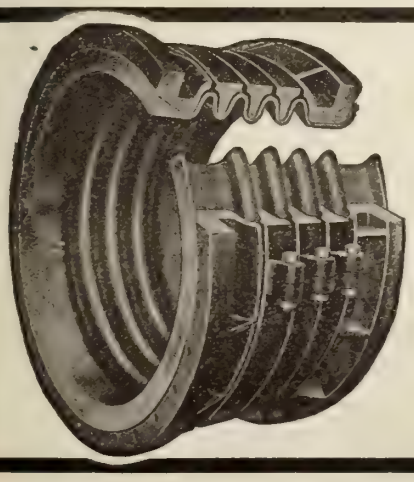
TUCK & COMPANY, LIMITED

London Liverpool Cardiff, Etc.

Canadian Representative:

Wm. J. Brown, 117 Youville Square - - - Montreal, Que.

All Sizes Stocked in Montreal TEL. No. MAIN 2387



Common sense would seem to indicate the installation of

BADGER SELF EQUALIZING EXPANSION JOINTS

that take up no more room than the diameter of the flanges on steam, water, gas, oil and nearly all pipe lines.

Write for our new book to-day

E. B. BADGER & SONS COMPANY

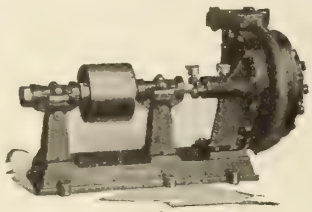
101 Park Ave., New York Pitts St., Boston 616 S. Michigan Ave., Chicago

AMERICAN-MARSH PUMPS

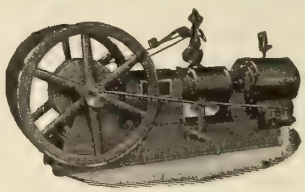
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



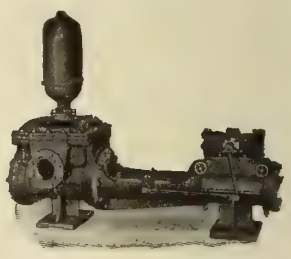
American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors

Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanics' Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

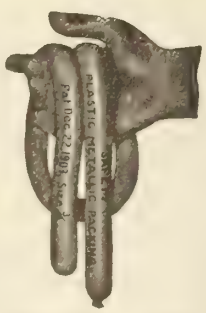
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

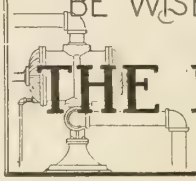
WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300

When writing to Advertisers kindly mention this paper.

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

LINCOLN ARC WELDER

S.S. CHIPPEWA CRACKS CYLINDER

Repaired in 24 Hours

Saved Season's Tie-up by LINCOLN WELDING

THIS news item clipped from a recent issue of a Toronto daily shows exactly what Lincoln welding will accomplish.

Every plant owner and every shipowner should read this article. We will be glad, indeed, if you will communicate with us for further information about Lincoln Electric Welding.

REPAIR WONDERS ARE DONE ON CHIPPEWA

Electric Welding Process Puts Steamer Rapidly Into Commission.

The steamer Chippewa of the Canada Steamship Company's fleet is lying at her dock at the foot of Yonge street to-day undergoing repairs, which are being performed by the same method as was used to get the interned German liners into commission during the war.

It will be recalled that the German crews damaged their ships to prevent them being used by the allies. In most cases cylinders were cracked. The Germans expected that it would take years to get them in commission again, and this view was generally accepted until an engineer, who was consulted, declared that the repairs could be made speedily by the new process of electric welding. As a result the ships were in commission in a few weeks and helped to win the war.

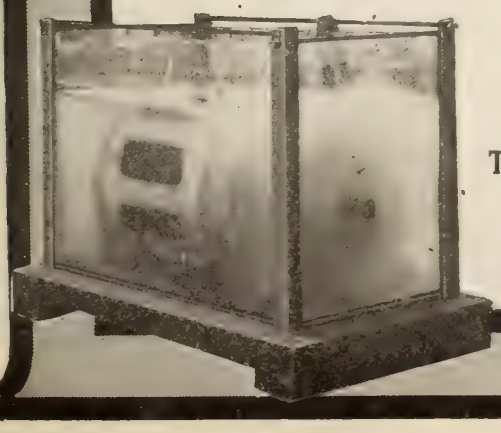
The Chippewa, having yesterday developed a small crack in her cylinder an emergency call was sent to the Lincoln Electric Company, 136 John street, who are experts in electric welding. The work of repair began at six o'clock last night, continued all night, and will if is expected be completed some time to-day when the Chippewa will be ready to go back on her regular run. It is said that by previously known processes the repairs would have probably involved putting the boat into drydock and going out of commission for the rest of the season.

A truck carrying the power engine operating on the dock beside the Chippewa attracted the attention of all lake-front visitors to-day. From this truck wires led the current to the scene of operations, in the interior of the boat.

Electric welding is one of the most interesting of the new industrial processes. It has come into use in Toronto only within the last year or two, but already a large number of important firms have installed electric welding equipment and staff.

Ships to Ottawa

Toronto Star Aug. 7, 1920



THE LINCOLN ELECTRIC COMPANY OF CANADA, LIMITED

Head Office: 136 John St., Toronto Phone Adel. 7200

Montreal Branch: Coristine Building

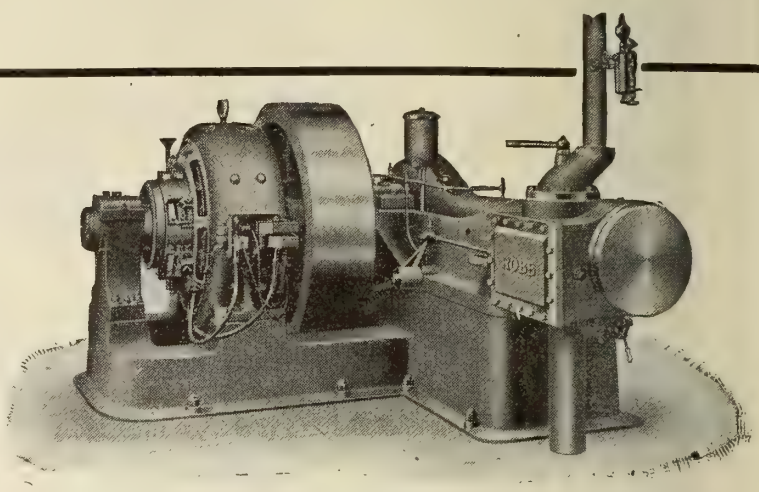
ROBB

For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.



Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.

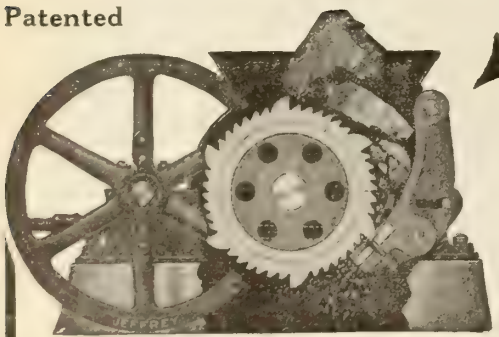
Robb Engineering Works Co., Ltd.

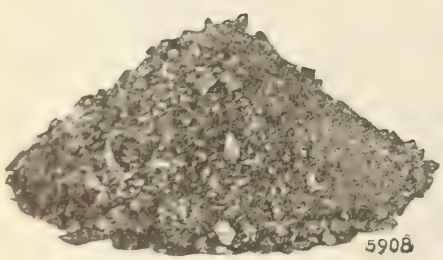
Amherst, N.S.

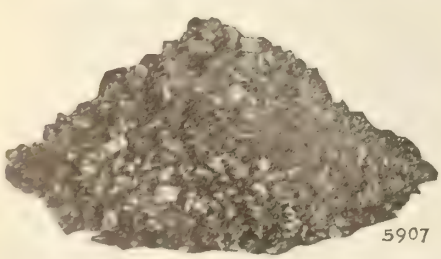
Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

Patented







Reduces Large Lumps and Run-of-Mine Coal to Stoker Size in a Single Operation

Insure a Supply of Proper Sizes and Qualities of Coal for your Stokers—by installing

a **Jeffrey**

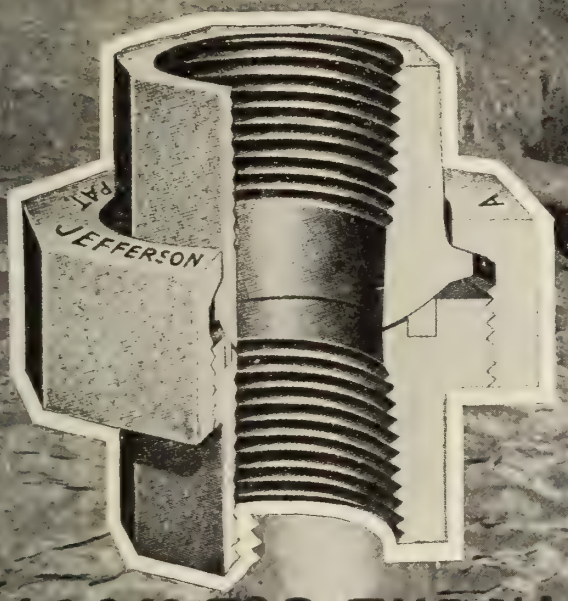
Single Roll Crusher

Write for Catalogue No. 141-5

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms: - Montreal

JEFFERSON



The Importance of Dependable Unions

The importance of dependable unions is emphasized in underground service—here the failure of a single union might mean serious loss of life and heavy damages.

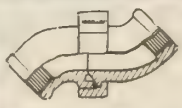
Insure against breakdowns with JEFFERSON UNIONS. You can tell them by "The name on the nut"—it is your protection against substitute "just as good" variety.

Your Jobber has JEFFERSONS in stock and can tell you why they always make good. Talk unions over with him.

Our catalog "UNIONS" shows the complete JEFFERSON LINE. Write for it to-day.

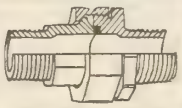
The Jefferson Union Co.
Lexington, Mass.

"LOOK FOR THE NAME ON THE NUT"

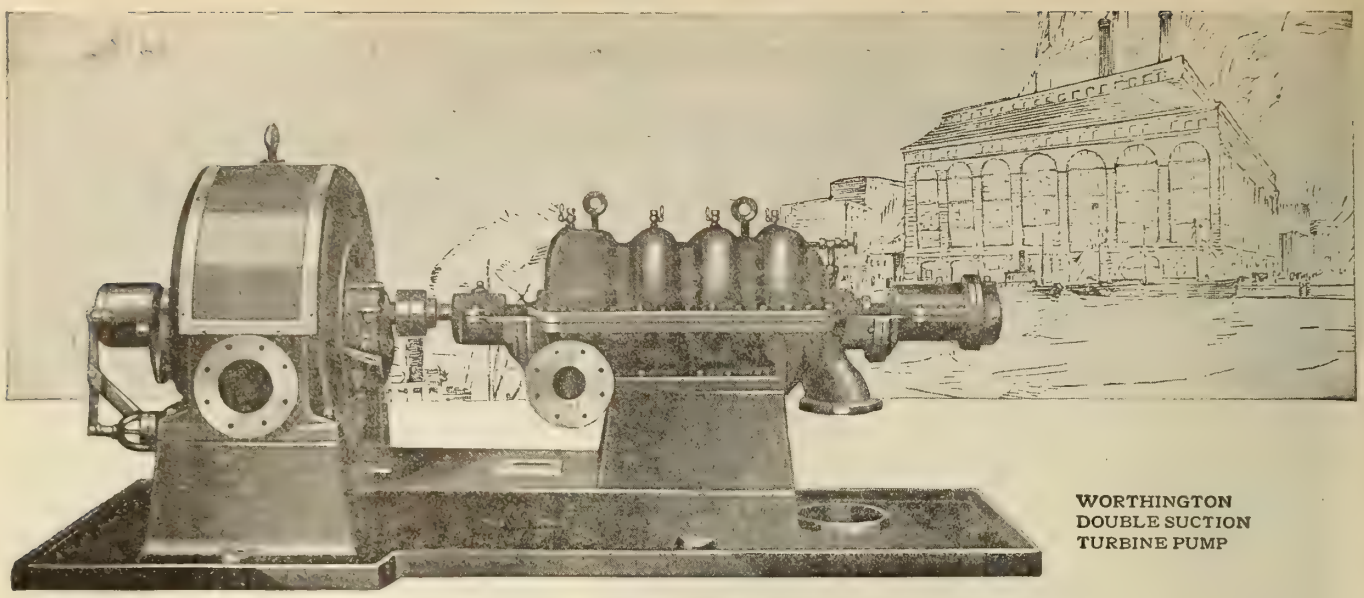


Jefferson Swing Union allows connections, ranging from a slight offset up to 90 degrees, and many angle connections.

Union Elbow, all female. Takes the place of a straight union, nipple and an elbow. Also made male and female.



All Male Union. Saves two pipe joints between two female threaded parts.



WORTHINGTON
DOUBLE SUCTION
TURBINE PUMP

Worthington Centrifugal Boiler Feed

TO satisfy the need for a centrifugal boiler feed pump that is free from end thrust, Worthington offer their Double Suction Turbine Pump for boiler feed.

Worthington have designed and built into this centrifugal type pump a distinctive hydraulic balance port which inhibits end thrust even when the pump becomes old. And this continuously good, long service has made Worthington Double Suction Turbine Pump leader in its field and worthy representative of the engineering skill and constructive ability of the 80 years old Worthington organization.

This pump is one of the varied Worthington line of power plant apparatus that has successfully satisfied over 200,000,000 boiler horse power since 1840.

Other Worthington Products:
Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

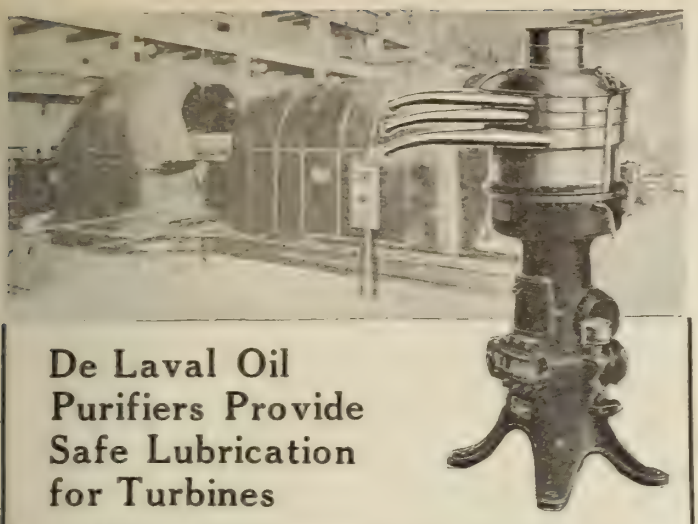
WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

W-332.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*



De Laval Oil Purifiers Provide Safe Lubrication for Turbines

Oil used to lubricate direct-connected or geared turbines inevitably picks up a large amount of foreign matter such as particles of metal, dirt, sand and water. If allowed to remain in the oil, these impurities cause the early destruction of the bearings and gear teeth.

All such impurities are instantaneously removed from lubricating oil by the DeLaval Oil Purifier. Core sand, red lead, pipe scale and pipe burrs, which frequently cause so much trouble when new plants are started up, are also effectually removed from the oil.

Waste of oil is entirely eliminated by the De Laval Method of Purifying Oil by centrifugal force. The dirty oil in the oiling system is pumped into the rapidly revolving bowl of the Purifier where all impurities are removed, the clean oil being delivered back into the lubricating system. The heavier solids remain in the bowl and the lighter solids are sludged out through the waste spout.

This self-sludging feature of the De Laval Purifier enables it to operate efficiently on long, continuous runs without stopping to clean the sediment pockets. When this becomes necessary, it is quickly and easily accomplished.

De Laval engineers have evolved a number of general types of De Laval Oil Purifier installations suited to most power plants. They will be glad to study your problem and recommend a type of installation to meet your particular needs.

Write to nearest De Laval office for Oil Purification Bulletin No. 100; also Crank Case Oil Bulletin No. 102.

The De Laval Separator Co.

New York Chicago

TURBINE EQUIPMENT CO.
Toronto, Ontario

THE DE LAVAL CO., LTD.
Peterboro, Ontario

You can again obtain Genuine "Resisto" Gauge Glasses with the Red Line—

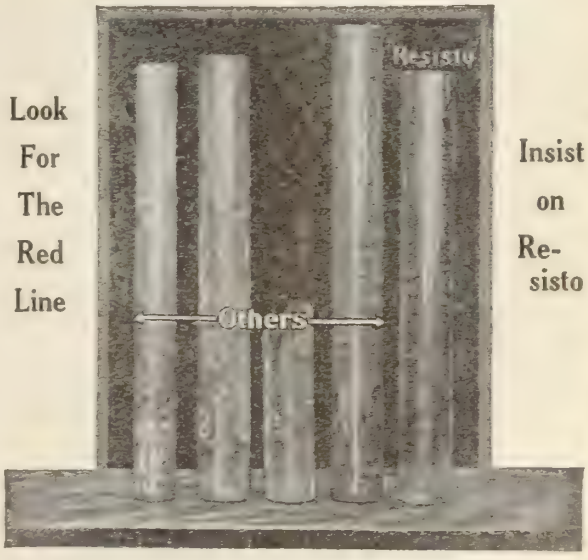
You'll be glad to know this. No more dangerous experimenting with inferior glasses. You can depend upon the "Resisto"—its reputation is your assurance of perfect service.

Get your order in at once.

Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.

THE SCHAEFFER & BUDENBERG MFG. CO. RESISTO HIGH PRESSURE GAUGE GLASS

Look For The Red Line



Insist on Resisto

THE
SCHAEFFER & BUDENBERG MFG. CO.

338 Berry St.
BROOKLYN, N.Y.

Toronto:—A. G. Milton, 32 Front St. West

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal

AIR DRILLS
Holden Co., Ltd., The, Montreal

AIR HOSE
Holden Co., Ltd., The, Montreal

AIR HOISTS
Holden Co., Ltd., The, Montreal

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal. Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

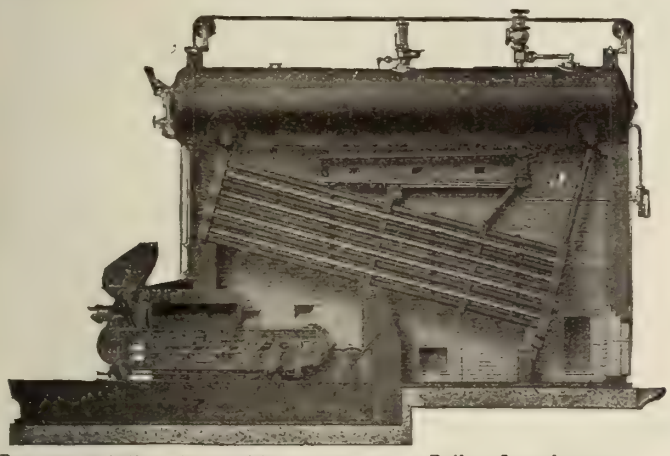
CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

CANADIAN MACHINERY wants a representative in every town and city where there is a metal working plant or large machine shop.

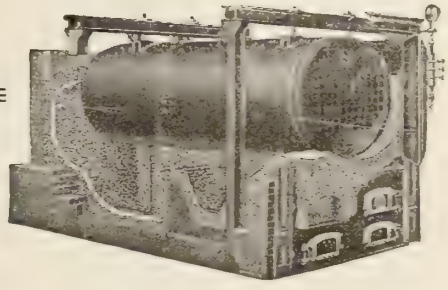
We require first of all the ability to demonstrate to mechanics the value of reading technical journals in general and CANADIAN MACHINERY in particular, and to secure their subscriptions.

Second—we want men who can tell news when they see it. Not necessarily men who can write, but men who are alert for news, and who will give us the facts, briefly and plainly.

We will pay you liberally if you can handle this work for us in your city.

Canadian Machinery and Manufacturing News

143 University Ave. Toronto, Ont.



For Furnace Linings and Baffles

That are easy to install—air and gas tight, that cannot crack, chip, spawl or peel off—no separate fire brick, no mortar joints and not affected by expansion and contraction.

BETSON'S TRADE MARK PLASTIC FIRE BRICK

is a plastic, unbaked fire brick material—made of the best fire clays and refractories—proportioned and mixed to withstand all strain, heat, gas and chemical action to which it may be subjected by the hardest usage. It outwears all other boiler furnace linings.

Write for informing pamphlet.

Betson Plastic Fire Brick Co., Inc.

P. O. Box 386-6 Rome, N.Y.

Canadian Distributors:
INTERNATIONAL CHEMICAL CO.,
44-6 Lombard Street, Toronto, Ontario, Canada
Warehouses in principal cities

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empare Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd,, Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

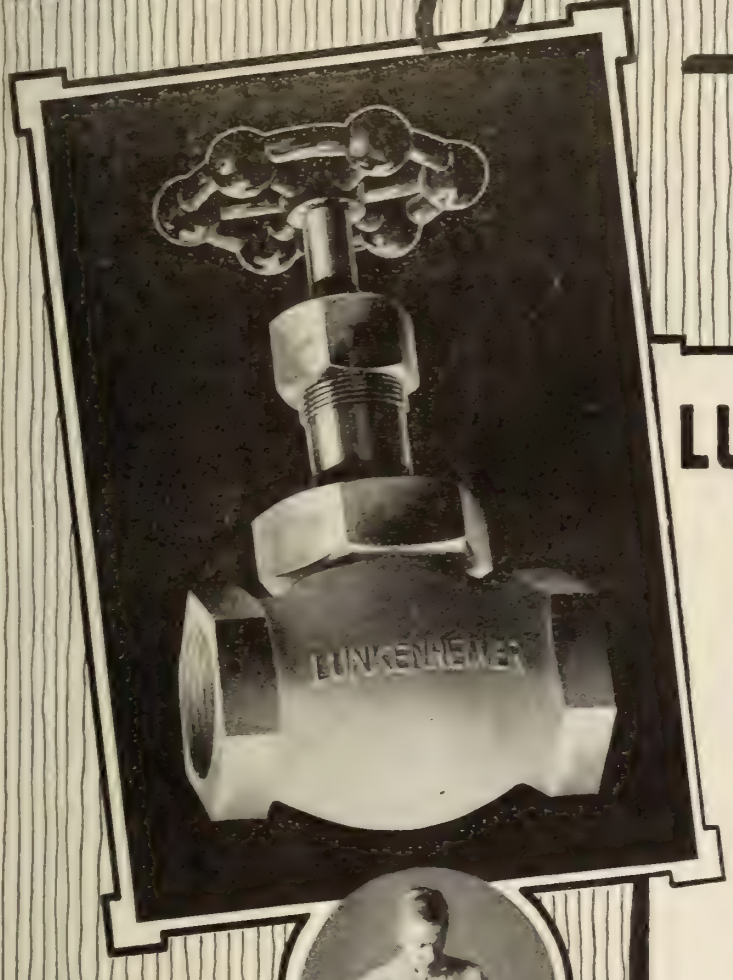
FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

Superiority—unfailing performance—service

AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862



The original Regrinding Valve

LUNKENHEIMER REGRINDING VALVES

have firmly established their unparalleled merit by the successful results they have given through many years of satisfactory service.

The metal to metal seat—ground to a tight fit, forms the ideal seating surface to resist the wearing action of steam at high velocity. And the fact that the seating surfaces can be re-ground (an inexpensive operation easily accomplished) makes the renewal of parts wholly unnecessary.

Their extreme durability due to correctly proportioned parts, high quality materials and expert workmanship insure economy in maintenance.

Globe, Angle and Cross Valves with Inside Screw and with Outside Screw and Yoke; and Horizontal, Angle, Vertical and Swing-Check Valves for 200 and 300 pounds working steam pressure.

Specify **Lunkenheimer** and insist on their installation. Distributors of Lunkenheimer Products situated in every commercial centre.

Write for descriptive booklet No. 517—DC

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI

New York Chicago Boston London

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co. Walkerville Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co. Toronto Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Stanford Riley Stoker Co. Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Pilley Packing & Flue Brush Mfg. Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co. New York, N.Y.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Empire Mfg. Co., Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Jenkins Bros., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

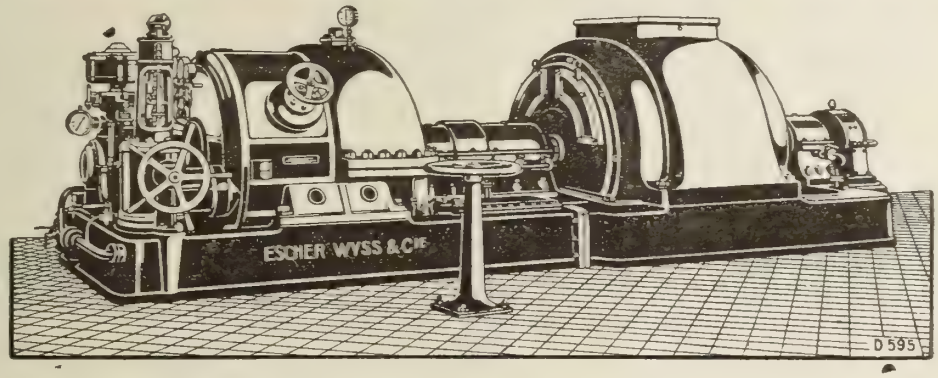
LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

Montreal Office: 112 Coristine Building

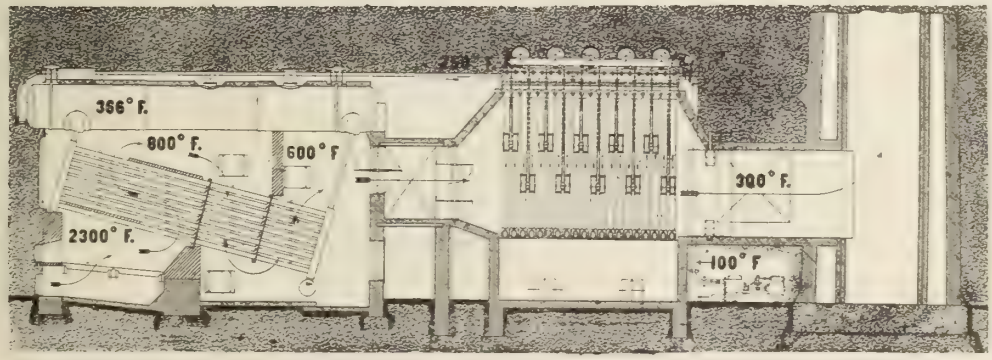
Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20

GREEN'S ECONOMISERS



A Saving of 13.6%

Green's Economiser "installation temperature diagram" showing a rise of 150° in feed water temperature above that of the feed water heated. This is not an unusual case, and under these conditions would show a saving of 13.6% based on 1% saving for each 11° increase in feed water temperature.
Modern economic operation of boiler plants demands that your boilers be operated above normal rating. This means higher exit temperatures on the flue gases.
Green's Fuel Economisers utilize this heat in the flue gases to heat the feed water under boiler pressure, which accounts for the fuel saving and also allows you greater boiler capacity.
Ask our engineers for data on economisers for your plant.

GREEN'S ECONOMISER, LTD.
TORONTO

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Telford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
E. J. Philip & Sons, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lunkenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Jenkins Bros., Montreal.
Dunkley Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Sturtevant Co., Ltd., B. F., Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd. Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd. Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd. London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd. Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

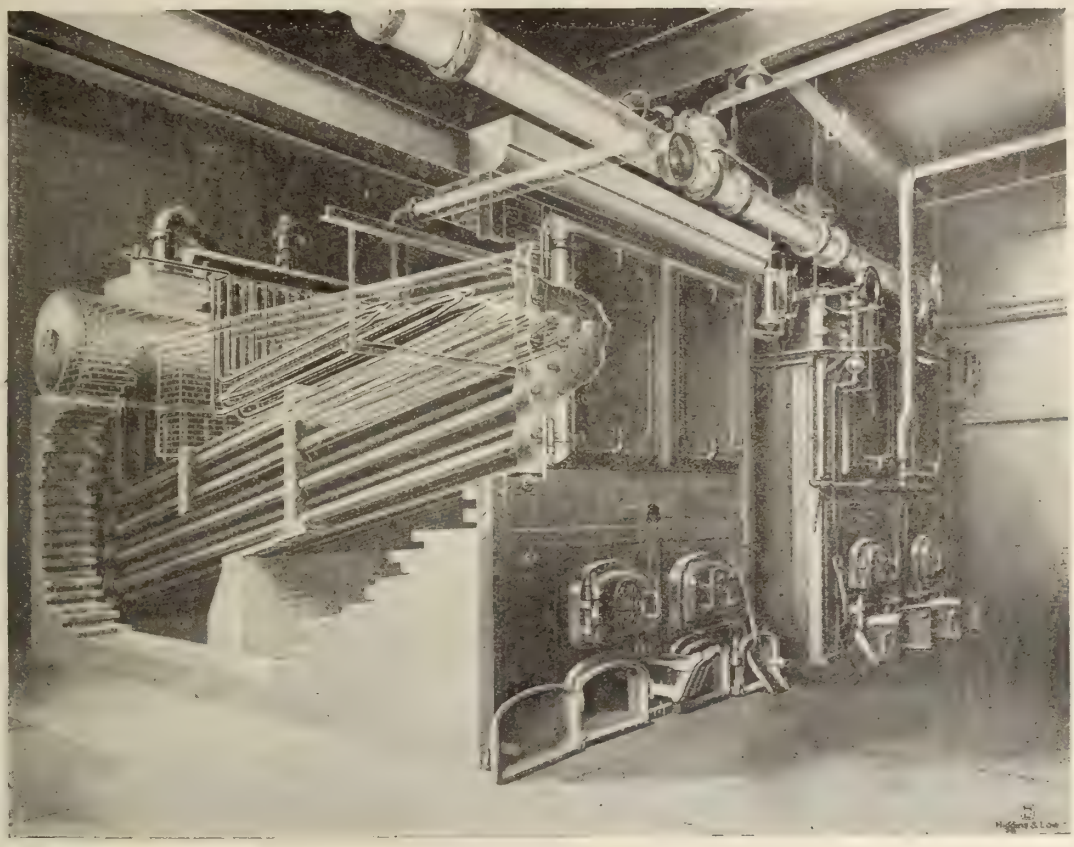
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.



Elements Vital to Effective Superheating

THERE are certain basic engineering principles in the design and installation of superheaters, which when practised insure success.

Among these is the location of the superheater heating surface. The heating surface of ELESCO Superheaters is made up of small diameter steel tubing, affording its location in advantageous gas temperatures. This makes possible a large ratio of superheating surface, an even distribution to the flow of the gases, and a proper distribution of the steam through the superheater.

Furthermore, the small diameter tubing of ELESCO units makes it possible to distribute the heating surface so as to insure a free flow of the gases past the superheater.

A correct combination of these and other vital elements, are the basis of the success of ELESCO Superheaters.

These Points are Covered in Our Bulletin—Send for Your Copies

The Superheater Company, Limited

Transportation Building, MONTREAL *Works at Sherbrooke, Que.*

Designing Engineers and Manufacturers of Superheaters and Pipe Coils for All Classes of Service

MADE IN CANADA

Darling Bros., Ltd. Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Reliance Electric Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J. 32 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Pitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works Ltd. Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co. Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole, Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Line Jn Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd. Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd. Sarnia.
Valve Engineering Company.

Where strength and dependability are requisites specify Williams' "W & B" Machinists' Knife Handle Wrenches. Fitted with the "W&B" easy-acting screw. At your dealers! Write for catalog.

J. H. WILLIAMS & CO., LIMITED

" The Wrench People"

ST. CATHARINES - - - ONTARIO

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T. St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co. H Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co. Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co. Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

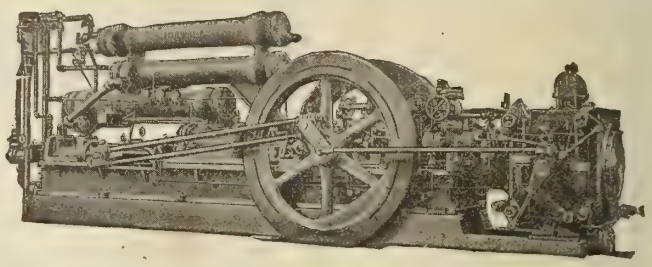
WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

NORWALK
AIR & GAS · COMPRESSORS

Time-Proven

Wherever there is a point of strain or wear in a Norwalk Compressor there is the special quality—the excellence of materials and careful workmanship—to minimize operating stresses and insure continuous efficiency. It is this manufacturing policy which has given Norwalk Compressors their high standard of reliability.

The satisfaction derived from a Norwalk Compressor at the time of installation is only a foretaste of the complete confidence which grows with years of service.



A Four-Stage Compressor driven by Compound Corliss Steam Cylinders.

Our Bulletins on air, oxygen, hydrogen, acetylene gas or carbonic acid gas describe in detail the structural features which account for the famed Norwalk durability.

Write for those which interest you.

Pioneer Builders of Compressors
OUTH NORWALK, CONN.

The Norwalk Iron Works Company

A. S. Leitch Company, Toronto
Canadian Sales Representatives

ANY·CAPACITY ANY·PRESSURE

INDEX TO ADVERTISERS

A
American Steam Gauge & Valve Mfg. Co. 41
American Steam Pump 64
Anderson Co., V. D. 58
Armstrong Cork & Insulation Co. 11

B
Babcock & Wilcox 71
Badger & Sons, E. B. 63
Betson Plastic Fire Brick Co.. 71
Boving Hydraulic Eng. Co. ... 55
Bowser & Co., S. F. 51
Brown, Wm. J. 63
Busch-Sulzer Bros. Diesel Engine Co. 57

C
Can. Consolidated Rubber Co.. 49
Can. Fairbanks-Morse Co. 37
Can. Johns-Manville Co. 7
Can. Mead-Morrison, Ltd. 50
Chaplin-Fulton Mfg. Co. 54
Cole Ltd., Geo. W. 52
Coppus Engr. & Equip. Co. .. 60
Crane Ltd. 54

D
Darling Bros. 54
Dart Union Co. 50
D'Este Co., Julian 58
De Laval Separator Co. 69
Department of Labor 55
Diamond Specialty Co. 42
Direct Separator Co. 38
Dominion Coal Co. 54
Dunham & Co., C. A. 4
Durabla Mfg. Co. 38

E
Economy Fuse Co. of Can., Ltd. 13
Electric Welding Co. 64
Empire Mfg. Co. 3
Engr. & Mach. Works of Can. 46
Escher, Wyss & Co. 75

F
Frick Co. 11

G
Garlock Packing Co. 40
Garth Co., The 55
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co. ..14, 15
Greene, Tweed & Co. 39
Green's Economizer, Ltd. 75

H
Hays Corp., Jos. W. 43
Holden Co., Ltd., The 62
Holmes Metallic Packing Co.... 55
Homestead Valve Mfg. Co. 58
Hoyt Metal Company 54

J
Jamison Cold Storage Door Co.. 12
Jefferson Union Co. 67
Jeffrey Mfg. Co. 66
Jenkins Bros. ...Outside front cover
Jointless Fire Brick Co. 57

K
Kellogg & Co., E. H. 36
Kerr Engine Co. 57

L
La Clede Christy Clay Products Co. 8, 9
Laurie & Lamb ..... Inside front cover, 55
Leitch, The Arthur S. 61
Leonard & Sons, Ltd.. E. 41
Linde Can. Refrig. Co. 10
Lincoln Electric Co. of Can. 65
Lunkenheimer Co. 73

M
MacGovern & Co. 63
Magnolia Metal Co. 4
Manny Co., E. S. 54, 64
Mason Regulator & Eng. Co... Inside back cover
Ministry of Munitions 59
Morrison Brass Mfg. Co., Jas. Outside back cover
Mueller Mfg. Co., H. 2
Murphy Iron Works 13

N
Northern Electric Co. 6
Norwalk Iron Works Co. 80

P
Page-Hersey Iron & Lead Co., Ltd. 56
Penberthy Injector Co. 5
Peacock Bros. 45
Pilley Packing & Flue Brush Mfg. Co. 55
Pratt & Cady Co., Inc. 41

R
Republic Flow Meters 44
Robb Engineering Co. 66

S
Sanford Riley Stoker Co. 13
Sexton Boiler Setting Co. 52
Scaife & Sons Co., Wm. B. ... 80
Schaeffer & Budenberg Mfg. Co. 69
Starrett Co., The L. S. 46
Steel Mill Packing Co. 64
Sterling Engine Co. 46
Sturtevant Co. of Canada, Ltd., B. F. 47
Superheater Co., Ltd., The..... 77

T
Trimont Mfg. Co., The 56

U
Underfeed Stoker Co. of Can., The 53
Uehling Instrument Co..... 56

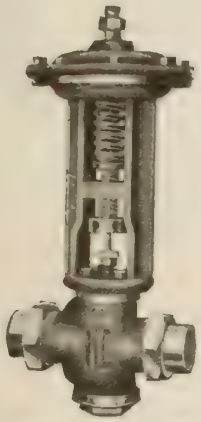
V
Victoria Foundry Co. 54
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd..... 38

W
Wall, W. J. 55
Waterous Engine Works Co..... 1
Watson & McDaniel Co. 55
Weir, W. & J. 45
Williams & Co., J. H. 79
Worthington Pump & Machine Co. 68

Y
Yarnall-Waring Co. 42
York Mfg. Co. 12

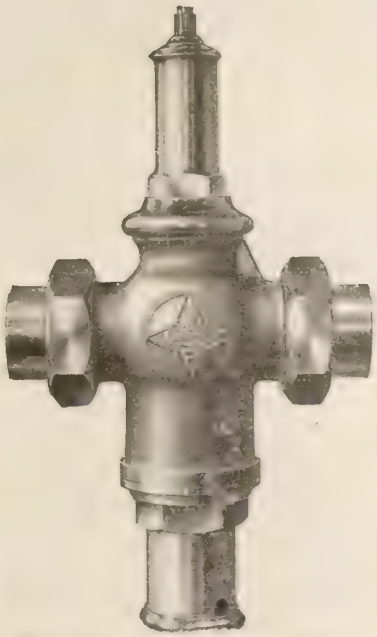
WATER
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

"SERVICE"

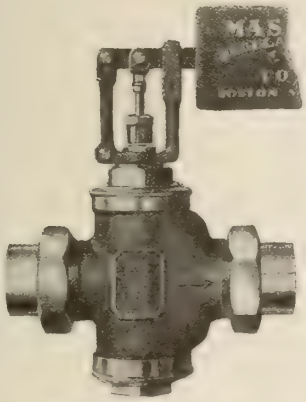


Mason No. 55 Style
Pump Pressure Regulator

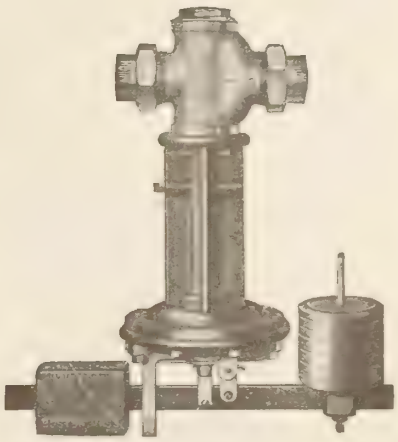
Mason Standard
Reducing Valve
Iron Body



Mason Standard Reducing Valve
Bronze Body



Mason Balanced Valve



Mason Lever Style Reducing
Valve

MASON STANDARD REDUCING VALVES ARE MADE IN CANADA

The Mason Regulator & Engineering Company, Limited

135-153 DAGENAIS ST. (ST. HENRY)
MONTREAL

ROOM 5, 145 WELLINGTON STREET WEST
TORONTO

MORRISON

STEAM SPECIALTIES

"Every Installation is a demonstration of merit"

The worth of a steam specialty is equivalent to the service it renders. For over fifty years, Morrison products have been giving dependable, care-free service to their users. Send for the Morrison catalog to-day and try Morrison Specialties for your most troublesome duties.

The James Morrison Brass Mfg. Company
LIMITED
93-97 Adelaide St. W., Toronto

ANNUAL DIRECTORY NUMBER

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Vol. XIII.—No. 20. Publication Office, Toronto—October 20, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

The Plant That Keeps
Other Plants in the

Forefront of Progress

A standardization of the most advanced engineering practice that has eliminated the vulnerable points of ordinary undergrate blower construction that sooner or later show up in actual service, Coppus Turbo Blowers are a distinctive system that is adaptable to any installation requirements from the smallest to the largest.

Being the adaptation of the best in centrifugal pump construction to the extremely difficult service of boiler feed, Coppus Turbo Feed Pumps make available to power plants a rugged, dependable, economical centrifugal pump in units of 100 to 4,000 B.H.P.

Intensive scientific study plus the unusual facilities of this great Coppus plant, have made possible this triumph of industry, best appreciated by the power plant engineer who feels he has done with experimenting and who has the matured judgment to recognize that the best is always cheapest.

To enable you to make this careful investigation on the correct determination of which rests the profits of many years, we will send you without charge the Coppus catalogue.

"COPPUS Equipment can Save You Money"

COPPUS ENGINEERING & EQUIPMENT COMPANY

Mfrs. of COPPUS Turbo Blowers, COPPUS Turbo Feed Pumps and COPPUS Power Turbines
341 Park Ave., Worcester, Mass.

Agents for Montreal—Mason Regulator & Engineering Co., [illegible] Agents for Vancouver—Frank Darling & Co., Limited, 1142 Hower St. Agents for Toronto—Arthur S. Leitch Co., 1001 Kent Bldg. Agents for Calgary:—W. J. Yeo & Co., [illegible]

REGISTERED COPPUS U.S. PAT. OFFICE

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto
MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

The Arthur S. Leitch Company

Modern Power Plant Equipment

Since 1910 we have been representing in Canada, those manufacturers of power plant equipment whose products have become established as the **standard,** each in its particular line. You'll know them all by reputation.

To give **good service** has always been our aim. This we have accomplished by handling only quality equipment, by fairness and promptness in all things. For a combination of **quality** and **good service**—come to us!

Equipment We Handle

Taylor Stokers
Kellogg Chimneys
Terry Steam Turbines and Reduction Gears
Skinner Uniflow Engines
Sims' Heaters
International Water Softeners and Filters
Hays' CO_2 Apparatus
Economy Sump Pumps
Dayton Dowd Centrifugal Pumps
Dean of Indianapolis Steam Pumps
Rumsey Rotary and Triplex Pumps
Nash Vacuum Pumps and Air Compressors
Coppus Turbo Boiler Feed Pumps and Under-grate Blowers (see front cover)
The Brown Instrument Co. Indicating and Recording Instruments

Watch for full details of each of these lines, which will be treated individually in future issues of Power House.

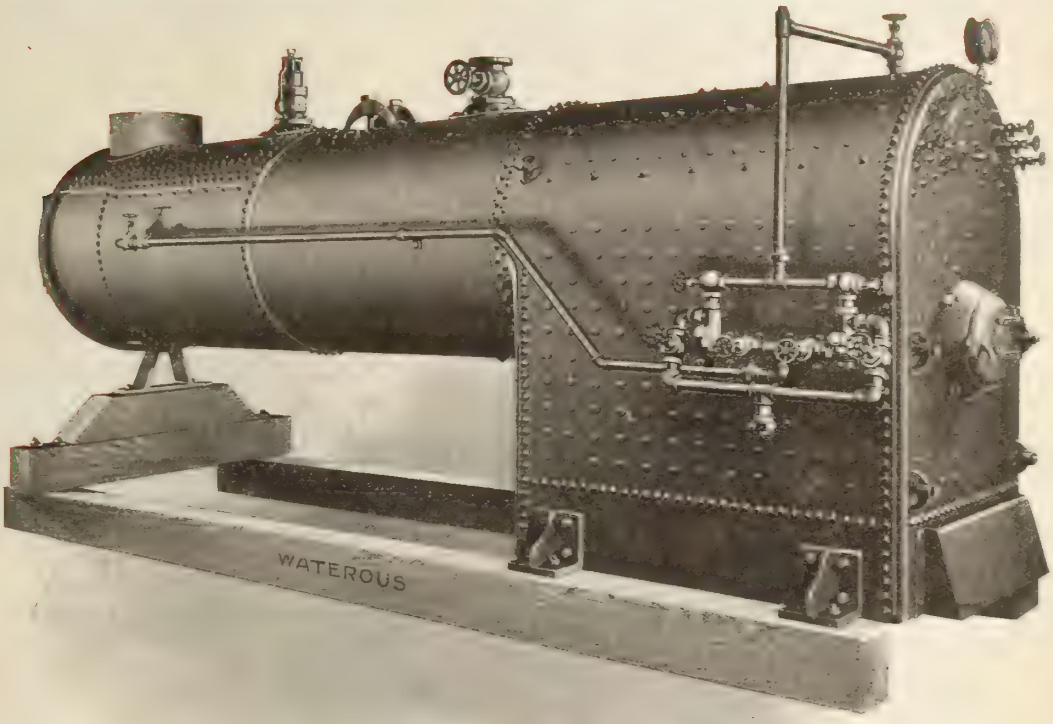
THE ARTHUR S. LEITCH CO.

1001-2 Kent Building, TORONTO, ONTARIO

Stationary and Portable Boilers

Boilers in Stock for Immediate Delivery

1—54x14 Horizontal
2—60x14 "
14—72x18 "
4—66x16 "
2—40 H.P. Locomotive



ECONOMY in fuel consumption, ease and convenience in operation, absolute trustworthiness—these are outstanding features of Waterous stationary and portable boilers. As with all other Waterous products, every part is rigidly factory tested to withstand stress far in excess of that at which they are rated, thus ensuring a high, positive safety factor.

We build different styles of boiler settings, designed to best handle various fuels. Waterous boilers assure you the highest possible efficiency. Let us specify on your requirements.

Catalogs upon request: Address 23 Market St. South, Brantford, Ont.

Waterous

BRANTFORD, ONTARIO, CANADA

MOLSONS BANK BLDG., VANCOUVER, B.C. - - WINNIPEG, MAN.

POWER HOUSE, October 20, 1920. Vol. XIII., No. 20. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

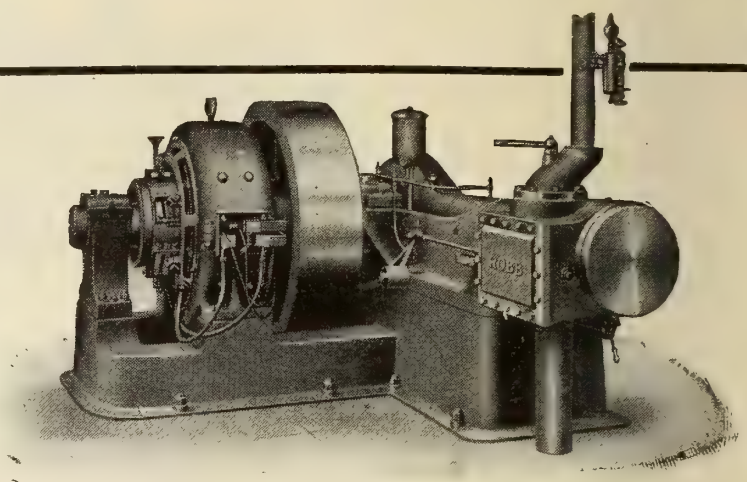
ROBB POWER PLANTS

For Quality Equipment

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Less Wear and Tear

IMPERIAL Lubricants keep plant machinery running smoothly, reducing friction and consequent power loss.

Their regular use prolongs the life of your equipment, and increases its efficiency.

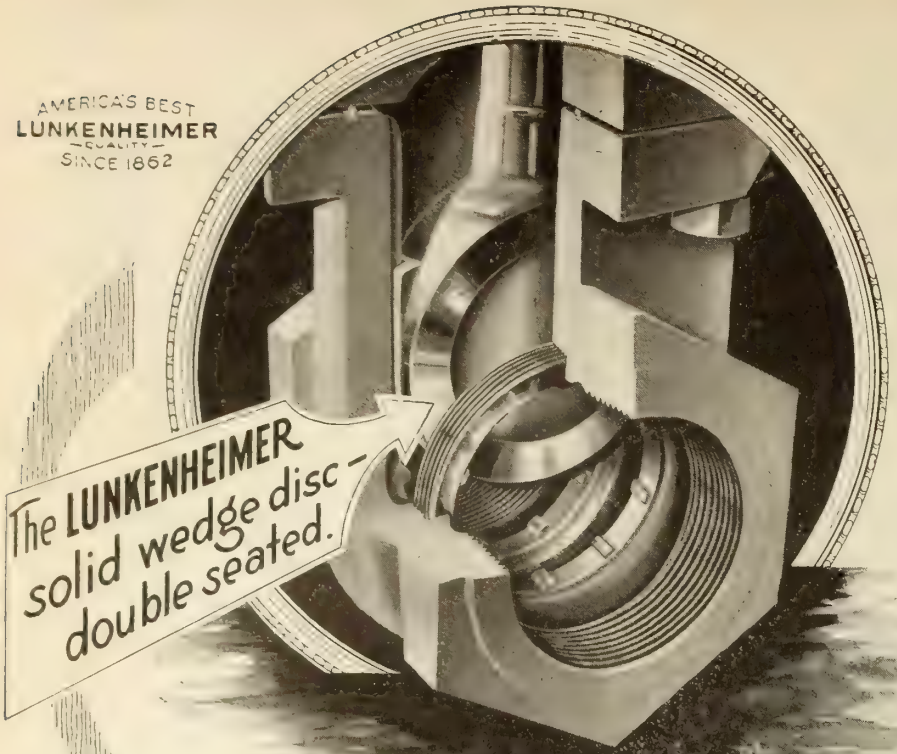
Imperial Lubricants are graded to meet the varied requirements of every type and make of machine. Each grade of oil is refined to the same exact, scientific standard. Ample supplies—every grade—carried in stock near you.

Many Imperial Oil customers voluntarily report savings as high as 35% in lubricating oil bills when following our recommendations. That's worth while economy that goes along with increased capacity and lowered depreciation costs.

Imperial Lubrication Engineers will gladly make it their business to see that you get full value from the lubricating oils you use. It will pay you to call in the Imperial Oil man and have him prescribe for your plant.

Write to 56 Church Street, Toronto, for more information.

AMERICA'S BEST
LUNKENHEIMER
—QUALITY—
SINCE 1862



LUNKENHEIMER "VICTOR" GATE VALVES

Fig. 602

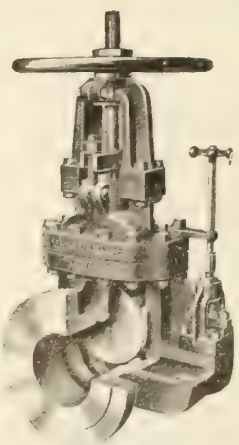


Fig. 894

have a solid wedge disc which seats on rings threaded into the body in exact alignment with the disc faces. The disc is guided and travels practically a closed position before coming in contact with the seat ring faces. This construction eliminates the "dragging" of the disc across the seats and the consequent wear prevalent in valves employing loose parts.

The generous proportion of all parts and the high quality materials insure ample safety factors for all service conditions.

An exclusive Lunkenheimer feature is the gasket between the body and bonnet-flanges, consisting of a seamless copper wire partly embedded in the body flange. It cannot blow out and is practically indestructible.

The bearings are bushed to insure long life to the wearing parts, and to further enhance their durability as a whole, all the parts are interchangeable.

Made with Inside Screw Stationary Stem and with Outside Screw and Yoke, Rising Stem in Bronze, Iron and Steel for pressures up to 350 pounds and temperatures to 800 degrees F.

For **Safety, Service** and **Economy,** specify LUNKENHEIMER "VICTOR" GATE VALVES and insist on their installation.

Distributors of Lunkenheimer Products situated in every commercial center.

THE LUNKENHEIMER CO.
—"QUALITY"—

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, U.S.A.

New York Chicago Boston London

Export Department: 129-135 Lafayette St., New York

6-20-43

Upper Run of Pivoted Bucket Carrier over coal bunkers.

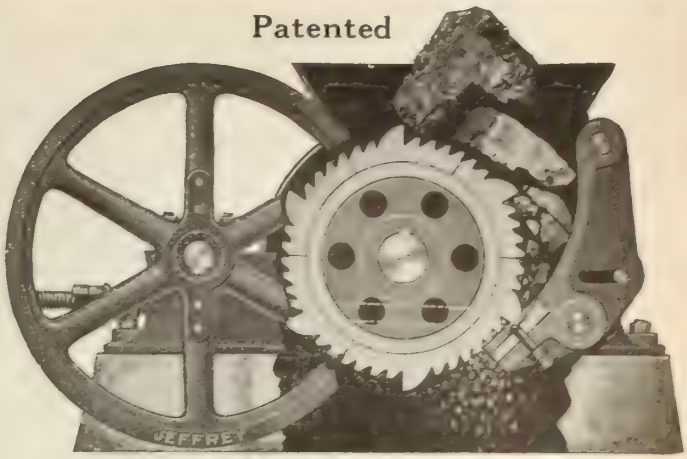
Lower run of Pivoted Bucket Carrier.

V-Bucket Elevator—Conveyer over bunkers

Handling ashes with a Jeffrey Drag Chain Conveyer in basement under boiler room.

Steel Apron Type Conveyer handling coal from track hopper to boiler house.

Patented



Single Roll Crusher for reducing coal to stoker size.

Jeffrey

Equipment

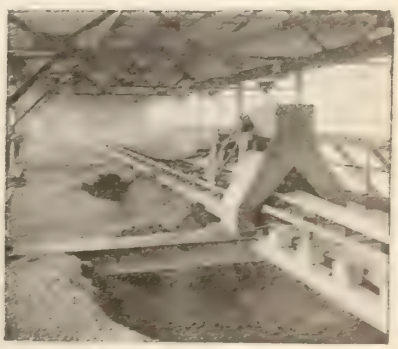
Is Adapted For Handling Coal And Ashes In All Sizes Of Power Plants

Your requirements can be economically met by some of our standard types of Pivoted Bucket, V-Bucket, Chain Scraper, Belt, Steel Apron or Drag Chain Conveyers, Bucket Elevators or other types of equipment.

Engineers with years of operating and field experience will make a study of your individual problems and recommend the "right equipment" to place your coal and ash handling on an economical basis. Send for latest catalogs.

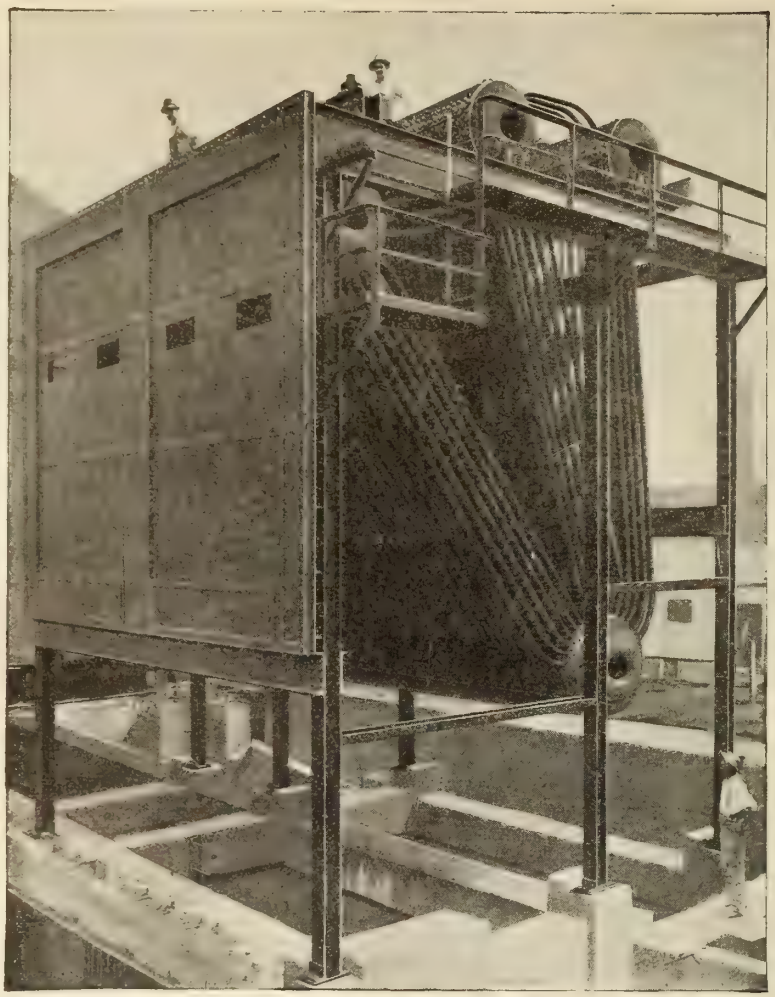
The Jeffrey Mfg. Co. Canadian Branch and Warerooms, **Montreal**

Chain Scraper Type Conveyer over bunkers.



Belt Conveyer and Tripper distributing coal to bunkers.

86th Year



86th Year

Connelly (Patented U.S. & Canada) Water Tube Boilers

are of the 4 drum type, have 100 per cent. tube area in the path of circulation and deliver steam superheated to from 5 to 10 degrees Fahrenheit.

Simple in design, no flat surfaces, no staybolts, no crown bars, no braces, no hand-holes, free from joints.

All parts easily accessible for cleaning, both internally and externally.

Can be built in units from 200 H.P. up to 4,000, H.P. and 300 lbs. pressure.

150,000 H.P. in successful operation.

E. LEONARD & SONS LIMITED

Head Office and Works : LONDON, Canada

Branches:

1790 St. James St., Montreal, Que. 62 Water Street, St. John, N.B.

Agents.

E. J. Philip & Sons, 57 Queen Street West, Toronto, Ont
Wm. W. Hicks, 567 Banning Street, Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave Street, St. John's, Nfld.

LEONARD

Nonpareil Grates

The Enemy of High Fuel Prices

When big manufacturing firms install new equipment they never jump at conclusions or take anybody's word as to its merits. They have their own experts investigate first. This is exactly the course taken by the following well-known firms before installing NONPAREIL SHAKING AND DUMPING GRATES.

H. J. Heinz & Co., Leamington, Ont.; 7 Sets
Canadian Allis-Chalmers, Limited, Toronto; 25 Sets
Simmons, Limited, Toronto; 2 Sets

Before any of these companies installed NONPAREIL GRATES they satisfied themselves of their efficiency and economy—that they would give perfect combustion, improved service and would SAVE FUEL, and otherwise live up to the claims we make for them. When firms like these place their stamp of approval on Nonpareil Shaking and Dumping Grates they must surely possess advantages.

Attractive Trial Offer

You are at liberty to order a set of NONPAREIL GRATES and test them out FREE of charge. We guarantee a saving of at least 10 per cent. on your fuel consumption. This is fair and reasonable—why hesitate?

Firebrick Work

Some of the largest power plants in Ontario have had their Firebrick Work done by "Safety First" Sexton and his staff. Quality work only! Remember, Nonpareil Grates and Sexton's Brick Work make an unbeatable combination.

REPAIRS—Grate Bars supplied, and Repairs made to all kinds of Shaking and Dumping Grates.

THE W. R. SEXTON BOILER SETTING CO.

127 D'Arcy Street, 114 Grenadier Road
TORONTO
Phones: Jct. 2259W; Coll. 682. Established 1900

Vulcan Soot Cleaners

As Dividend Earners

HERE is a very conservative estimate of what may be expected from an average installation of Vulcan Soot Cleaners as computed by Messrs. Hale-Stephan Co., Vulcan representatives and engineers and contractors for power plant equipment at Cleveland, Ohio. This estimate is based on an actual case at the request of a Results Engineer in charge of a widely known public service corporation in Ohio. In this case a temperature drop of only 50° F. is assumed.

As a basis for computation, the Results Engineer assumed a 5 lb. consumption of coal per boiler horsepower per hour. The estimate follows:

"Assuming a 400 H. P. boiler—Stirling, 3 pass, operating at 150% rating. Average CO_2 equals 9% or 130% excess air, or about 19 lbs. air per pound coal burned. Assume about 5 lb. coal burned per horsepower hour.

600 boiler H. P. equals 150% rating.
5 lbs. coal per H. P. hour.
3,000 lbs. coal burned per hour.
19 lbs. air per lb. coal.
57,000 lbs. gas per hour goes through boiler.

Assume soot cleaner will give an average flue temperature drop of 50° F. Specific heat of flue gas equals about .25.

57,000 × 50 × .25 equals 712,500 B.t.u. per hour through soot cleaner. One boiler horsepower equals

33,478 B.t.u. per hour.
712,500 ÷ 33,478 = 21.3 boiler horsepower gained.
21.3 ÷ 600 = 3.55% gain due to soot cleaner per hour.
One ton of coal saved per day of 20 hours.

Any combustion engineer will at once see that both the basic assumption and the resulting estimates are very conservative; anyone acquainted with actual results from the use of Vulcan Soot Cleaners knows them to be far below the average.

Either Canadian office will gladly send descriptive Bulletin of Vulcan Cleaner for your boilers upon request. Or address the home office.

THE VULCAN SOOT CLEANER CO.

32 LONG AVE., DU BOIS, PA.

WINNIPEG
William W. Hicks,
567 Banning Street

TORONTO
Green's Economisers, Ltd.,
Kent Building.

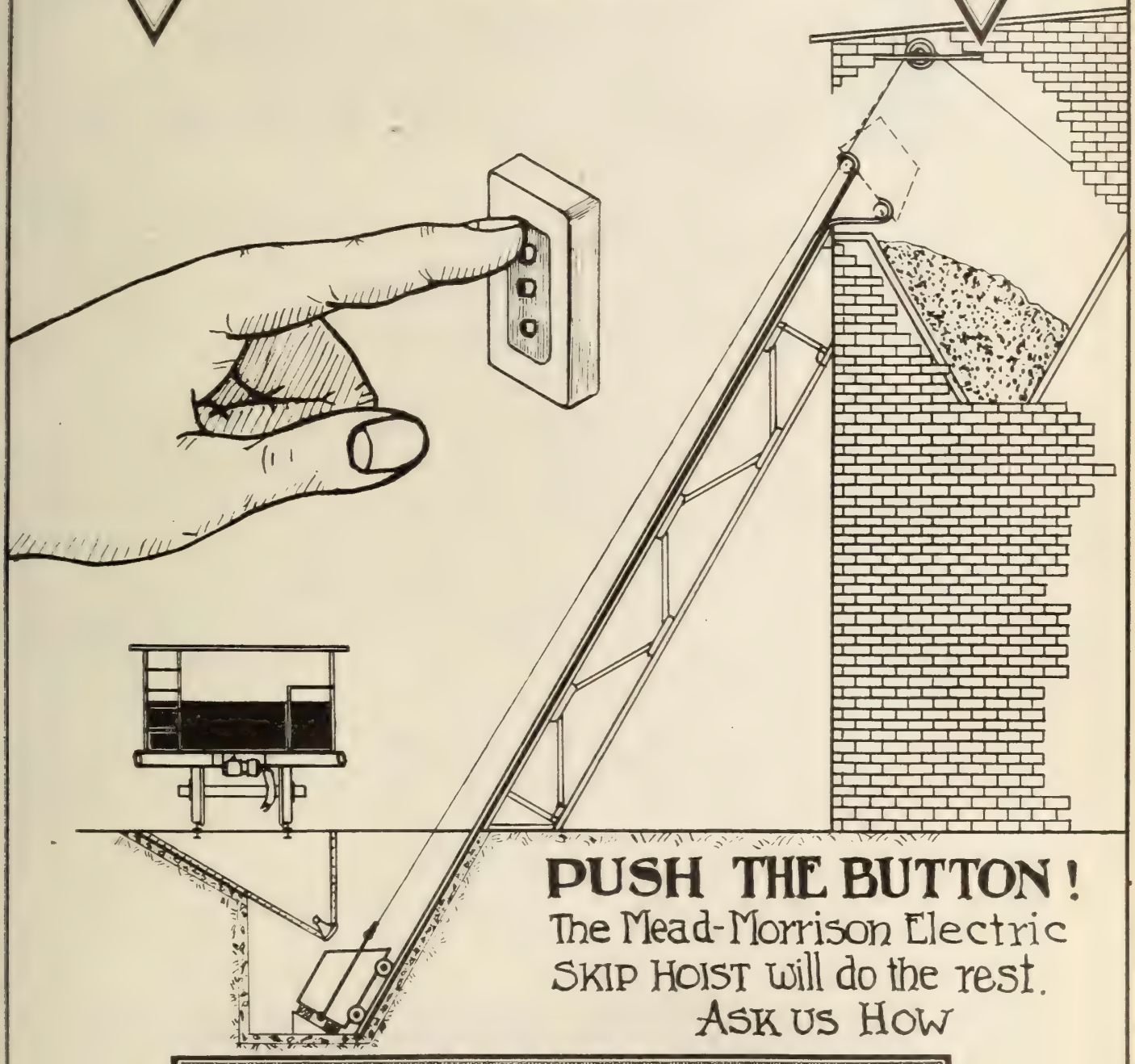
"MEAD-MORRISON"

CANADIAN MM Co

SKIP HOISTS

Made in Canada

CANADIAN MM Co



PUSH THE BUTTON!

The Mead-Morrison Electric SKIP HOIST will do the rest.

ASK US HOW

CANADIAN MEAD-MORRISON CO

LIMITED

285 BEAVER HALL HILL

MONTREAL

WORKS WELLAND ONT.

WEIR

Pumps for Feed and Other Duties

The slow, steady, powerful strokes of Weir Pumps inspire a confidence fully justified by the service of the 65,000 Weir Pumps at work all over the world.

Weir Pumps are designed to work at moderate speeds. Thus they last longer and work more satisfactorily than high-speed running pumps.

The boiler is the heart of the ship or power plant. Any possibility of a stoppage is exceedingly serious. Therefore it pays to use pumps whose past and present performance proves that they are to be relied upon at all times.

Full particulars of Weir Pumps and other auxiliaries will gladly be furnished upon request

G. & J. Weir (Canada) Limited

SALES ENGINEERS

Peacock Brothers, Limited, Montreal

D.K.McLAREN'S

Genuine British Oak Tanned

LEATHER BELTING

The Choice of Many Power Plants

The large, efficient power plants do not choose the belting upon which they depend for their power transmission by any haphazard method. They investigate and weigh carefully the advantages of each brand.

D. K. McLaren's Leather Belting is made of the **backs** of the finest steers and is **Genuine British Oak Tanned.** Every workman is highly skilled each in his particular way. This is **why** D. K. McLaren's Belting is good!

Finally, many of the largest power plants throughout Canada choose D. K. McLaren's Belting to maintain their efficiency. And, after all, the service which this belting renders its users is the greatest proof of its quality.

Ask us for the names of some of these plants. Then write them and secure their impartial opinion.

Bear this Maple Leaf in mind when purchasing belting. It is your guarantee of dependability —a guide to efficient belting service.

D·K·McLAREN

LIMITED

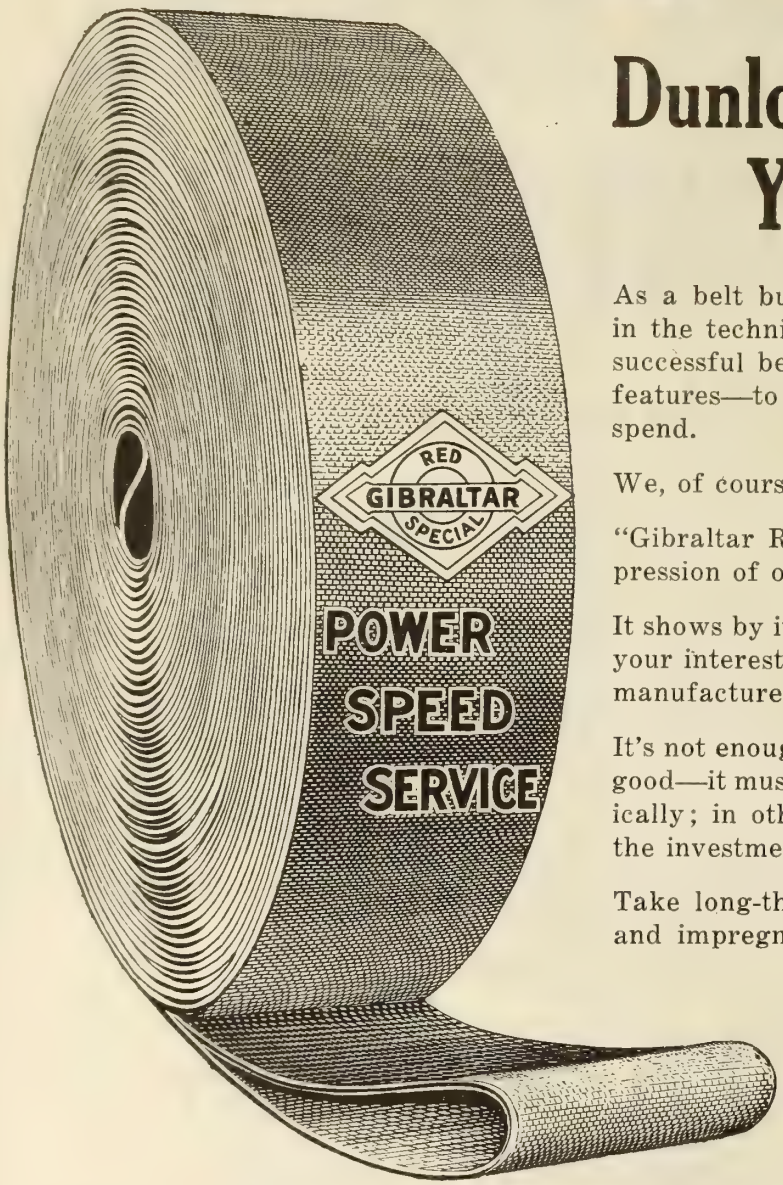
Head Office and Factory: 351 St. James St., Montreal, P.Q.

VANCOUVER, B.C. 334 Cordova St. West

TORONTO, ONT. 194 King St. West

ST. JOHN, N.B. 90 Germain St.

The "Long Service" Belting



Dunlop Belts Protect Your Profits

As a belt buyer you are not so much interested in the technical features which go to make up a successful belt, as you are in the benefit of these features—to realize full value for the money you spend.

We, of course, are, naturally, interested in both.

"Gibraltar RedSpecial" Belting is a tangible expression of our interest.

It shows by its performances just how we consider your interests when you buy a product of Dunlop manufacture.

It's not enough to let it go out of our plant looking good—it must act well, and serve well and economically; in other words, show a good dividend on the investment you make.

Take long-thread, tough cotton, carefully woven and impregnated with a high-grade rubber friction; build it up ply upon ply and cure and stretch it in the Dunlop way—then you have "Gibraltar RedSpecial."

It's a Transmission Belt built to deliver.

Its stretch is practically nil—because of the way it is made.

It won't slip because of its frictioned-surface, which gives great clinging power.

Our Belt Department will be glad to serve you.

Dunlop Tire & Rubber Goods Co.

LIMITED

Head Office and Factories: TORONTO

Branches in the Leading Cities

MAKERS OF HIGH-GRADE TIRES, HOSE AND PACKINGS FOR ALL PURPOSES

VULCABESTON

A Resilient Packing Means Tight Joints

The resiliency of Vulcabeston Red Fibre Sheet Packing ensures its conforming perfectly when pipes expand and contract. Under any temperature

VULCABESTON
RED FIBRE SHEET PACKING

gaskets fit tight and fast. Their resiliency is never lost. They fit automatically in a wide range of temperature and pressure.

Unaffected by heat, moisture, acid or alkali, Vulcabeston is truly "The Universal Packing."

We would be pleased to furnish sample upon request

The Johns-Pratt Company
Hartford, Conn. U. S. A.
Dealers in all large cities

"VULCABESTON" RED FIBRE STEAM SHEET PACKING

20-10

Where there's
difficult transmission
there's the place for a

"P.M.S." Belt

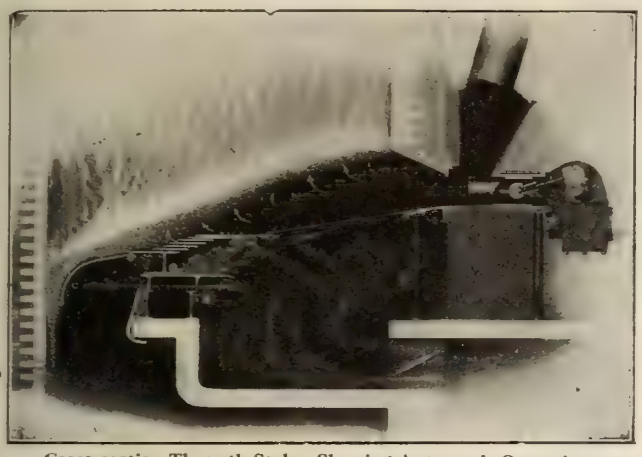
This trade-mark—"P.M.S."—is well known to Engineers and Plant Superintendents. It stands for the highest accomplishment in Belting Manufacture. We suggest that anyone having difficulty in power transmission due to dampness, heat, or mechanical awkwardness, should get the advice of one of our Belting Engineers. We are at your service.

Gutta Percha & Rubber, Limited

Head Offices and Factory, Toronto

Branches in all Leading Cities of Canada

BURN ALL GRADES OF COAL



Cross-section Through Stoker Showing Automatic Operation

No device has shown itself better adapted to burn any available coal than the

RILEY UNDERFEED STOKERS

Low-grade coals—those high in ash—in sulphur and clinker-forming qualities—can be handled successfully for the following reasons:

1. The moving grates keep the clinkers broken up—combustion is intensified—the fuel bed is always active, even and in a homogeneous state.

2. The rocker dump, with its combination of vertical thrust and rocking motion, grinds up—discharges the ash continuously and automatically—keeps the fire clean and the bridge wall free from accumulations.

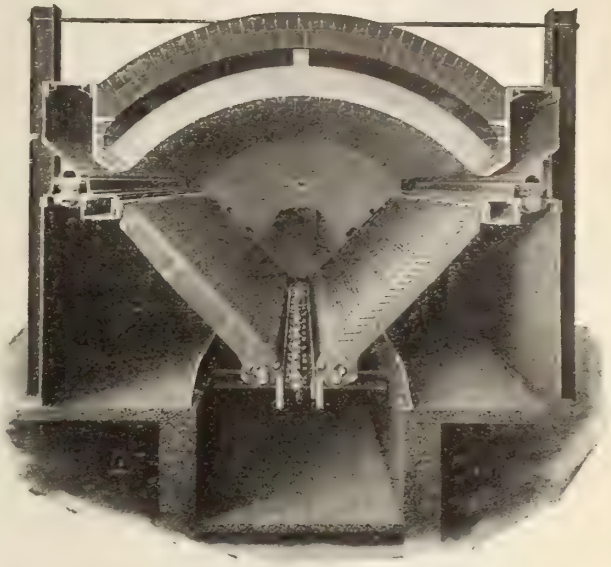
3. The underfeed feature makes possible high capacity and instant response to overload demands.

Our engineers will be glad to acquaint you with the wide range of fuels now being handled by the RILEY UNDERFEED STOKER under many varying conditions.

Write for Catalog HM-10

Sanford Riley Stoker Co.
Worcester, Mass.

MURPHY AUTOMATIC FURNACES



WHEN COAL WAS CHEAP —AND NOW

The Murphy Furnace earned its way forty years ago when coal was "dirt cheap." Think how much more quickly it can pay for itself when it saves 15 to 25 per cent. of the price you pay for coal to-day!

Murphy Furnaces bring to the smaller plant the economical advantages of the larger plant without resorting to forced draft, so the money you save on auxiliary equipment goes far toward paying for their installation.

Under present conditions it is economy to equip even the smaller boilers with Murphy Furnaces—for it saves your fuel and enables you to burn the poorer grades of coal that everyone gets these days.

If your boilers are 50 H.P. or larger you should get in touch with us. Send for Catalog HM-11 and see how easily the Murphy Furnace can be installed under any type of boiler.

For information on Riley Underfeed Stokers for large boilers, see last month's advertisement—or send for Riley Stoker Catalog HR-11.

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

Hose Which Resists Wear

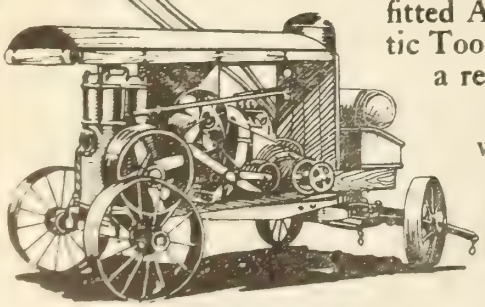
WE have records of Goodyear Air Drill Hose giving from 18 months' to 2 years' service--though the life of most air drill and pneumatic tool hose is comparatively short.

Dragged over rocks and steel girders, beaten by ore and building materials, the cover on air drill or pneumatic tool hose is greatly responsible for the life of the hose.

The extra heavy cover of white rubber, tough as a tire tread, with which Goodyear has fitted Air Drill and Pneumatic Tool Hose resists wear to a remarkable degree.

Inside this hard-wearing cover is a special, oil-resisting inner tube, and a fabric of such strength that Goodyear Hose is very much lighter than ordinary hose of the same strength.

In the same painstaking way, Goodyear has solved each individual hose problem—whether for steam, water, air, acids, or other substances. The creation of hose which would successfully withstand the strain of *present* industrial conditions was the task Goodyear scientists faced and solved. The hose problems in your plant can be greatly reduced with the help of Goodyear data and a Goodyear trained man. This service is without charge. Just phone, wire or write the nearest branch or Goodyear Mechanical Goods Service Station.



The Goodyear Tire & Rubber Co. of Canada, Limited

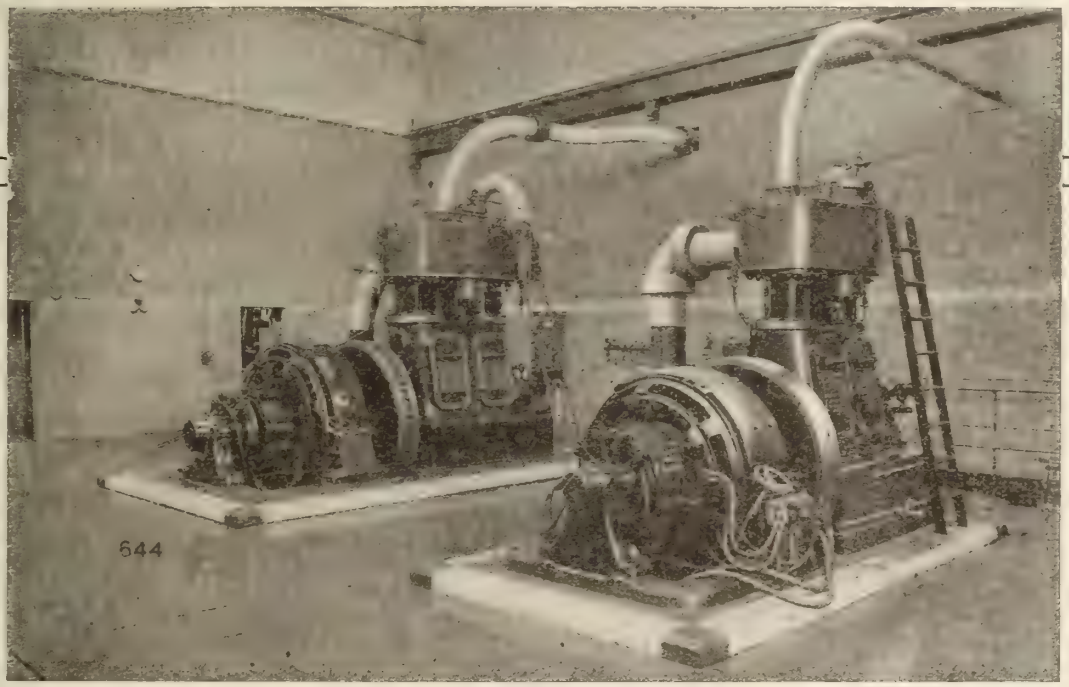
Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.

GOODYEAR

MADE IN CANADA

INDUSTRIAL HOSE

Belliss & Morcom
LIMITED
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

Are you using your exhaust Steam? Belliss engines are in use working against back pressures up to 190 lb. per square inch. In this way exhaust steam can be furnished to suit all heating requirements.

Write for Exhaust Steam Pamphlet.

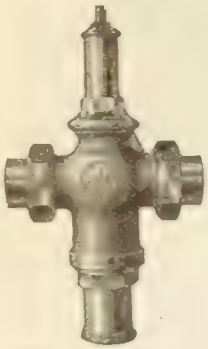
Send us your enquiries for the following

Steam Engines	Air Compressors	Pressure Filters
Gas Engines	Condensing Plants	Gravity Filters
Oil Engines	Centrifugal Pumps	Water Softening Plants
Diesel Engines	Boiler Feed Pumps	Refuse Destructors.
Steam Turbines		

All enquiries carefully and promptly answered

LAURIE & LAMB
Engineers
211 Board of Trade Bldg. Montreal, Quebec

WHY "MASON"?

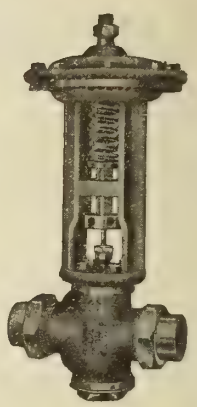


Mason Standard Bronze Reducing Valve

THE splendid reputation of the Mason Engineering Equipment is not the result of an accident, but the expected outcome of forty years of persistent effort backed by large capital and superior manufacturing facilities.

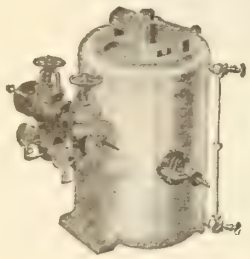
They hold the first place to-day because their merits entitle them to that position.

No other devices work so accurately, wear so long, nor accomplish their purpose so fully as the Mason. Once installed they are always demanded thereafter, and thousands of manufacturers absolutely depend on these devices working in many critical locations and find them satisfactory. This is where Mason Service comes in. We have at your service a staff of engineers, specialists in the application of our devices. Their job is to see that you do not throw money away on unsatisfactory equipment, and to help you to choose equipment that will do the work required.

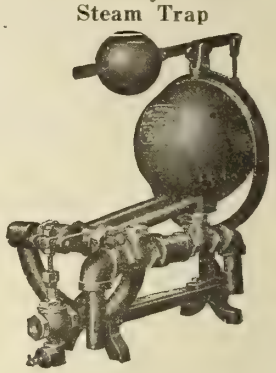


Mason No. 55 Pump Pressure Regulator

Reilly Feed Water Filter and Grease Extractor



New Bundy Return Steam Trap

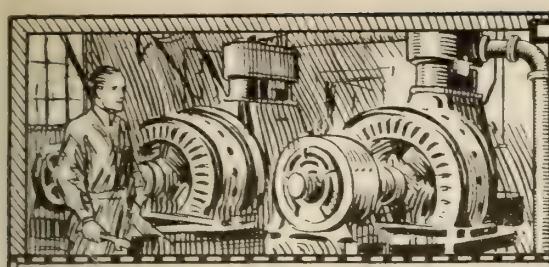


We are very glad to hear from engineers who have a difficult problem in pressure regulation, engine or pump control, damper or blower regulation, or condensation drainage or returns. We have yet to hear of a problem, to which there is a possible solution, that we cannot solve.

THE MASON REGULATOR & ENGINEERING CO., LIMITED

MONTREAL
135-153 Dagenais St.

TORONTO
145 Wellington St. W.



MINISTRY of MUNITIONS G R

The
Disposal Board have

STOCKS

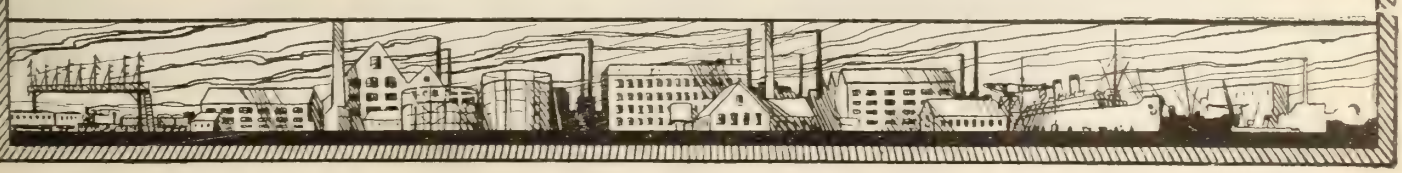
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address : "DISPEXPORT, MUNORGIZE, LONDON."



TRADE
JENKINS
MARK

Jenkins Bros

A Mark *of* Identification

In appearance one make of valve may closely resemble another. An inferior valve may look as good as a valve whose quality is guaranteed. The **Service** that each will render is the only true basis of comparison. That's where **Quality** counts.

If the Diamond Trade Mark shown above is cast upon the body of the valves you buy you can be positive you are getting the very best valves on the market. Their appearance can be imitated but the **guarantee** of Service goes only with the original—and you'll know the original—the genuine Jenkins Valve—by the Diamond Trade Mark.

First-class dealers everywhere carry an assorted stock of Jenkins Valves. By writing us you can secure a free copy of Catalog No. 8, which describes the complete Jenkins line—a valve for every service.

Jenkins Bros.
LIMITED

TRADE JENKINS MARK Jenkins Bros

TRADE JENKINS MARK Jenkins Bros

Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO — *European Branch* 6 Great Queen St., Kingsway, London, W.C.2. Eng. — VANCOUVER

AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

NORWALK AIR & GAS COMPRESSORS

PROGRESSIVENESS and caution are factors of equal importance in the policy which we apply to the manufacture of Norwalk air and gas compressors. Norwalk Compressors are always thoroughly up to date but never experimental.

Distinctive Norwalk features of design, and points of special advantage, are described in Bulletins covering compression for air, oxygen, hydrogen, acetylene and carbonic acid gas.

Write for the ones which interest you

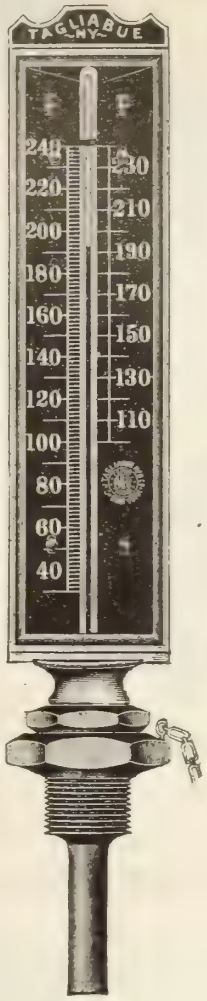
THE NORWALK IRON WORKS COMPANY

Pioneer Builders of Compressors

SOUTH NORWALK - CONN.

Canadian Sales Representative

A. S. LEITCH COMPANY - TORONTO



A FINISHED instrument of precision and accuracy.

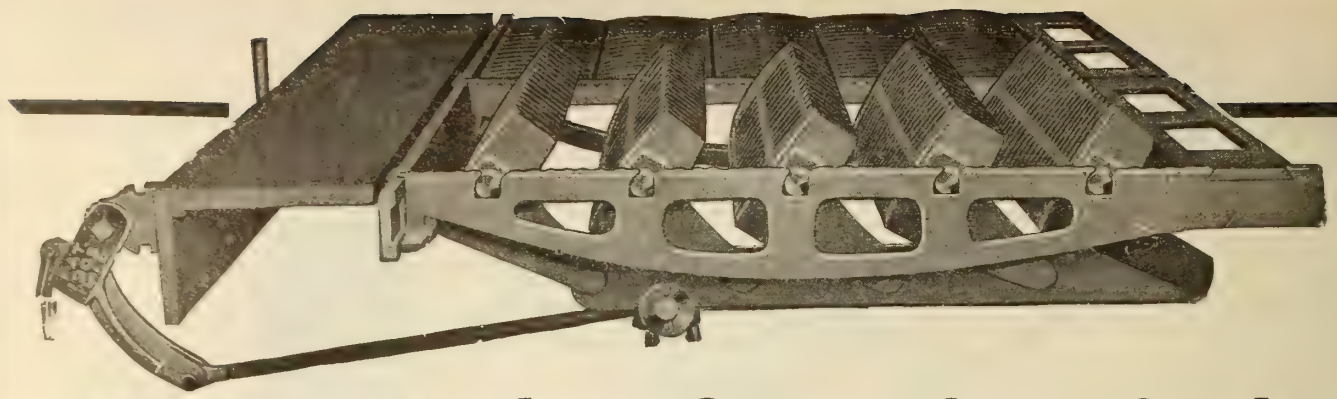
A guarantee of exactness in your temperature work.

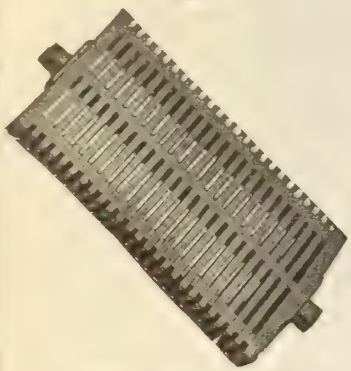
A durable and dependable indicator of heat in fifty thousand boiler rooms, engine rooms, factories and ships.

A product of one hundred and fifty years of experience.

A TAG Thermometer

C. J. TAGLIABUE MFG. CO.
18 TO 88 Thirty-Third Street
BROOKLYN, N.Y.





1.—Note new jarring, shaking movement whereby ashes are shaken off centre of bar without letting good fuel into ash pit.
2.—Note new lock frame. Also new coupling device.
3.—And centre rib on grate bar

Cyclone Grates Save Coal!

Think of the size of your last coal bill; isn't a device which will mean a saving of at least 10% of your bill worth investigation?

Cyclone Grates will save you that 10% or more! How? They extract every bit of energy from the coal you use by supplying 60% air space and 90% underdraft.

Write to-day for full details of Cyclone Grates and our thirty-day free trial offer.

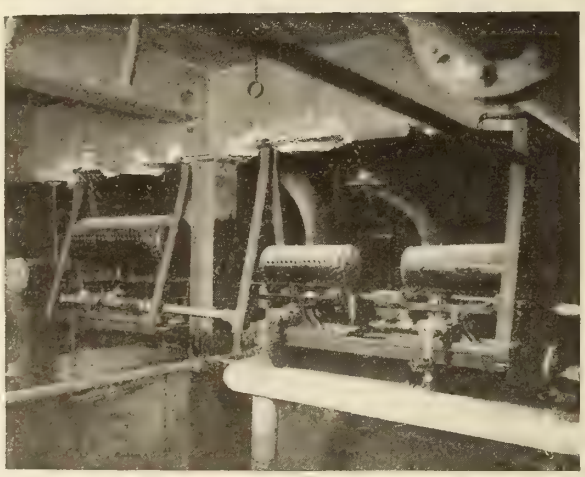
The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street **Toronto, Ontario**

Phone G. 3660

AGENTS:—Ottawa, Campbell Steel & Iron Works, 855 Carling Ave.; St. John, N.B., F. W. Blizzard, 331 Charlotte St.; Montreal, Mason Regulator & Engineering Co., Ltd., 135 Dagenais St.; Hamilton, Robt. Fitzsimmons, Ltd.; Calgary, The Western Foundry & Metal Co.; Winnipeg, Vulcan Iron Works.



Cole Installation at Hospital for Sick Children Toronto, Ont.

Proof Is The Most Convincing Argument

We have it in abundance and it is yours for the asking.

No matter how large or small the plant may be The COLE Engineering Department is fully qualified to handle them.

Let us correct your difficulties.

GEO. W. COLE LIMITED

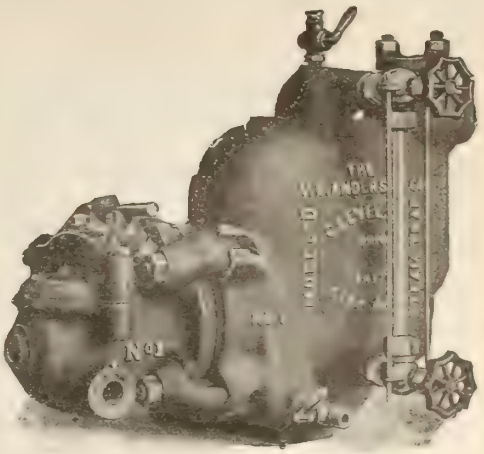
2002 DUNDAS STREET W. TORONTO

Montreal, Que. Winnipeg, Man. Vancouver, B.C. New Glasgow, N.S.

The Anderson

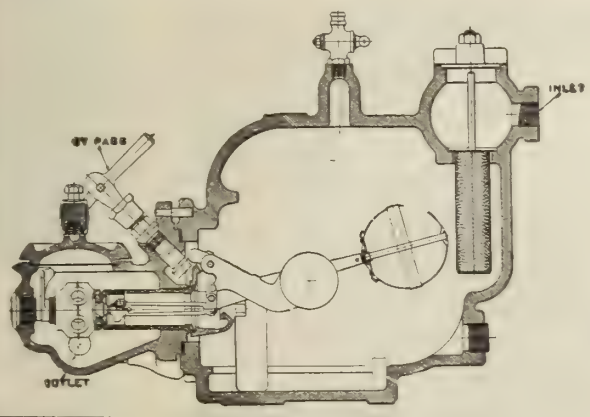
Model "D" Steam Trap

Accurate in Every Detail



The Anderson Model "D" Steam Trap is accurately designed and carefully made of materials best suited for the purpose. Every part is interchangeable.

The valve is locked with at least three inches of water at all times, thus making the escape of live steam an impossibility.



The trap will lift water at any pressure five pounds less than the pressure at the trap.

It is possible to ascertain whether the valve is functioning properly by glancing at the glass water gauge.

Both the valve and valve seat can be removed without breaking a steam joint or pipe connection.

Full particulars of these and other outstanding features of the **Anderson** will be gladly forwarded upon request.

The V. D. Anderson Company

1935 West 96th St., Cleveland, Ohio.

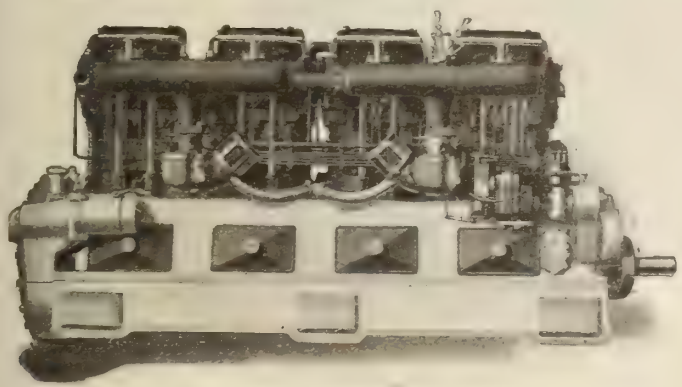
Sterling

THE ENGINE of REFINEMENT

For the finest boats that float

SAVE COAL!

A Sterling high-duty gasoline engine consumes no fuel when standing by, yet is ready instantly to assume fuel load.



Model GC 8-cylinder-engine, developing 300 H.P. at 1500 R.P.M., rated for continuous emergency duty at 200 H.P. at 1200 R.P.M., capable of turning dependably at the higher speed. List price, $4,750, F.O.B. Buffalo.

Catalog on request.

STERLING ENGINE CO. Buffalo, N.Y.

Dept. C-4

12 to 300 H.P. for centrifugal pumps and electric generator drives.

HOMESTEAD

Quarter-Turn Valves

Homestead Valves are made in straight-way, three-way and four-way patterns.

A Homestead Was Chosen!

When one of the largest stoker manufacturers ran a competitive test for a valve which would give satisfaction under the severe service encountered in connection with their stokers, a HOMESTEAD was chosen.

This firm has since backed up its experience by standardizing on HOMESTEADS.

There is but one way of convincing yourself, give them a trial.

Our Catalog is Yours for the Asking.

HOMESTEAD VALVE MFG. CO.

HOMESTEAD, PA.

UNLOAD YOUR —COAL— FOR 2c. PER TON WITH A NICHOLSON CAR UNLOADER

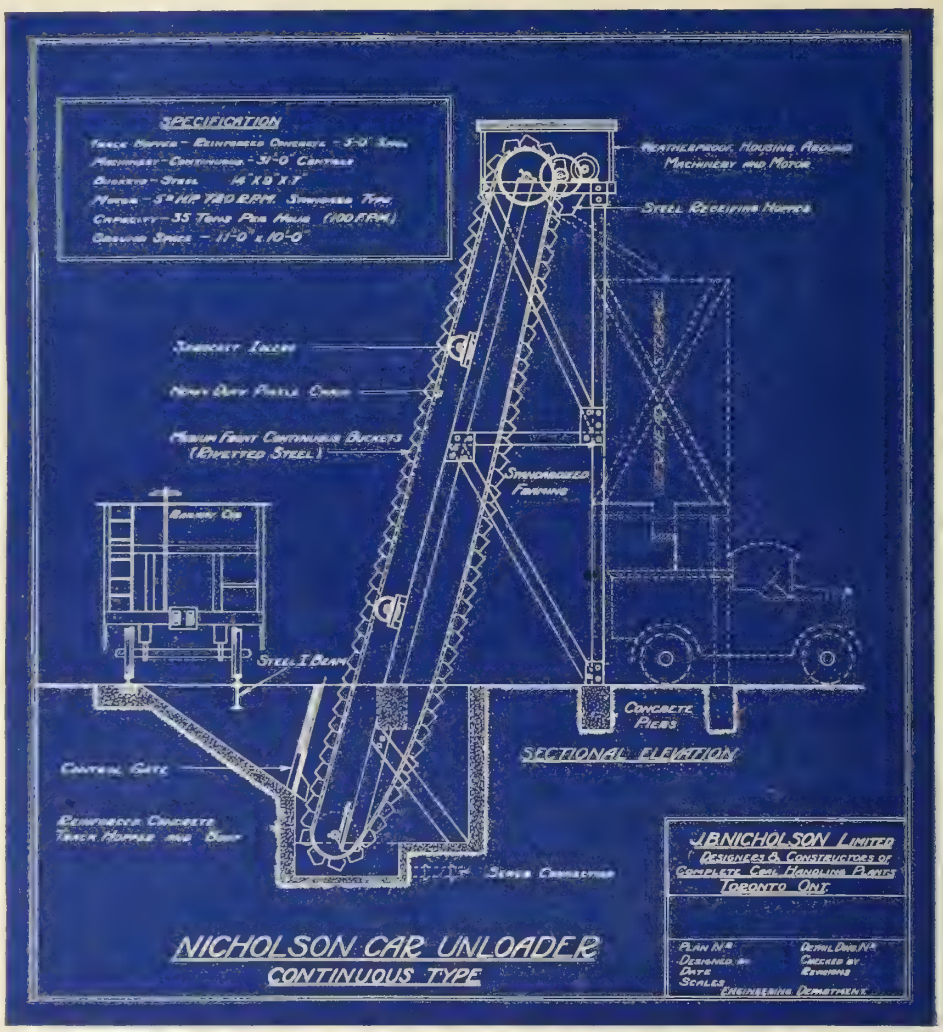
3 Types

No. 507—
Gravity
Discharge
For Industrial
Plants
$2,550.00

No. 508—
Continuous
For Large
Coal Dealers
$2,375.00

No. 509—
Centrifugal
For Smaller
Coal Dealers
$2,125.00

On request, one of our engineers will call and submit complete information.



Description:

A Standardized Plant

Consists of:—
- Concrete Track Hopper
- Steel Bucket Elevator
- Special Gearing
- Electric Motor
- Distribution Chute
- Machinery Enclosure
- Framing Erection

It Will:—
Unload all kinds of coal and distribute to storage pile — covering an area 90 feet x 40 feet.

Provides:—

An economical and efficient machine of heavy construction.

Strong Construction
A modernized machine backed by our unconditional guarantee and service.

We supply all materials—do all erection work—and hand over the plant—in complete running order—in 25 days.

J. B. NICHOLSON LIMITED

ENGINEERS — MANUFACTURERS CONTRACTORS

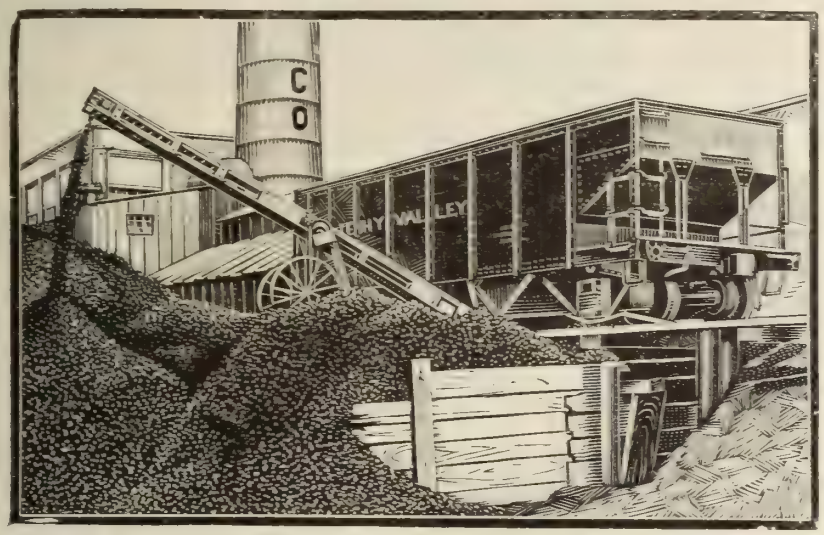
Designers and Constructors of Industrial and Retail Coal Plants

EXCELSIOR LIFE BUILDING, TORONTO

How Much Does It Cost You To Handle Coal?

You can SAVE $^{5}/_{6}$ of the cost of shovelling it by using

THE PORTABLE SCOOP CONVEYOR



IT SAVES 6 to 12 shovellers, has capacity of 1 TON per minute, unloads cars into stock piles or into wagons or trucks, LOADS from stock piles into trucks, will handle any material—

COAL, SCREENINGS, ASHES, CINDERS, DIRT, CRUSHED STONE, SAND, GRAVEL, ETC.

Save car demurrage, unloading 50-TON car in a few hours.

ELECTRIC MOTOR OR GASOLINE DRIVE.

EASILY MOVED BY ONE MAN

THREE THOUSAND SATISFIED USERS.

WRITE FOR BULLETIN "P. H." AND PRICES

Is Your Boiler Plant Ready For Winter?

We Can Make Prompt Shipment of the Following:

RETURN TUBULAR BOILERS

New power boilers, 15 H.P., 20 H.P., 25 H.P.—130 lbs. steam.
Used power boilers, 110 H.P., 135 H.P., 150 H.P., 110 to 120 lbs.
Used water tube boilers, 90 H.P. and 212 H.P., 120 lbs.
Used heating boilers, 60 H.P., 70 H.P., 80 H.P., 100 H.P., 120 H.P., 150 H.P.

LOCOMOTIVE FIRE BOX BOILERS

2—50 H.P. boilers, 130 lbs., slightly used, good as new.
New 30 H.P. and 40 H.P.—immediate shipment—65 lbs. steam.
Used 15 H.P., 25 H.P. and 50 H.P., 70 to 80 lbs. steam.

VERTICAL BOILERS

Used 4, 5, 6, 8, 10, 20, 30, 40, 50, 60 and 120 H.P. for various pressures for power and heating.

Let Us Know Your Requirements, and Quote Prices.

If it's Machinery—Write "Williams"

The A. R. Williams Machinery Co., Limited

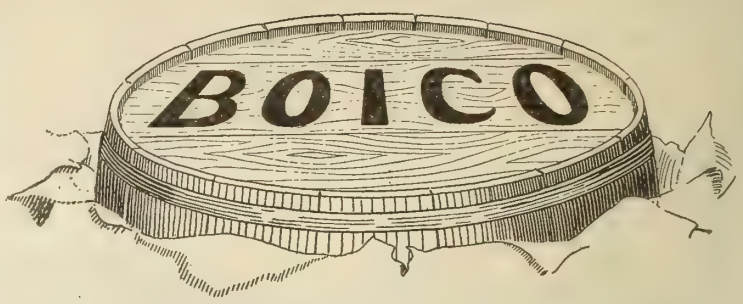
64 FRONT ST. W. - - TORONTO

Phone Adel. 20.

HALIFAX, N.S. ST. JOHN, N.B. MONTREAL, P.Q. TORONTO, ONT.
WINNIPEG, MAN. VANCOUVER, B.C.

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.



Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

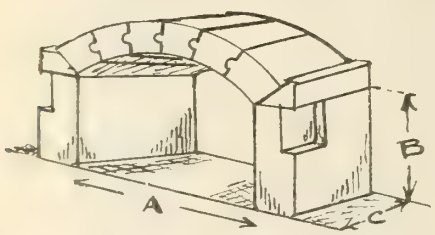
With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

Gates Refractories



Contractors for All Kinds of Power Plant Brickwork

Estimates on All Jobs

EXPERTS ON REPAIR WORK

Furnace Linings, High Temperature Cements, Special Shaped Fire Bricks.

Gates Refractories, Ltd.

Head Office: 382 St. James St., Montreal

CRANE VALVES

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE

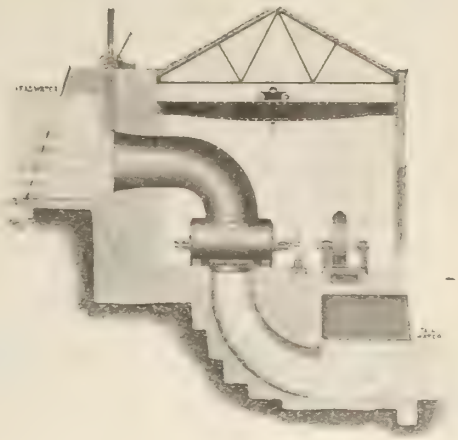
Packing Bearing Our MARK

TUCK & COMPANY, LIMITED
LONDON LIVERPOOL CARDIFF, ETC.

Canadian Representative
Wm. J. Brown, 117 Youville Square, Montreal

Stocks Carried in All Sizes TEL. No. MAIN 2387

HYDRAULIC TURBINES



Head Gate Hoists
Stop Log Winches
Feeder Pipes and Valves
Structural Steel and Steel Plate Work

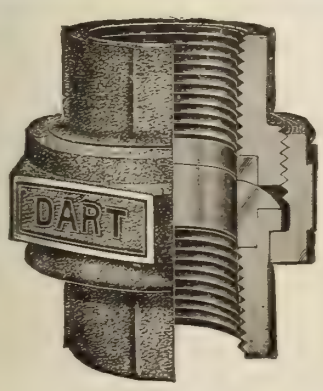
Send Us Your Specifications

William Hamilton Company, Ltd.

Peterborough, Ontario

A Good Line to Connect up With!

DART



UNIONS *Absolutely Dependable They Will Not Leak*

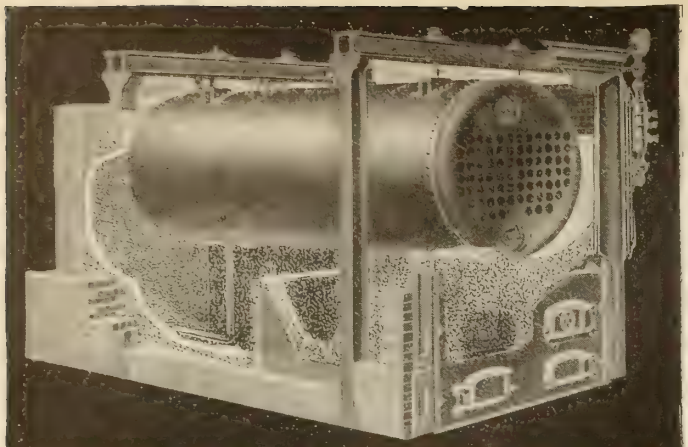
Both Faces of the joint are Bronze (a non-deteriorating metal).

Heavy Iron Parts will not stretch or pull apart.

Pipe Coupling troubles and their upkeep expense do not exist where Dart Unions are used.

YOUR JOBBER HAS THEM

MANUFACTURED BY DART UNION CO., LIMITED, TORONTO



SMILES AT HIGH HEAT

Boiler furnace linings moulded into place, forming a solid, one-piece monolithic lining, will withstand the variations and extremes of heat under continuous service, when the proper lining material is used, viz:—

BETSON'S

REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

The result of twenty years of scientific and practical experience. Only those refractory materials that are of tested quality and purpose are used, and these years of experience have produced a most generally satisfactory lining material. Not theoretically but under actual everyday conditions.

There is only ONE Plastic Fire Brick and it comes to you in barrels in a moist, plastic condition, ready for use. Any intelligent person can do the work, no special tools, forms or skill is required.

Costs less than fire brick or special blocks, is always available and will outlast other linings.

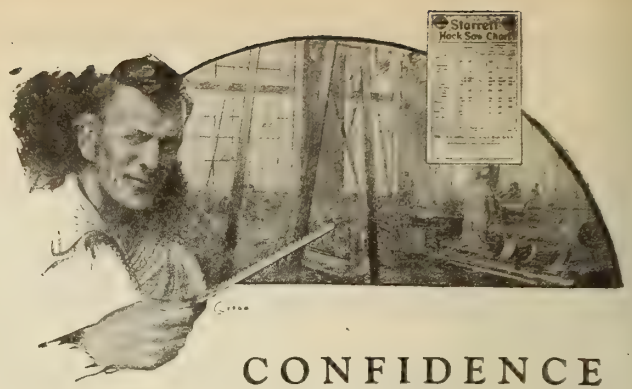
Write for our informing pamphlet — it is worth having in your file whether you need lining material now or not.

Order in advance of your need on account of slow freight delivery.

Betson Plastic Fire Brick Co.
Inc.
P. O. Box 386 — 6,
Rome, N.Y.

Canadian Distributors:
International Chemical Co.
44-46 Lombard St.
Toronto, Ont., Canada

Shipment F.O.B. nearest warehouse in our new substantial "Yellow-Top" barrel.



CONFIDENCE

—in yourself and in the tools you're using means efficient work.

Mechanics who use Starrett Hack Saws according to the Starrett Hack Saw Chart, are sure of their results. Starrett Saws are sold upon the *confidence* mechanics have in them.

A saw for each kind of material to be cut—each blade made of the finest grade of hack saw steel. And behind them the Starrett Service, helping hack saw users to get every bit of value out of Starrett Blades that we put into them. That's why they "cut quicker and last longer."

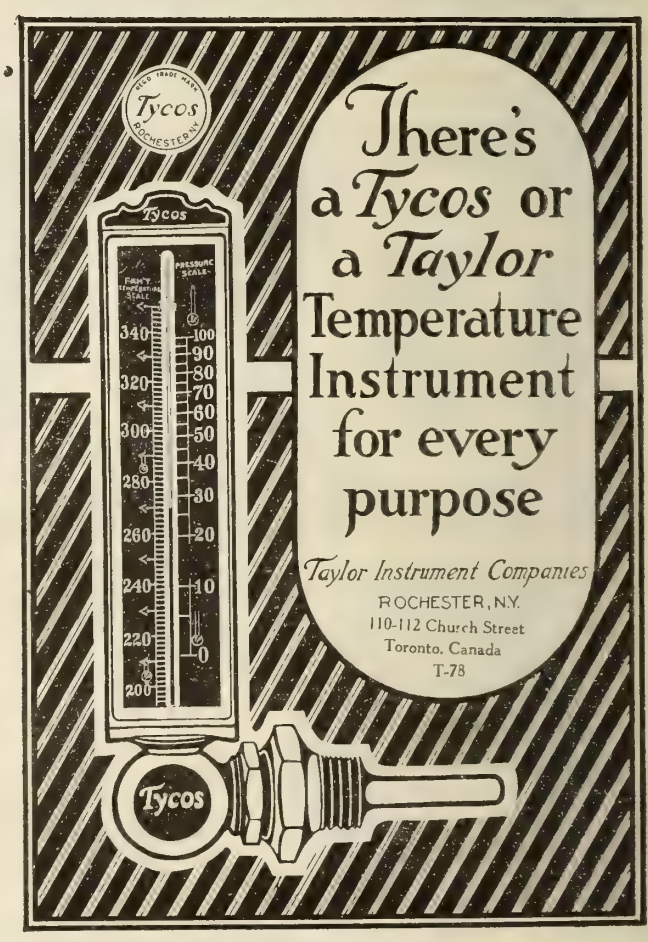
Begin to-day to lower your cost per cut. Write for "Hack Saws and Their Use," the first practical book on hack saws ever published.

"The book that helps you lower your cost per cut."

THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS

42-83

Use Starrett Hack Saws

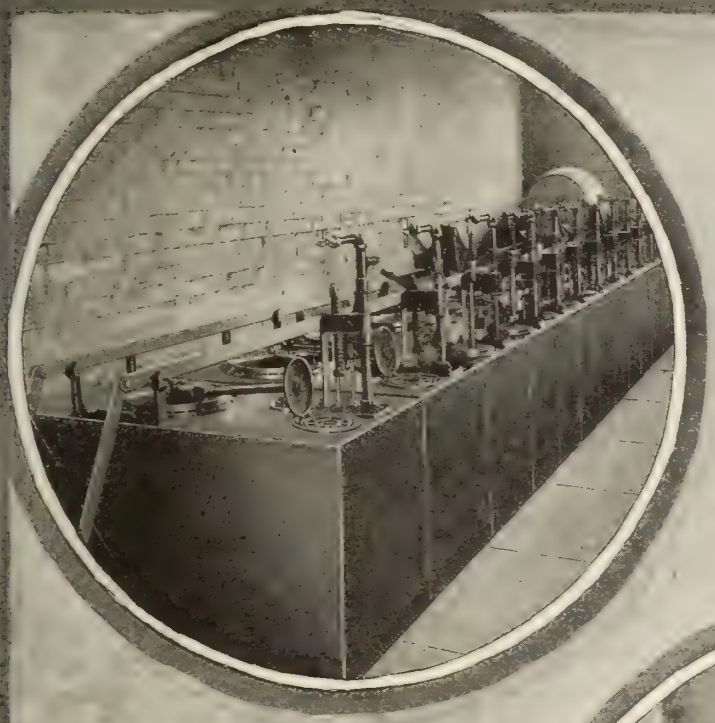


There's a *Tycos* or a *Taylor* Temperature Instrument for every purpose

Taylor Instrument Companies
ROCHESTER, N.Y.
110-112 Church Street
Toronto, Canada
T-78

BOWSER

ESTABLISHED 1885



Savings Count Big!

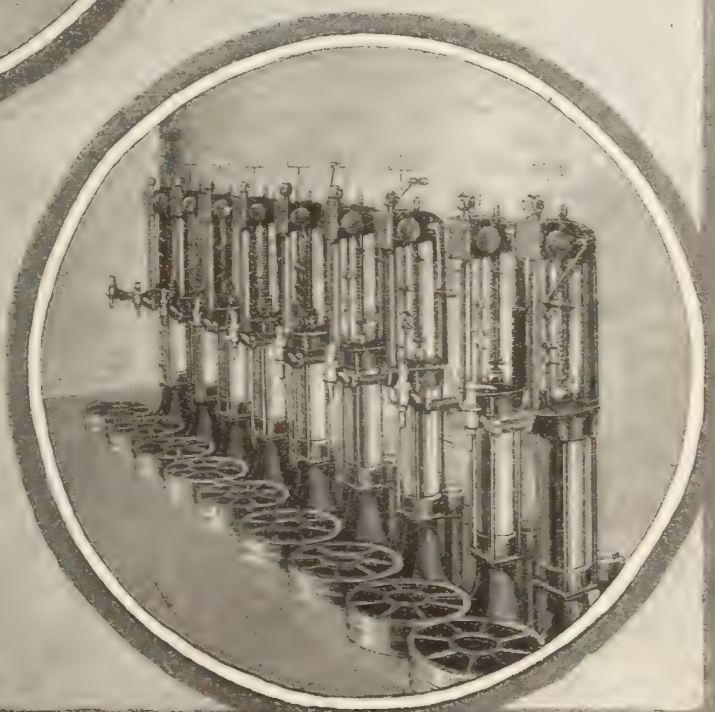
With space at a premium, labor scarce and high, the price of oils way up, a

BOWSER

Oil Storage System

is a necessity that cannot be overlooked. Once its real value is understood, every one concerned in the handling of oils will want a Bowser System.

It saves an immense amount of oil and cuts labor cost. It is clean, safe and systematic.



Illustrations show two installations of Bowser Equipment used by the Lukens Steel Company, Coatesville, Pa.

Upper view shows battery of lubricating oil outfits with barrel, track and cradle.

Lower view shows battery of self-measuring pumps for paints and other non-lubricating liquids. These pumps are connected to a battery of tanks in another room.

Interesting literature will be sent on request.

S. F. BOWSER COMPANY, LTD.

66-68 Fraser Avenue

Toronto - - Canada

"Cyclone" Hoists *and* "Matchless" Trolleys

Lighten Labor *Lessen Costs*

For the same reason that you put in any kind of labor-saving equipment, you should put in the kind that saves **the most labor.** In chain hoists that means the "Cyclone."

The power applied to the hand chain of the "Cyclone" is multiplied in a different way from that used in any other hoist. The gears used are extra large, accurately cut, mounted on graphite bronze or roller bearings, and several teeth are always in mesh at every point where the load is transmitted.

There is less friction—no vibration—just a smooth, easy motion that raises the load with minimum effort yet maximum speed. The "Cyclone" is easier on itself as well as on the man using it and, as a natural consequence, it far outwears any other hoist.

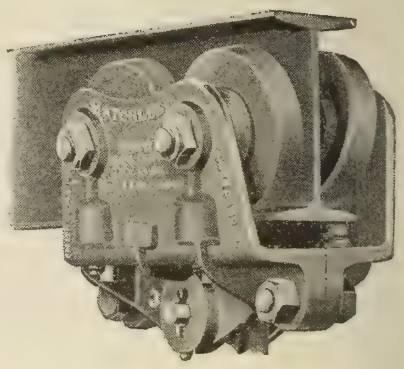
Made in sizes from ½ to 40 tons—every size a single, self-contained, compact unit.

For conveying the hoisted load with similar easy smoothness, hook the "Cyclone to a

"Matchless" Trolley

This trolley has flangeless track wheels and vertical adjustable guide rollers, so that it works freely on curves as short as 18-inch radius. Each size is adjustable for three sizes of standard I-beams. Hardened steel roller bearings on the track wheels reduce friction and lengthen service.

Made plain as illustrated, and geared.
Capacities from ½ to 12 tons.



Made by Chisholm-Moore Mfg. Co., Cleveland, Ohio.

Canadian Distributors:

LYMAN TUBE & SUPPLY COMPANY, LIMITED.

Montreal Toronto Winnipeg New York

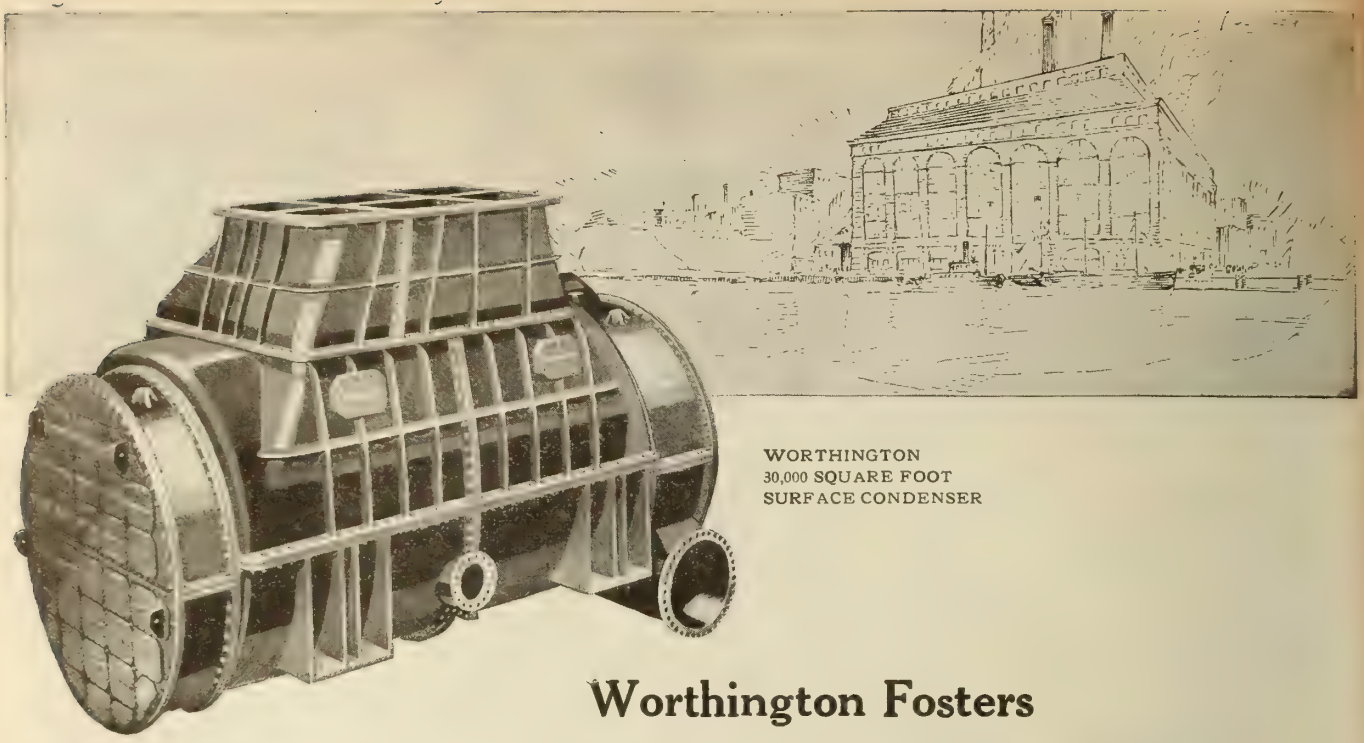
A Great Labor Saver—It can do the work of many men

IF you need a low-first-cost system for unloading or loading coal and similar materials, investigate this simple and efficient Link-Belt Portable Belt Conveyor.

These illustrations show just how it works. It is practical in operation, requires but one or two men to handle it, and hundreds are in successful use carrying a wide variety of materials. Write for prices and full particulars.

CANADIAN LINK-BELT COMPANY, LIMITED

WELLINGTON AND PETER STREETS, TORONTO



WORTHINGTON
30,000 SQUARE FOOT
SURFACE CONDENSER

Worthington Fosters Power Plant Efficiency

THROUGH a period of at least 40 years, Worthington has been "pathfinder" in the field of Condensing Apparatus manufacture.

The Worthington line of Condensing Apparatus includes every type of jet, barometric and surface condenser and auxiliaries for low or high vacuum pan, evaporating work and every field in the engineering arts, as well as the production of power. Material and workmanship are of the best, and style and type are dictated by plant needs.

Worthington maintains an engineering corps whose service is freely tendered, is authoritative and does not obligate you in any way.

Other Worthington Products:
Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

W-331.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

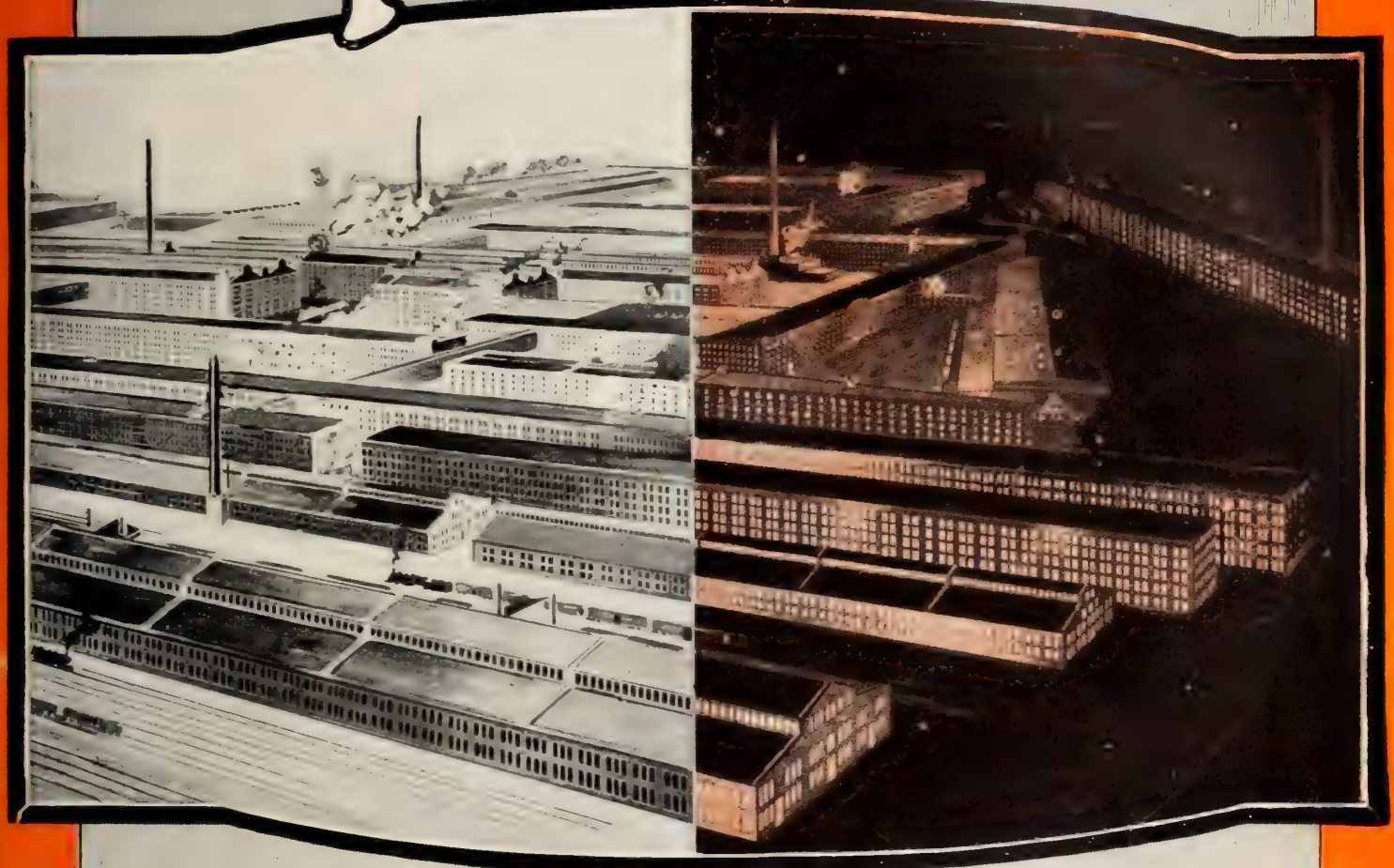
WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*

Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

Continuous Operation



Day and Night From January to December With the Jones "A-C"

Stoker

Five Months of Steady Overloads—

Boilers were kept on the line continuously for five months, operating at 150% to 250% of rating.

Three Months of Continuous Operation with Peak Loads of 340 Per Cent.

Boilers on the line continuously for three months, loads varying from rating to 340%.

Three Months of Continuous Operation at High Capacity

Boilers were kept on the line continuously for over three months, loads varying from 75% of rating to 250%.

Service that Costs Less Per Year

WHAT is the cost of a mechanical stoker? This question is answered by another question: What is the cost of stoker *service?*

In the face of unprecedented coal and labor costs, *"service"* has become the big word in Canadian power plants. Briefly, it means lowest cost per ton of coal fired. And lowest cost per ton of coal fired is only possible where a real high-duty stoker is installed.

Foremost in importance, and therefore foremost in the saving effected by the Jones "A-C" (Automatic-Cleaning) Stoker, is economy of fuel.

The Jones "A-C" saves coal as a result of the perfected application of the Jones under-feed principle of correct combustion, and because of its ability to burn all grades of coal, consequently the cheapest *local* coal.

The Jones costs less per year because it will carry the heaviest power burden endlessly day and night; without replacements and the shut-downs that replacements entail; without repairs and the expense that repairs involve; at highest efficiency and the economy that always follows.

The plant records opposite establish the fact that the heavy overloads which the Jones "A-C" meets almost momentarily can be carried continuously over periods of months, not merely during carefully conducted test periods of short duration. The names of these plants will be furnished on application.

The cost of the Jones "A-C" is no greater than that of any other multiple retort stoker of the same general class. But it pays a greater dividend in annual economy.

The services of the engineering organization described on the next page are at your disposal.

THE Under-Feed Stoker Company of Canada, Limited, is an old-established organization, newly reorganized for the purpose of putting before industrial Canada an engineering service of the broadest possible scope.

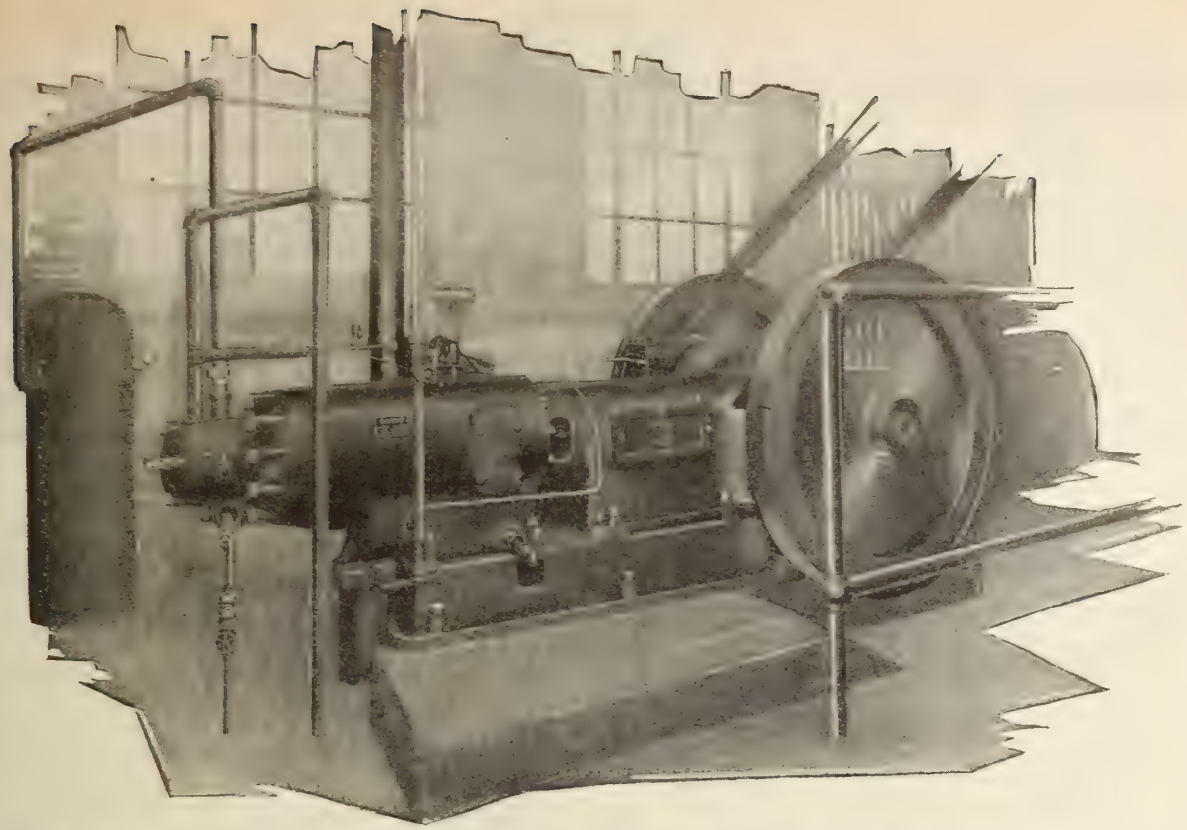
To the wealth of experience gained in installing the famous Jones Standard Stoker in Canadian plants for over a quarter-century, has been added the engineering resources of the well-known Under-Feed Stoker Company of America —a business institution of equal tenure.

Jones Stokers are made in Canada by Canadians, and are sold for Canadian money at par.

Write for extensive catalogs describing the new Jones "A-C" Stoker and "Standard" Stoker

The Under-Feed Stoker Co. of Canada, Limited

81 Victoria Street
TORONTO



Giant oil engines pay for themselves

GIANT Oil Engines cut down monthly power bills sufficient in most cases to return their initial cost within a short time.

The cost of oil for fuel is low. Giant Oil Engines burn most efficiently the lower grades of low-cost fuel oil.

Through automatic regulation they prevent waste of fuel and power and eliminate the human factor in obtaining power efficiency.

Their sturdy, simple construction—free from valves, magnetos, carburetors, wiring and other complicated devices—prevents breakdowns and the expense of frequent replacements.

Power costs of ½ to ¾ cent per horse power hour are common amongst Giant Oil Engine users.

Performance records are available showing the dependability and operating economy of Giant Oil Engines under service conditions similar to yours.

Ask for bulletin.

Giant Semi-Diesel Oil Engines are built in capacities from 12 to 200 H. P., both single and duplex types. They embody such important features as box-type crosshead construction, hot liner ignition, and totally enclosed frame and automatic lubrication.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

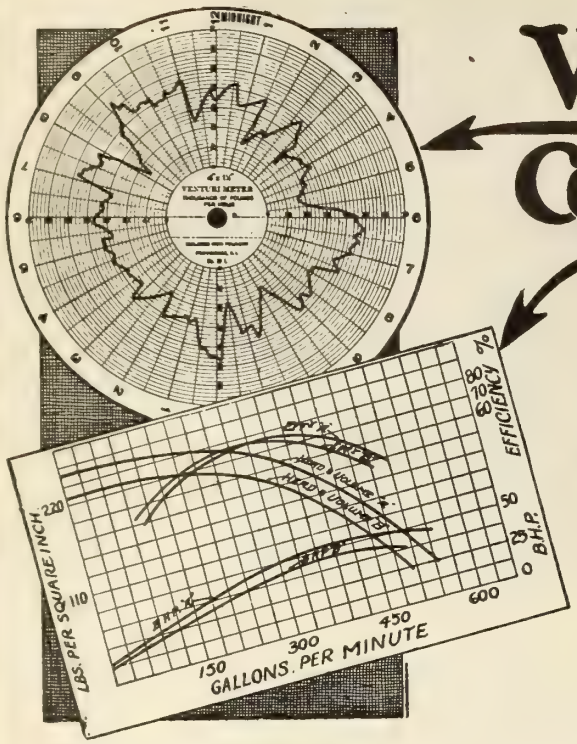
Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

GIANT ENGINES

Dependable Power at *Less Cost Per Hour*



Variable Volume Constant Efficiency

THE REES RoTURBo

A Centrifugal Pump for Any Service

IN the "Rees-RoTURBo" we have the very latest development in centrifugal pump design. The disadvantages of the ordinary pump have been entirely overcome and it meets perfectly the conditions of to-day for high efficiency.

The fluid velocities are low, reducing friction losses to a minimum, and there is no wear even from gritty water, and high permanent efficiency is maintained. This means that the "Rees-RoTURBo" is ideal for multi-stage operation and may be said to be a pump for any service.

Should there be any point on which you would like to be enlightened, our engineering department is always at your service and without any obligation on your part we heartily invite enquiries.

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Factory: GALT, ONT., CANADA

Branches and Offices:

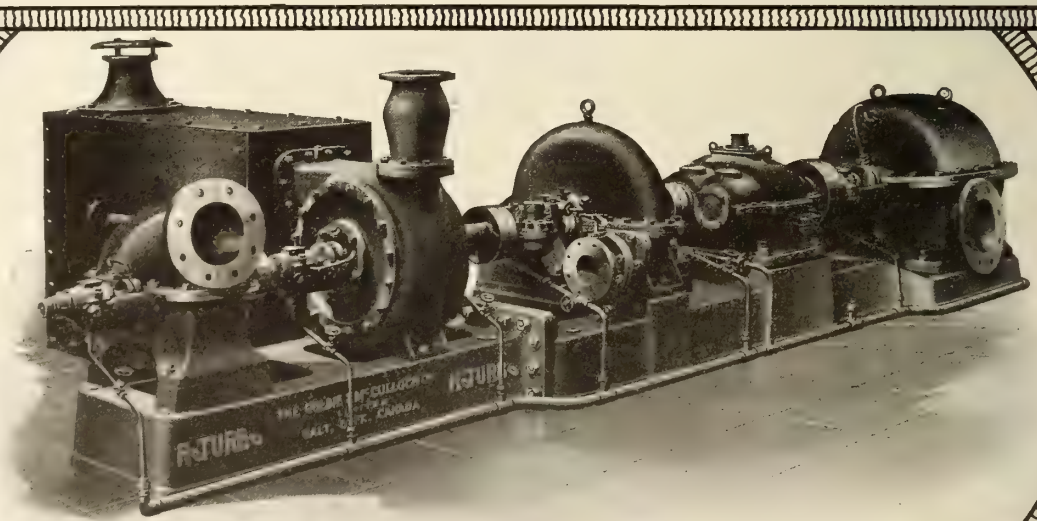
Toronto Office: **Suite 1101-Bank of Hamilton Bldg.**

Quebec Agents: **Ross & Greig, 400 St. James St. Montreal, Que.**

Western Branch: **248 McDermott Ave. Winnipeg, Man.**

British Columbia Agents: **Robt. Hamilton & Co. Vancouver., B.C**

DEPENDABLE POWER EQUIPMENT



POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Utilization of Low Grade Peat For Fuel

Although the Following Paper Read Before the Royal Dublin Society by Professor Purcell, A. M. Inst. C. E., Deals With Irish Peat It is of Interest to All Who Study Low-Grade Fuel Utilization

PEAT in an undrained bog contains anything from 90 to 95 per cent. of water, and this statement is equally true whether we are dealing with Irish peat or peat in other countries, with the exception of some deposits in Italy, which are specially situated. By thoroughly draining the bog the water content may be reduced to some value between 91 per cent. and 88 per cent. We see, therefore, that the proportion of solids in the raw material will not exceed 9 to 12 per cent., and that the handling of such a low-grade material must present a serious economic problem.

When we compare a peat with 95 per cent. of water to one with 90 per cent. of water at first glance it looks as if the difference were only slight, but if the statement were put that in the first case you had 5 per cent. of dry peat and in the second 10 per cent., or that the "water ratios" or the relative proportions of peat and water were 19 to 1 in the first and 9 to 1 in the second, it would be quite obvious that the second peat contained twice as much valuable matter as the first. A glance at the diagram—Fig. 1— will make this clear. The weight of anhydrous peat or dry peat substance present is assumed to be the same in each case, and is shown by a cross hatched square representing one unit of peat by weight, and the proportion of water is shown by the number of open squares, so that the water ratio is seen by inspection. The advantage of stating the "water ratio" rather than the percentage of water will be seen from the example first quoted where we saw that an increase of 5 per cent. in the percentage of water (90 to 95) means that the relative amount of water is more than doubled, whereas if we reduce the water content from 33 1-3 per cent. to 25 per cent. (water ratio 0.5 reduced to 0.33) the diagram shows that there is little difference in the actual amount of water present in the two cases, although when stated as a percentage the difference seems considerable.

For the wet undrained bog let us take 95 per cent. water (water ratio 19 to 1) as shown by the first column in Fig. 1. The second column which can be called standard peat with 90 per cent. water, represents what may be considered the average condition of a well-drained bog, and the third column with 88 per cent. would hold near the exposed face of a bog where the drainage conditions were exceptionally good. Peat cut by hand and air dried under normal conditions in this country should not contain more than 25 per cent. of water, and that has been taken as the standard for air-dried peat.

It will be seen from the diagram that to produce 1 ton of air-dried peat we must handle 15 tons of raw peat containing 95 per cent. of water, or 7 1-2 tons of 88 per cent. moisture peat. The tons of 90 per cent. moist peat, or 6 1-4 cost of excavating, handling, and spreading a ton or a cubic yard of peat with 95 per cent. water is just as much as that for the same quantity of one with 90 per cent., but in the latter case the yield of finished product is double that in the former. We see, therefore, that between working on a drained and an undrained bog may easily mean the difference between success and failure.

The Calorific Value of Peat

The next diagram, Fig. 2, shows the calorific value of peat containing different percentages of water. On the left we have the number of British thermal units contained in 1 pound of peat, the B.Th.U. being the amount of heat required to raise 1 pound of water 1 deg. Fah. The calorific value of anhydrous peat varies with the percentage of ash and other constituents, but lies between 8,000 and 10,000 B.Th.U. per pound. In the diagram 9,500 B.Th.U. has been taken as an average value for Irish peat. Take the case of a peat with 25 per cent. water. Here 1 pound of the peat fuel contains only 3-4 pound of dry peat, and this can give off 7,125 B.Th.U., but at the same time 1-4 pound

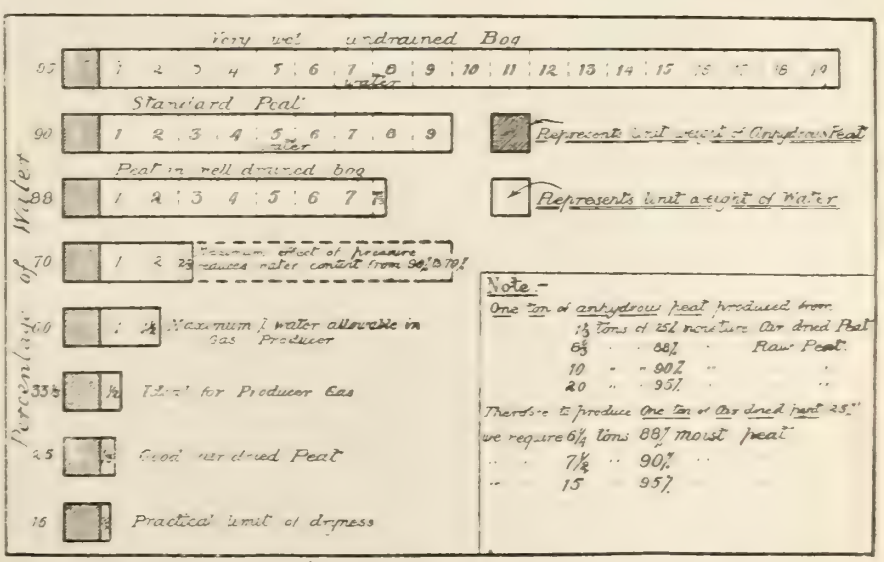

Very wet undrained Bog
Standard Peat
Peat in well drained bog
Represents unit weight of Anhydrous Peat
Represents unit weight of Water
Maximum effect of pressure
Maximum ½ water allowable in Gas Producer
Ideal for Producer Gas
Good air dried Peat
Practical limit of dryness
Percentage of Water
Note:-
One ton of anhydrous peat produced from
1⅓ tons of 25% moisture Air dried Peat
6⅔ " " 88% " Raw Peat
10 " " 90% " "
20 " " 95% " "
Therefore to produce One ton of Air dried peat 25%
we require 6¼ tons 88% moist peat
" 7½ " 90% "
" 15 " 95% "

FIG. 1—DIAGRAM SHOWING PROPORTION OF WATER IN PEAT.

of water has to be evaporated, which requires 280 B.Th.U., leaving the net calorific value 6,845 B.Th.U. It will be seen from the diagram that with 89 per cent. of water the calorific value of the 11 per cent. of dry peat will be just sufficient to evaporate the 89 per cent. of water and that hence such peat has no net calorific value.

Taking air-dried peat with 25 per cent. water the average net calorific value as fired will be 6,000 to 7,000 B.Th.U., and as coal used for industrial purposes gives from 12,000 to 14,000 B.Th.U. per pound we may take it that 1 ton of coal is the calorific equivalent of 2 tons of air-dried peat.

Fig. 2 also shows the proportion of fixed carbon to volatiles in the various fuels, commencing with anthracite coal and ending in peat, which may be said to be coal in the first stage of formation. In the case of anthracite the carbon runs from 98 to 92 per cent., whereas for peat the fixed carbon is only 25 to 35 per cent.

The ash in Irish peat averages 4 per cent. of the anhydrous peat and is low, judged by American standards, and usually increases from the surface downwards owing to the increased humefication of the vegetable matter which has taken place in the lower layers.

The Elimination of Water From Peat

Part of the water contained in peat is mechanically held and may be removed by pressure, but the remainder appears to be held by the colloidal matter in the peat so firmly that it cannot be removed by even very high pressures. Its complete removal can only be effected by evaporation, but a part of the remaining water may be pressed out after subjecting the peat to some process which alters its structure.

The best way to utilize the calorific energy of the peat, originally the product of the radiant heat of the sun, is to make use of the heat of the sun and its dynamic effects to dry the peat naturally as it is spread on the surface of the bog and not to waste the heat energy of the peat in evaporating the contained water.

When peat, as taken from the bog, is subjected to high and long continued pressure almost three-quarters of the contained water is driven off and the moisture content is reduced from 90 per cent. to 70 per cent., but even in this condition it is still useless for fuel purposes. This represents the maximum effects of pressure on raw heat, and it is now accepted as a fact that peat fuel cannot be prepared by pressure alone.

The drying of peat by artificial heat does not become a practical consideration until the moisture content has reached 70 per cent., and even then it is a very doubtful financial proposition.

Peat has been place in centrifuges, electrical currents, alternating and direct, have been passed through it, freezing has been tried and chemicals been added, and although a certain amount of success has been claimed in laboratory experiments, the economic solution of the problem of artificially dehydrating peat seems to have baffled all.

To get over the objection of leaving the peat in contact with the wet surface of the bog various devices have been employed. In Carinthia poles about 10 feet long are driven into the bog to a depth of 4 feet and transverse spikes driven through the poles, on which the peat blocks are then stuck so that drying is accelerated. Timber trays with wooden laths have also been used and a sample of one is exhibited, but the depreciation and capital charges for such systems are very high.

The Mechanical Winning of Peat

The peat fibres in the bog are arranged

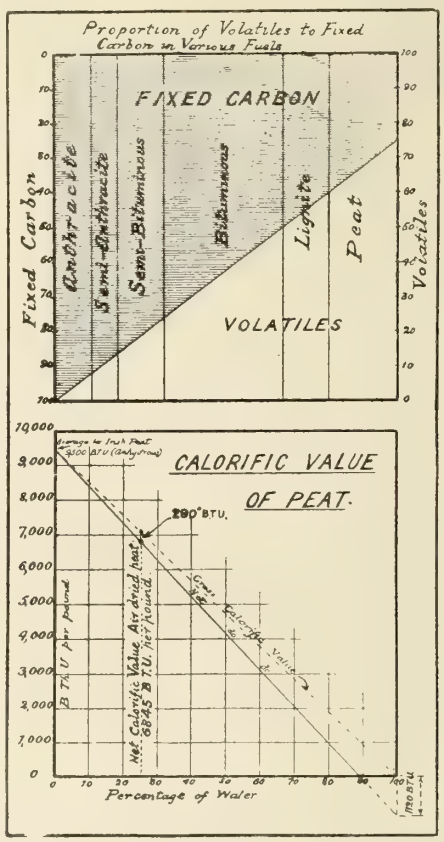


FIG. 3.

more or less in horizontal layers, and for the past sixty years it has been recognized that by macerating and mixing the raw peat the fibres become more uniformly distributed through the mass. This causes a more uniform shrinkage and greater contraction to take place on drying and produces a denser and tougher fuel. Many forms of peat macerating machines have been devised, some of which simply mix the peat to secure uniformity, whilst others attempt the cutting and tearing the fibres. The peat fed into a hopper is pushed through the body of the macerator by a single or double spiral screw. Whilst being forced through the machine the peat is mixed and in some cases forced past rotating and fixed knives of different forms as in the Anrep and Anderson machines.

The peat pulp is then forced through the mouthpiece in the form of one or more streams or bands of peat. Sometimes these bands of peat are received on boards fed over a roller table, the streams of peat being cut into suitable lengths and the boards of peat transported on small wagons from which they are taken and spread on the bog surface to dry. Another method adopted is to run the peat pulp into wagons and transport it to the drying ground, on which it is tipped and levelled to form a layer 5 inches or 6 inches thick.

The present tendency is to concentrate the excavating, macerating, and sod forming and spreading mechanism in one unit. This allows of greater concentration of power units and requires the minimum of supervision and labour.

The dredger excavates the peat from the bog, delivers it into the hopper of the macerator, which in turn forms it into separate pieces. These are automatically placed on a conveyer band which moves out from the macerator as it is gradually loaded, and when completely loaded it automatically tips its contents on to the bog. In this way a strip 100 yards long by 14 inches wide is covered at the same time with the formed peat blocks, and the whole machine then moves forward 14 inches and the next strip of peat is laid down as before. The conveyor girder is supported on mono-rail trucks or on caterpillar tractors.

The peat when spread flat upon the bog is treated just as ordinary "hand cut" peat and subjected to the usual turning, footing, and stacking operations.

Uses of Peat

Attempts have been made from time to time to make paper, building material, alcohol, petrol, and clothes from peat, but the main uses of peat must continue to be for peat moss litter, peat dust for use in the manufacture of cattle feeding, and peat fuel for domestic and industrial purposes, including under the fuel the various distillation products.

The Utilization of Peat for the Production of Power.

When considering the utilization of peat for power production there are two main lines of procedure open to us. The first is to burn the peat and with its fixed carbon and volatiles to complete oxidation in a water-tube or other form of steam boiler and then use the steam thus produced in a turbo-generator for the production of electrical energy. The second alternative is to consume the peat in a gas producer, the peat being partly oxidized with the production from each ton of peat used of some 60,000 to 80,000 cubic feet of a power gas of low calorific value—say, 100 to 150 B.Th.U. per cubic foot—the power gas produced being used in a gas engine or in a gas-

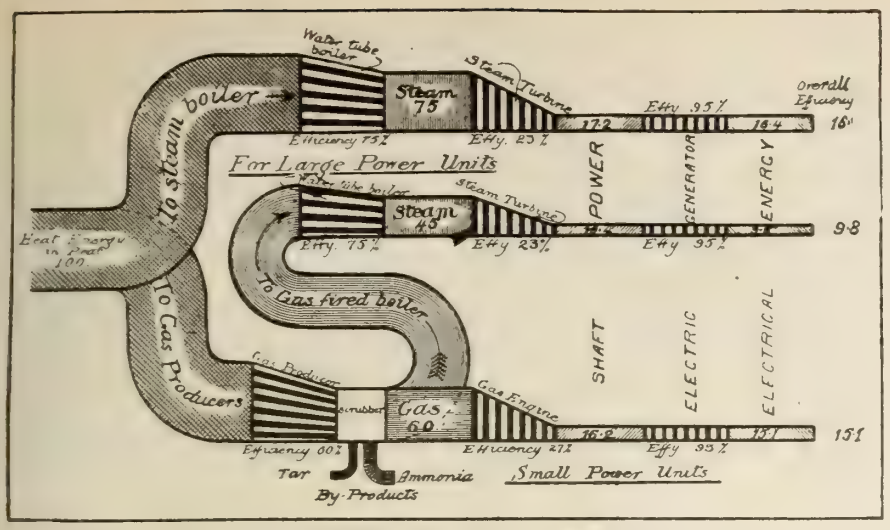


FIG. 3—PRODUCTION OF POWER FROM PEAT.

fired steam boiler and the steam used in a turbo-generator.

Allowable Percentage of Moisture in Peat for Producer Work

Several leading manufacturers of gas producer plants have claimed that they have been successful in using peat containing 60 per cent. to 70 per cent. of moisture, whereas to burn peat in the furnace of a steam boiler the moisture content ought not to exceed 30 per cent. to 35 per cent. Since steam has to be supplied to the producer when using a dry fuel it would naturally be a great advantage if the moisture required could be supplied by the peat, thereby avoiding the necessity of drying the peat to so great an extent.

The diagram Fig. 3 has been prepared to represent the possible ways of utilising the energy in peat fuel. To do this certain efficiencies have been assumed for each stage, at which one form of energy has been converted into another.

Following the upper line in the diagram, about 75 per cent. of the 100 heat units in the peat are available for the production of steam by burning the peat in a water-tube boiler, and these 75 steam units, when used in a modern steam turbine, with a thermal efficiency of 23 per cent., will give 17.25 units of shaft power, which in turn yield 16.4 units as electrical energy. Taking the lower line, the 100 units put through a gas producer with 60 per cent. to 70 per cent. thermal efficiency will give, let us say, 60 units of energy contained in the gas if by-products are recovered. At the same time, certain by-products in the form of tar and ammonia are produced and these may be recovered, the latter as sulphate of ammonia, for which there is wide demand.

Two alternate methods are open to us for the utilisation of the gas. It may be sent by the middle route and burned in a gas-fired boiler, the resulting steam being used in a turbo-generator. A thermal efficiency of 75 per cent. to 80 per cent. with the gas-fired boilers is said to be attainable. but it will be seen that we have one extra step introduced, so that two operations are necessary to convert the heat energy in the peat into steam, as compare to one in the peat-fired steam boiler. This involves further loss of energy, and, in addition, increased capital charges must be borne, so that unless the profits on the by-product recovery plant are of sufficient value this system cannot compete with the direct peat-fired steam boiler. The energy produced by this system equals $100 \times .6 \times .75 \times .23 \times .95 = 9.8$ per cent. of that put in. The method, however, allows large units to be employed, while at the same time by-products are recovered.

The second alternative is to use the power gas from the producer in a gas engine which in turn works a generator. This method offers fairly high efficiencies, but it is doubtful if it can be employed on the large scale, as it is said that serious mechanical difficulties are experienced in the working of large gas engines of 500 horse-power and upwards, and 300 horsepower would appear to be a useful limit. For such powers as 300 horsepower this method gives good results. About 16 per cent. of the heat energy put in appear as shaft power and $(100 \times .6 \times .27 \times .93 = 15.1)$ about 15.1 per cent. as electrical energy. Little can be said about the gas turbine, which would form another alternative. So far it has not proved successful and does not appear to have got beyond the experimental stage.

To arrive at a sound conclusion as to the best method to adopt for the utilisation of the peat we must take into account not only the overall efficiency of the processes involved, but also the labour, depreciation, maintenance, and capital charges. We must further take account of the profits from the by-products when peat is gasified in a producer, and this involves the estimation of the costs of production of the by-products, with the labour, maintenance, capital and amortisation charges on the recovery plant. Even then we are dealing with sulphate of ammonia, a product the price of which has been subject to considerable variation, and one for which, owing to recent developments in connection with the war, it would not be easy to predict a price a couple of years ahead. We must remember that the process of gasification in a producer can be varied within wide limits, and the working of the system and its thermal efficiency depends on the end in view, whether it be the maximum production of by-products or the maximum production of power gas. Both these objects cannot be achieved at the same time, and, in a measure, the failure to recognize this point has led to a good deal of confused thought and rather optimistic forecasts as to the possibilities of by-product recovery plants. The yield of sulphate of ammonia is dependent on the percentage of nitrogen in the peat, and therefore, whereas by-product recovery on one bog might pay, it would prove a failure on another. It will therefore be seen that the problem is a very complex one.

ALCOHOL MOTOR FUEL RESEARCH

Vigorous efforts are being made by British men of science and engineers to discover all the possibilities of alcohol as a motor fuel. The increasing scarcity of petrol, and the prospects that the supplies from all visible resources will gradually shrink until they disappear in twenty-five years or so, lend a special urgency to the problem of finding a cheap and plentiful substitute. Realizing how serious the situation was, the Royal Automobile Club and the Commercial Motor Users' Association, both of Great Britain, united in paying the cost of an ambitious programme of research, at the University of Manchester, into the value of alcohol as fuel. At the request of the Alcohol Motor Fuel Committee, appointed by the British Government to survey the whole question, the programme was put in the hands of Professor Dixon, who recently gave the results of his investigations in a lecture delivered in London. A scientific study was made by Professor Dixon and his assistants of the behaviour of alcohol and of mixtures of alcohol and benzole after ignition. The main object was to find out the conditions which would give the highest efficiency with existing internal combustion engines when run on alcohol or alcohol mixtures. Information of the greatest value to designers has been collected. Investigations in this field have extended to the value of potatoes, beet, maize, and other sources of power alcohol. It is quite possible that many tropical and subtropical plants which have hitherto been regarded as a nuisance or as of little value will prove to have a high yield of the substances out of which, by fermentation, alcohol may be produced in large quantities at a low price. The research now being conducted may therefore be the means of transforming the economic prospects of more than one country.

The Advantages of Superheated Steam

A General Discussion of the Properties of Superheated Steam, and Its Uses in Both Turbine and Reciprocating Engine Practice—A Comparative Test on a Recent Installation is Given.

BECAUSE fuel used for power plant or power station service represents the largest single item in the cost of producing power, its utility must be increased. Each pound of coal burned, each gallon of oil consumed under a boiler for the generation of steam not only must be accounted for, but also must be made to do more useful work.

Of all the means known or practiced to improve the efficiency of a plant, the application of high degrees of superheat, for the investment, shows the most profitable and practical returns. Because superheat offers economies greater than any other single improvement in power plant design, it commends itself to even closer consideration than engineers have hitherto given it.

The returns from superheating are evidenced by a considerable reduction in the cost of operating a steam plant. Within practical limits of temperature, it has been found that the higher the superheat, the greater the economy.

The increased economy is effected in general in four ways, viz.: by increasing boiler efficiency, by reducing condensation losses in steam lines, by reducing the steam consumption of the prime mover, and by increasing the capacity of the plant.

Superheating Increases the Boiler Efficiency

A definite amount of heat is required to superheat steam to a certain temperature and this heat is furnished by the fuel. When a definite weight of steam is generated, additional fuel will be consumed to superheat this steam.

Let us assume a boiler designed without a superheater to give the highest practical thermal efficiency. Suppose we install a properly-designed superheater in this boiler. It will be found that the overall thermal efficiency of the combined boiler and superheater will be greater than the boiler without the superheater when evaporating the same amount of water, because, by the addition of the superheating surface more heat is absorbed and the final uptake gas temperature is lowered. This result can be accomplished, however, only when the superheater is correctly designed so as not to obstruct unduly the flow of the gases through the boiler. Undue obstruction to the gases would decrease the overload capacity of the boiler. A properly designed superheater will not alter furnace conditions in any way. Considering a given furnace condition and a given rate of firing, these facts are indications of added efficiency.

Eliminating Steam Line Condensation

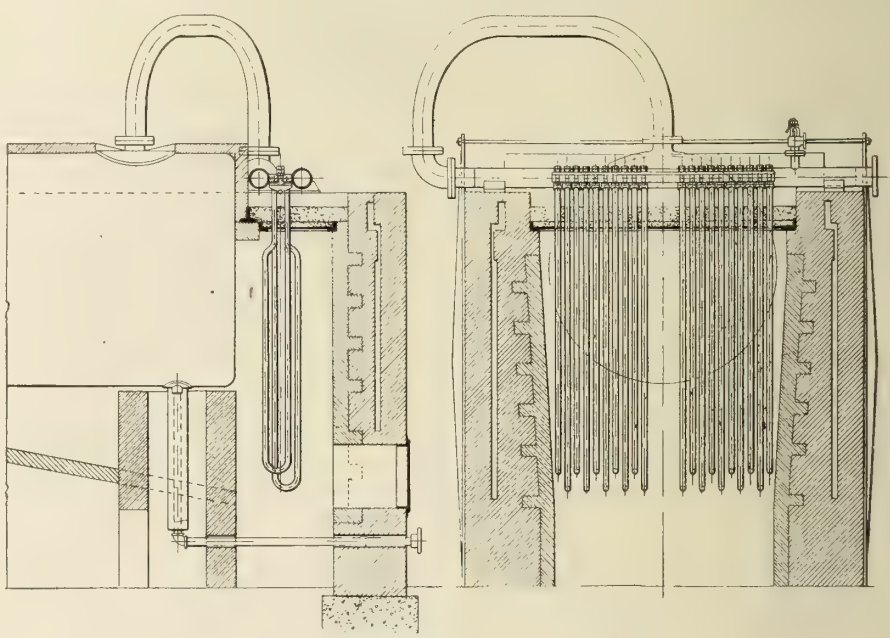
Many power plant installations are forced by local conditions to operate their prime movers at long distances from the boilers supplying the steam. The long pipe lines carrying the steam often are run out of doors where they are exposed to all kinds of weather. These conditions naturally have a marked effect on the quality of steam when it reaches the point where it is to be used.

Superheated steam prevents condensation in steam lines and delivers dry or superheated steam within practical limits to the steam user. This advantage is due to the fact that no moisture or water is carried over from the superheater and also because the low thermal conductivity of the superheated steam prevents condensation. Superheating is advantageous not only from an economical standpoint, but also because it eliminates water hammer and its attendant engine and pipe troubles.

It is a matter of historical interest that the first recorded use of superheated steam was necessitated by the condensation which took place in a long steam line.

Long pipe lines now carrying saturated steam can be used for superheated steam without any change, resulting in a great saving in the available heat and quantity of steam delivered for power purposes. This fact alone should make the use of superheated steam on long pipe lines universal practice.

When condensation in steam lines is reduced, both steam and coal are saved, because in the generation of steam, about nine-tenths of the heat absorbed by the water in evaporating it and raising the steam pressure is latent heat. When steam is condensed, latent heat is liberated and unless it performs useful work it is wasted. Condensation, therefore, occurring in pipe lines, represents an absolute waste of nine-tenths of the heat, and if the condensate is not returned to the boiler all the heat is wasted. A superheater is absolutely essential to raise the temperature of the steam to a point that all of it may be transmitted to its destination and used without condensation losses.



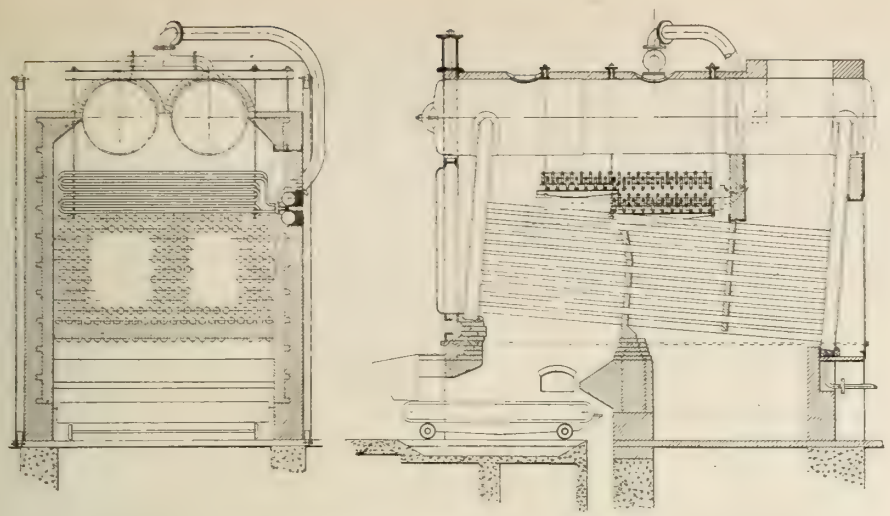
TYPICAL ARRANGEMENT FOR H. R. T. BOILER.

Importance of Superheat in Steam Turbines

High degree superheat is of vital importance in steam turbines, and the steam turbine is particularly adapted to its use. All turbine plants of any size are now using superheat, several modern plants operating at superheat temperature up to 250 deg. Turbine manufactures have made a strong claim in favor of turbines, in that high degrees of superheat can be used. The most economical steam prime movers of to-day realize steam with as high as 300 deg. superheat. These turbines produce a K.W.H. for 11.5 pounds of steam or a brake horsepower hour for 8 pounds of steam.

The water rate of an economical steam turbine will be reduced 1 per cent. for every twelve degrees of superheat up to 200 deg. This figure is based on large and economical turbines. Small turbines, inherently less economical, show a greater proportionate saving with superheated steam.

The above results are based upon the assumption that perfectly dry steam has been delivered to the superheater. This condition, however, seldom exists. The usual type of horizontal return tubular



TYPICAL ARRANGEMENT FOR HORIZONTAL WATER TUBE BOILERS.

boiler with a comparatively large water and steam capacity delivers wet steam. The modern water tube boiler with less water and steam space is much worse. This condition is accentuated, particularly by the fact that the modern water-tube boiler is forced to evaporate water at a rate of 3 or 4 times that of the return tubular boiler, and the percentage of moisture in the steam from such a boiler is high. Take for example a 500 h.p. water tube boiler having a 42 in. diameter steam drum. At normal rating such a boiler will deliver 15,000 lbs. of steam per hour. Conditions often arise when such a boiler will be called upon to evaporate 30,000 to 40,000 lbs. of water per hour. Superheat takes out all the moisture that otherwise would be carried over, and is, therefore, particularly beneficial when boilers operate at high capacities.

It is this moisture which is particularly damaging to steam turbines. It reduces the efficiency by the excessive friction between the water and turbine parts. One authority points out that a turbine without superheat is merely a form of water brake, for every ounce of water passing through, no matter how finely divided, is inert material, and serves to check the running of the machine.

The internal surfaces of the turbines are enormously increased beyond those in reciprocating engines, and the effect of temperature range in augmenting condensation is very great, even though the temperature in the turbine does not change so widely.

The destructive effect of water and moisture on the turbine blading is too well known to be more than mentioned. The erosion of turbine blades due to water is very rapid. The effect of this erosion is immediately felt in increased steam consumption. When highly superheated steam is used, however, water is not present to cause this erosion. Blade wear is greatly reduced through superheating and reblading is necessary only after much longer periods of operation than when saturated steam is used.

Superheating Increases the Efficiency of Reciprocating Engines

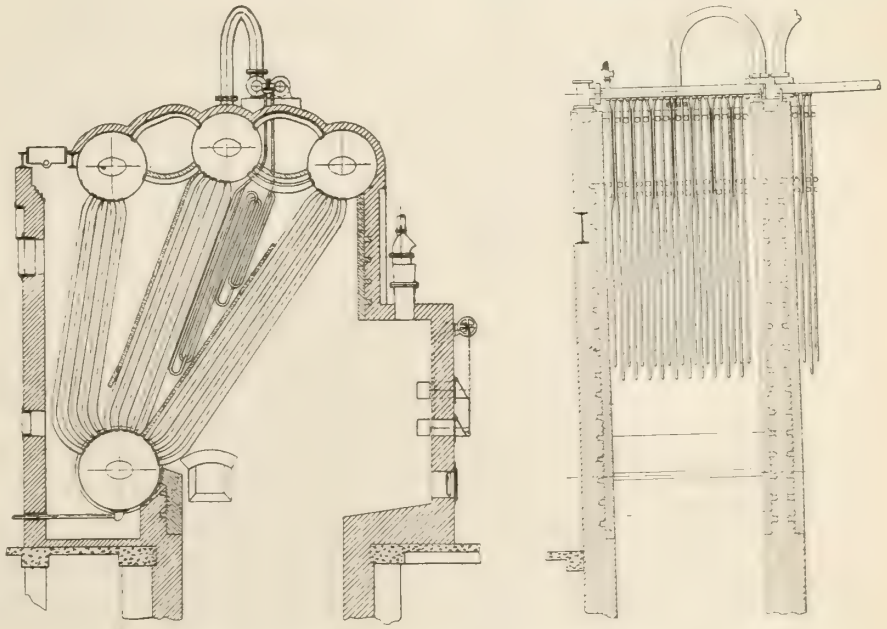
Generally speaking the reciprocating engine will be benefited more by superheat than the steam turbine will. The saving to be expected by superheating is dependent on the amount of cylinder condensation that would occur in the same engine if no superheat were used. Evidently, the greater this condensation, the larger is the saving possible.

When steam is superheated 200 deg. or even 250 deg. Fahr., it can be exposed to the cooling action of the steam chest and cylinder walls without condensation, and has 30 to 40 per cent. greater specific volume than saturated steam of the same pressure. For example, 1 lb. of water at 170 lb. pressure absolute produces 2.68 ft. of saturated steam at 368 deg. Fahr. temperature. After passing through the superheater and gaining 200 deg. superheat, the volume will have been increased to 3.54 cu. ft. A part of this increased specific volume is lost before the expansion of the steam in the cylinder takes place on account of the cooling action of the cylinder head, piston and cylinder walls. While the superheat in the steam entering the cylinder may be 200 deg. to 250 deg., the superheat of the steam in the cylinder at the moment of cut-off is considerably less. The elimination of all condensation losses together with the increased volume of the steam, effects substantial savings in the steam consumption and in the fuel consumption when compared with saturated steam operation under the same conditions.

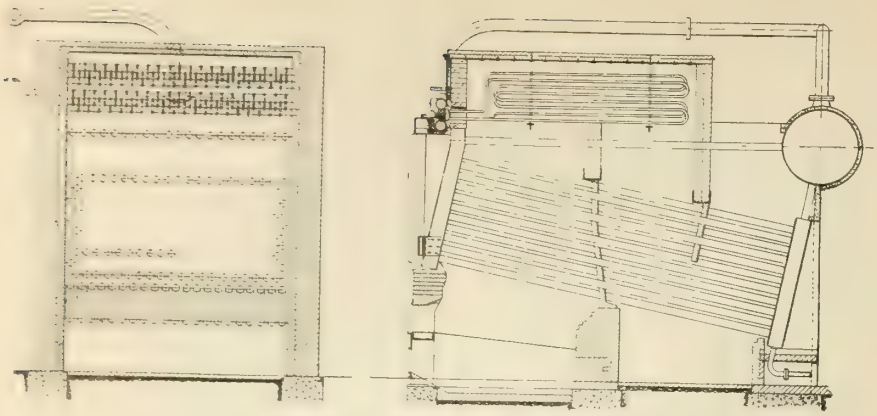
The opinion frequently has been advanced that the mean effective pressure in cylinders using superheated steam is altered from that existing when saturated steam is used, the initial pressure, the point of cut-off and piston speed, of course, being assumed as the same in each case. Theoretical considerations would indicate that a lower mean effective pressure with superheated steam is obtained, and this conclusion would be based upon the knowledge that the expansion curve of superheated steam is steeper, that is to say falls more rapidly than with saturated steam. In practice, however, with highly superheated steam a mean effective pressure at least equal to that with saturated steam is obtained. An explanation will make this point clear. For example: in simple non-condensing engines the back pressure line of an indicator card is decidedly lower with superheated steam than with saturated steam, a condition to be expected because the steam exhausted contains less moisture. It is, therefore, lighter than saturated steam, and flows through the exhaust passages with less resistance. Mr. C. D. Young, before the American Society of Mechanical Engineers, in December, 1912, gave conclusive evidence of this fact.

In the case of multi-expansion reciprocating engines the cards taken from the low pressure, and, in the case of triple engines, from the intermediate pressure cylinder, show that a higher m. e. p. is obtained with superheated steam. In the high pressure cylinder of multi-expansion engines it is generally true that the cut-off should be increased if the power output of the engine is to be maintained.

But our consideration of the possi-



SUPERHEATER ADAPTED TO STIRLING TYPE.



TYPICAL ARRANGEMENT FOR CROSS DRUM TYPE.

bility of increased engine power, due to superheating, must not stop here. Consider a saturated steam plant in which the boilers are operating at their full capacity to supply the steam demanded by the prime movers. Take this same plant and superheat it—the decrease in steam consumption per horsepower hour will result in a reserve boiler capacity which will make possible either the operation of the boilers at lower rating or will furnish the additional steam necessary to meet an overload on the prime mover. In other words, superheating makes it possible to increase the power which the prime mover may develop over what it could produce with saturated steam.

In new installations, the use of superheated steam permits the use of engines having larger cylinder diameters and enables them to be operated with shorter cut-offs. Because cylinder condensation is eliminated, the gain in economy due to a more effective expansion of the steam is realized.

Experiments have shown that the degree of superheat necessary to prevent cylinder condensation varies as a general rule with the ratio of expansion. In American practice the steam temperatures ordinarily recommended are: up to 500 deg. Fahr. for Corliss and slide valves; up to 650 deg. Fahr. to 700 deg. Fahr. for piston and poppet valves.

The gain from decreased steam consumption due to superheated steam is ordinarily expressed in per cent. This gain will vary in various types of engines with the different superheat temperatures used. For example, with 150 deg. superheat, the following gains are produced: in simple engines 22 to 24 per cent.; compound engines 16 to 19 per cent.; triple expansion engines 14 to 16 per cent.; uniflow engines 10 to 12 per cent. It is, however, an assured fact, and a strong argument for the more general adoption of high degree superheat, that only engines designed for high degrees of superheat and using it can successfully compete in economy in the power generation field.

Advantages When Operating at Reduced Pressures

It is often necessary, particularly with old boilers, to reduce the operating pressure. This condition results in a loss in plant capacity. Superheating such boilers will enable them to meet the power demands of the plant at the reduced pressure just as well as the boilers did before the pressure was reduced. Furthermore, superheating in the majority of cases will provide an additional reserve power over that of the plant before the pressure was reduced.

Power Plant Cost With Superheat

The installation of superheaters materially lowers the plant cost. Where it is used, a smaller amount of boiler horsepower is needed to deliver the same power. Roughly speaking, six boilers equipped with superheaters, furnishing 150 deg. of superheat, will carry the same power load as seven boilers delivering saturated steam. By reason of this fact alone, smaller feed pumps, smaller stacks, smaller coal handling apparatus and less coal storage space are sufficient for the demands.

Piping can be reduced in size because higher steam velocities with superheated steam are possible. This reduction in pipe size will effect a saving not only in the pipe line but also in valves, fittings and covering.

In the turbine room, superheated steam will allow the use of a condenser of smaller size than if saturated steam were used. Consequently, smaller circulating water pumps, hot well and vacuum pumps can be used and minor apparatus such as steam separators often can be dispensed with.

These items materially reduce the initial plant cost.

Conclusion

When superheating is correctly applied to the individual conditions in a specific plant, it is the one means which will positively show an improvement in power plant operation in at least one and probably all parts of the plant where steam is used.

The following test was recently carried out at the Conneaut, Ohio, shop power plant of the "Nickel Plate" R.R. The plant contains the following equipment—Boilers (3) 180 horsepower H.R.T. boilers; furnaces: hand-fired; fuel: coal and sawdust; engines: 1 150 h.p. Corliss, 1 175 kw. direct-connected high-speed engine, 1 75 h.p. balanced valve engine; air compressor: 1 1,050 cubic feet capacity, slide valves on steam end; pumps; duplex; steam hammers: 1 1,200-lb, 1 2,000-lb. All these units are now operated on superheated steam, and some of them are several hundred feet from the boiler room.

MACHINE SHOP ONLY UNDER CONSTANT LOAD CONDITIONS AT NIGHT.
TESTS WERE MADE ABOUT TWO WEEKS APART WITH FLUES IN APPROXIMATELY THE SAME CONDITION

	DURATION OF TESTS - 4 HOURS EACH			
	SATURATED STEAM	SUPERHEATED STEAM	% INCREASE	% DECREASE
TOTAL COAL CONSUMED - POUNDS	9316	6827		26.7
STEAM CONSUMPTION - LBS. OF WATER	57500	46000		20.0
AV. STEAM PRES. OF BOILERS	118.0	115.0		2.5
AVER LOAD ON CORLISS ENGINE - I.H.P.	43.0	43.6	1.4	
" " " WOODMILL ENGINE - I.H.P	43.2	42.8		0.9
" " " ELECTRIC GENERATOR - K.W.	56.7	56.8	0.2	
REVOLUTIONS OF AIR COMPRESSOR. TOTAL	26590	26630	0.1	
BOILER H.P DEVELOPED	386	336		12.9
PERCENT RATED CAPACITY DEVELOPED	107.0	93.3		—
EFFICIENCY BOILER, FURNACE AND GRATE	47.6	57.7	21.2	
TEMP. FEED WATER - °F.	212	207		2.4
HEAT VALUE - 1 LB. COAL - B.T.U.	13510	13190		2.4
DEGREES SUPERHEAT - MAIN HEADER	—	163	—	—

AND THE SAVING
IN FUEL
IN WATER
WITH INCREASED EFFICIENCY

TEST MADE UNDER ACTUAL OPERATING CONDITIONS.

Development of Long Distance Transmission

In This Lecture Delivered Before the Johns Hopkins University as One of the John Aldred Lectures the Progress of Electrical Development is Reviewed from 1876 to Date.

By PAUL M. LINCOLN, Consulting Engineer, Cleveland

(Continued from last issue.)

THE fact that power could be brought into these mines by electrical means opened up a tremendously large field for electric transmission of power, and this industry immediately took hold of the West and developed rapidly. Mr. P. N. Munn gives a very interesting history of the development of the Telluride Power Company and the other companies which sprang from this development in Cassiers' magazine for January, 1905. Those interested will find a complete account of this development in that magazine.

The most interesting feature of this development, historically speaking, is that pointed out above, namely, that single phase alternating current was used, and not the polyphase alternating current, which would be the only thing considered under similar conditions to-day.

The use of the single phase system by this Colorado gold mine brought strongly to the attention of the engineers of the time the necessity of developing an alternating current system of generating and transmission and distribution, which should better take care of the needs of the time. Development work was, therefore, pushed by the Westinghouse Company on the polyphase alternating current system of generating and distributing, which had a beginning about two years previously. While most of the demand was for single phase power used for lighting only, the demand for power for the purpose of driving machinery began to be recognized as a very important future development for alternating current, and all possible energy was directed at improving the methods of generating, transmitting and distributing polyphase alternating current power.

During the summer of 1891 an experiment in power transmission of rather extensive character occurred in Germany, which had an important influence upon the development of power generation and distribution by alternating current. This was the so-called Frankfort-Lauffen transmission. There were three unique features of this Frankfort-Lauffen transmission. The first was that the voltage used was higher than anything that had previously been attempted, namely, 30,000 volts. The second was that the distance of transmission was longer than anything heretofore attempted, being about 30 miles. The third unique feature was that polyphase was used and not the single phase, which had been used universally in all commercial enterprises before that time. This transmission was admittedly an experiment, undertaken mainly for the advertising value it had in connection with an exposition which was going on during that summer in the City of Frankfort. There is a water power of some considerable size at Lauffen, and this alternating current transmission was undertaken for the purpose of bringing the water power from Lauffen to Frankfort, the power being used largely for illumination. However, the fact that this transmission was carried on successfully had a very marked influence upon the development of the art of transmission and distribution of electrical energy. It gave electrical engineers great confidence in some features of this method of transmission, in which, before that time, there was not much confidence. The fact that a voltage as high as 30,000 volts could be carried successfully and that power could be successfully transmitted over distances up as high as 30 miles gave electrical engineers of that time great hope that the alternating current polyphase method of transmission had a great future before it.

It was at about this period that a group of New York financiers decided to undertake the development of power at Niagara Falls on a scale that exceeded anything attempted up to that time. The question immediately arose as to how this power should be generated, transmitted and distributed. An International Commission of Engineers was appointed by these financiers for the purpose of advising upon this question. This commission was composed of some of the best known scientists and engineers of the day. Dr. Coleman Sellers, of Philadelphia, served as chairman. Dr. Sellers was recognized as one of the foremost mechanical engineers of his day. Undoubtedly the best known member of this commission was Lord Kelvin, the well known English scientist. Two other members were Professor Wm. C. Unwin, a well known English mechanical and hydraulic engineer, and Colonel Turretini, a Swiss hydraulic engineer. It is significant to note that the electrical profession was not represented by a single member on this commission. It is also significant to note that it was by no means a foregone conclusion that the electrical method of generation and distribution would be adopted by this commission. If a similar commission should be appointed to-day to pass upon a similar question the electrical method would be the only one which would have the slightest consideration, but in those days the electrical method was still on trial, and it by no means had the call when so large and important a problem as transmitting an amount of power which was expected to reach from 50 to 100,000 h.p. was to be developed and distributed. A fact which is of interest to Baltimoreans is that Professor Henry Rowland, at that time Professor of Physics in the John Hopkins University, appeared before this commission in the capacity of an expert and was one of the advocates of the electrical method of generating and distributing power, and he also advocated that the method adopted be the alternating current polyphase method.

The upshot of the deliberations of this commission was that during the year 1893 the alternating current two-phase system was chosen for the purpose of developing and distributing Niagara power. The engineering advice rendered by the Westinghouse Electric and Manufacturing Company was one of the important factors in arriving at this decision. The engineering advice from that source was followed in almost every particular in the decisions arrived at by this commission. One of the points, however, where the decision of the commission differed from the advice given them by the Westinghouse engineers was in the matter of frequency. A short history of the matter of frequency up to that time may be of interest.

The frequencies first used with alternating current were comparatively high, being 133 cycles per second as the standard chosen by the Westinghouse Electric and Manufacturing Company, and 125 cycles per second by the Thomson-Houston Company and other competitors that entered that field after the Westinghouse Company had demonstrated the successful application of alternating currents to electric lighting. These frequencies were standard for a number of years after the beginning of the alternating current method of generating and distributing electricity for lighting purposes. As soon as it became evident that the alternating current would have to enter the power field, as well as the lighting field, it became recognized that a lower frequency would be desirable. After some consideration a frequency of 60 cycles per second was selected by the engineers of the Westinghouse Company, and about the year 1890 equipment for the lower frequency of 60 cycles began to make its appearance upon the market. When the decision to use alternating current polyphase system for the Niagara development was finally made by the commission the engineers of the Westinghouse Company recommended that this frequency of 60 cycles per second, then a comparatively new thing, be used for the Niagara development. Objection to so high a frequency was made by some of the advisers of the Niagara commission, not-

ably Professor George Forbes, a well known English electrical engineer, who advocated the adoption of 16 2-3 cycles per second, and even suggested going to one-half of this value, namely, 8 1-3 cycles per second. On the other hand, as indicated above, the engineers of the Westinghouse Company advocated 60 cycles per second. The question was finally solved by the directors of the Niagara Falls Power Company adopting a compromise between these two frequencies, namely, 25 cycles per second. A factor which entered into this decision was that the speed of the water wheel had already been chosen at the time that the frequency was made—250 revolutions per minute — and the frequency selected must, of course, correspond with the water wheel and generator speed. I think I am safe in stating that if this decision were to be made again to-day, in the light of all of the knowledge which we have gained in the last 25 years, the advice given by the Westinghouse engineers at that time would be followed and a frequency of 60 cycles rather than 25 adopted for this important development. However, there were reasons which seemed thoroughly convincing to the commission at that time for making the decision which they did; the main reason was that this was a power plant, not a lighting plant, and that the frequency selected should be one suitable for power transmission and power development rather than for lighting purposes. The decision to use two-phase rather than three-phase for this development followed from the consideration that a large amount of the energy would be used in single-phase furnaces and for other single-phase purposes. The consideration that it was easier to divide single-phase load among two phases rather than among three led to the adoption of the two-phase system instead of the three-phase system.

This decision in the year 1893 to use the alternating current polyphase system for the purpose of generating and distributing the Niagara power was followed shortly by an order given to the Westinghouse Electric and Manufacturing Company for three 5,000 h.p. alternating current generators, together with some of the other necessary equipment to go with them. It is interesting to note that these generators, at the time they were designed and built, had a capacity of more than four times the capacity of the largest previous alternating current generators. A capacity of 5,000 h.p. for an alternating current generator does not seem large to-day, but at that time it was far beyond anything which had been built before, and as a consequence many new problems entered into the design of these generators. The engineers of the Westinghouse Company are, in my opinion, due for a very great amount of credit for the manner in which the work was carried out. The use of an "all mica insulation" in the armature of these generators is one of the unique features adopted in that design, and is one of the things which has lasted to this day.

Commercial operation of the Niagara Falls Power Company in distributing power to its customers began on August 26th, 1895, and it is interesting to note that at least one of the original generators still runs after a lapse of nearly 25 years, with exactly the same armature windings as it started with on August 26th, 1895. The fact that mica insulations were used on these generators is unquestionably responsible, to a very large degree, for this long period of uninterrupted service. During the following summer a transmission line between Niagara Falls and Buffalo was built, and operation on this was started during the summer of 1896. The distance of transmission on this transmission line is 22 miles, and the voltage first used was 11,000 volts, three-phase. While this was not excessive either in point of distance or in point of voltage in one this transmission exceeded anything that had been put into operation before, and that is in the amount of power which was transmitted over it. This feature introduced some new problems, and a great many of these new problems introduced by the increase in the amount of power were met for the first time in that particular transmission.

The problem of circuit interruption was met in aggravated form in that transmission. Up to the time of this transmission it had been customary to use fuses as the only protection on transmission lines, and they had served very satisfactorily. However, in the case of the Niagara-Buffalo transmission line the amount of power was so large that fuses did not give satisfactory operation, and it was recognized there for the first time that something other than fuses would have to be developed in order to get proper protection from overloads, short circuits, etc. To meet this condition the oil switch was suggested and developed, the first step in this important development being taken by the General Electric Company of Schenectady. This, however, was only one of the many new problems that were met with for the first time in this installation, and in the solution of which the engineers of that enterprise were vitally interested.

The Niagara plant was the pioneer central power plant of this country, and its success in both a financial and engineering sense gave a great impetus to the development of power transmission and distribution, particularly by the alternating current method. While this Niagara system was one of the first, and one of the largest, it was by no means the last of such systems to be installed. They began to appear in all parts of the country, and the use of transmitted power began to assume a very important place in the industrial life of the country. Growth and development in all phases of the alternating current method of transmitting and distributing power were the order of the day. It may be interesting to trace first a brief history of the development that has taken place in the matter of the voltage of transmission.

REMARKABLE DROP IN OUTPUT OF CENTRIFUGAL PUMPS AFTER STARTING

Observations made by the author indicate that many centrifugal pumps show a gradual falling-off in efficiency after running for some time. Two characteristic cases are cited in connection with the large pumps used for pumping the Haarlem mere. In the first the output fell to 30 per cent. below the normal, and in the second case a marked increase in the energy consumption was noticeable shortly after the pump was started. On stopping and restarting the pump, the normal output and energy consumption were again obtained; but the conditions gradually fell back to those previously observed. After discussing the influence of a possible accumulation of gas (from the peaty soil) in the suction pipe, the author rejects this explanation as being insufficient. He ascribes the cause to the fact that turbine pumps of the Francis type are designed on the assumption that the inflowing water is moving in an axial and not a rotary direction. This assumption is undoubtedly correct during starting, but it can be readily demonstrated that very little would be required to impart a rotary movement to the incoming water column—i.e., the mass of water would move in a spiral through the pipe. This rotary effect would explain the phenomenon and also the fact that in turbine pumps with a high circumferential speed, and where little or no rotary motion would be imparted to the incoming column of water, this falling-off in output disappears. The author is of opinion that the transmission of this rotary motion from the rotor of the pump back along the incoming water column is considerably accelerated by the presence of large quantities of suspended matter in the water. The obvious solution of the difficulty for low-speed turbine pumps would be the introduction of a rib or ribs in the suction pipe, to prevent a rotary motion from being imparted to the incoming water column.—J. C. Dijxhoorn ("De Ing.").

"THE PETROLEUM OUTLOOK"

What should prove of great interest to all persons genuinely concerned in fuel problems, is a monograph published by Arthur D. Little Inc., of 30 Charles River Road, Cambridge, Mass., and entitled "The Petroleum Outlook." The work discusses in plain language the status of all the oil fields and their present development, with future prospects. Several charts and a large map are included, showing the entire resources of the United States. The subject matter is highly interesting and gives food for thought. The monograph will be supplied free to those interested on application.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

AS an aid to the better understanding of the principle underlying the action of the dynamo and motor, Fig. 1 is given. A conductor is shown passing between the poles of a magnet and assuming first the case of a motor current is assumed to be flowing through it in the direction given by the large arrow. Remembering what has been said about the magnetic flux surrounding a wire and its direction in space, the small arrow running in a circular direction around the wire will represent the magnetic flux surrounding it. Arrows are also shown travelling from one pole of the magnet to the opposite one. These represent the magnetic flux due to the magnet itself. Observe the directions of these two fluxes above the wire. One will be seen to oppose the other. On the other hand the directions of the two fluxes below the wire will be seen to be the same. The resulting action may be considered to be as follows:—

When the two fluxes oppose each other the one counteracts the other and the number of lines of force is lessened. On the other hand where they are in the same direction the field will be strengthened. It will be as if the magnetic lines of force proceeding from the north pole of the magnet finding the path above the wire difficult slide around the wire on the under side even though the path be slightly longer. Since the path is longer they will, however, tend to straighten out and in doing so will exert a force upon the wire tending to push it upwards. The action corresponds to that which would take place if the lines of magnetic force consisted of bands of elastic stretched into exactly the same shape. A force due to the interaction of the conductor magnetism and that due to the magnet pole faces then results which for this particular instance acts upwards. In the motor the conductor moving upwards, as it is supposed to be free and not rigidly held down, continually cuts lines of force or may be said to pick them up from in front of itself and crowd them in behind.

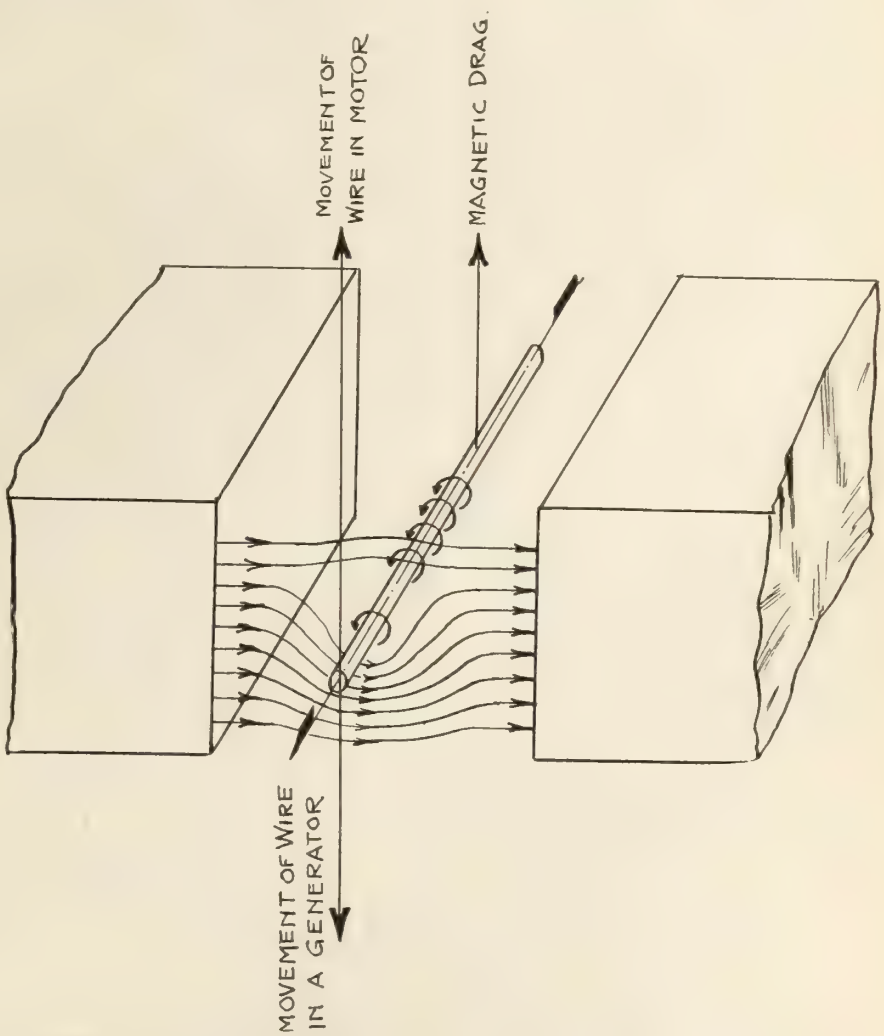
In the dynamo the action may be represented by the same diagram. Only in this case the conductor is pushed by mechanical force in a direction opposite to that which it would take if left free to move as in the motor. The magnetic force still exists but in this case is weaker than the force tending to move the wire between the pole faces. It is just as though a wire were pushed across a number of stretched elastic bands. The cutting of the lines of force by the conductor in this case generates the current of electricity. In other words in the motor the directions of the tendency to move and the actual movement are the same, while in the dynamo they are opposite and the magnetic force or drag may be spoken of as the resisting force which absorbs the work done in rotating the armature.

In the dynamo not only does the direction of the generated e.m.f. depend upon the directions of the magnetic flux and the motion but its strength varies as the speed with which the conductor moves and with the strength of the magnetic field. That is to say, if the speed with which the conductor moves were doubled, the voltage generated would also be doubled and if the flux were doubled while the speed remains constant the voltage would also be increased to the same extent. If the speed and voltage were both doubled the voltage would be quadrupled.

Three quantities are involved in the elementary dynamo or motor, the direction of magnetic flux, the direction of the electro-motive-force in the wire and finally the direction in which the wire moves. The action in the case of the motor, as explained above is not the same as in the dynamo and for the easy remembering of the relations for both cases two simple rules are given.

In the case of the **dynamo** the **right** hand is used and if the forefinger be taken as representing the lines of force, and the thumb as representing the direction in which the conductor is moved, then the middle finger shown pointing downwards will represent the direction in which current will flow.

In the case of the **motor** the **left** hand is used, the thumb, first finger and



MAGNETIC FORCE AND ACTION OF CONDUCTOR IN A MOTOR AND DYNAMO.

middle one representing the same quantities; the left hand is shown in Fig. 3 with the forefinger pointing in the direction of the magnetic flux and the

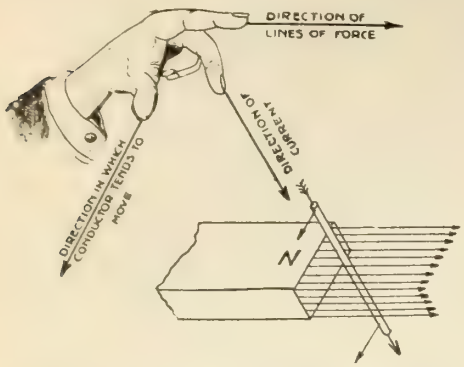


FIG. 2—RIGHT HAND RULE FOR REMEMBERING FLUX CURRENT AND MOVEMENT OF CONDUCTOR RELATIONS FOR THE DYNAMO.

middle finger pointing in the direction in which the current flows. The thumb indicates the direction in which the conductor will move under these conditions.

The Commutator

In actual practice an armature never consists of a single wire as shown in Fig. 1 but at the very least would contain two in the form of a loop as shown in Fig. 4. Let us suppose Fig. 4 is an elementary armature of a generator and suppose it to be moving in the direction indicated by the arrow. The left hand turn moving downwards and cutting

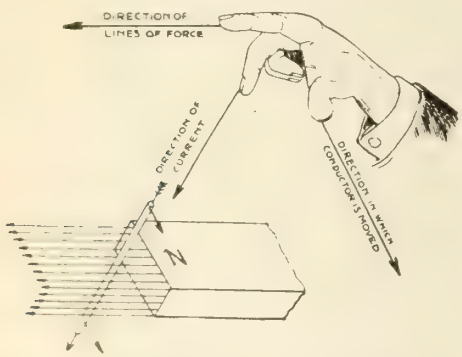


FIG. 3—LEFT HAND RULE FOR REMEMBERING FLUX CURRENT AND MOVEMENT OF CONDUCTOR RELATIONS FOR THE MOTOR.

magnetic flux will have an electro-motive-force induced in it causing current to flow towards the observer and out through the left hand brush. The right hand wire moving upwards at the same instant has an electro-motive-force induced in it in the opposite direction or away from the observer. Travelling in this direction this electro-motive-force will cause current to flow around the wire at the rear and down the left hand side of the loop to the left hand brush the same as before, the two conductors thus reinforcing each other and if the circuit exterior to the generator be closed causing a flow of current out the left hand brush through the exterior circuit and back through the right hand one. When the wires, due to their rotation reach a point at right angles to that shown or when they are in a vertical position no voltage is generated and no current flows. In this position the brushes are touching both sectors on the commutator if they be wide enough. Immediately after this position is reached the conductor which formerly was on the right hand side and was moving upwards, begins to move downwards on the left hand side and its end connected to the commutator is put into communication with the left hand brush. Since in moving downwards the electro-motive-force generated is towards the observer as before a continuous flow of current is set up.

The brushes by rubbing on the commutator thus not only form a path for the current to flow to and from the armature but serve also to give a continuous or uni-directional current.

If instead of a split commutator two rings had been installed one to each

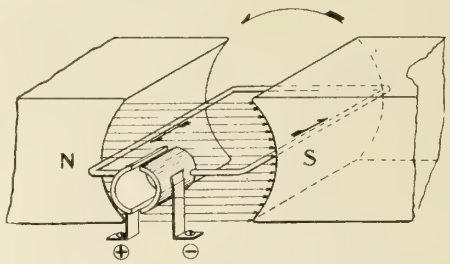


FIG. 4—SIMPLE ARMATURE WITH ONE COIL.

end of the coil, an alternating current would be delivered, for each side of the loop would have a current flowing in it first one way and then the other as it came under the influence of first one pole and then the other.

If two coils of wire similar to the one described be mounted on an axis at right angles to each other with the four terminals of each coil connected to a four

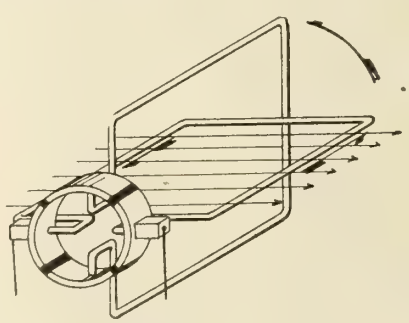


FIG. 5 -TWO-COIL ARMATURE.

part commutator as shown in Fig. 9 then the electro-motive-force generated would be more nearly uniform and in practice commercial machines having a large number of coils give an almost uniform flow of current and in the case of motors give a uniform turning movement or torque.

NEW PUBLICATIONS

The Armstrong Cork Company, Pittsburgh, have issued a new publication, "Nonpareil Insulating Brick," a 72-page book on the insulation of high temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens, kilns, etc.

While dealing particularly with the description of Nonpareil Brick and their uses, the book is more than a catalogue. The subject of heat insulation has been thoroughly studied from both the theoretical and practical standpoints, and the results here compiled contribute to make this book a really valuable and instructive treatise. It is conveniently divided into sections, each dealing with a particular type of industrial apparatus so that any one can readily find the data for the equipment in which he is especially interested. Operating records, with and without insulation, are given, actual dollars-and-cents savings demonstrated, and the economy and advantages to be secured by the use of Nonpareil Brick described in a most interesting and convincing manner.

The book is attractively and substantially bound and profusely illustrated. Its subject matter is of such vital importance to all industries employing high temperature equipment, that plant managers, superintendents and engineers will find it a valuable addition to the technical library.

COAL RESEARCH

The economical use of coal is a problem which concerns engineers in all parts of the world. It is especially interesting in connection with the "carbonisation" of coal at temperatures in order to obtain smokeless fuel, gas, oil and numerous valuable by-products. This problem involves a close scientific study of exactly what happens to different kinds of coal at various temperatures. Mr. Sinkinson of the Imperial College of Science, London, has hit upon a most ingenious method of discovering at what temperature coal begins to change into coke. He makes use of the fact that coke conducts electricity, while coal does not. By measuring the electrical resistance of a sample of coal as it is gradually heated he has fixed the temperatures at which various coals enter into the critical stage at which they give off their valuable products.

The Arthur S. Leitch Co., 1,002 Kent Building, Toronto, have recently taken over the agency for the Brown Instrument Company, of Philadelphia, and will handle their complete line of thermometers, recording pressure gauges, pyrometers, draft gauges, and recording tachometers. This will add greatly to the convenience of users of these instruments in Ontario, and should be of interest to those interested in this class of equipment.

Steam Engine Development in the Maritimes

An Interesting Account of the Growth and Development of Engineering Practice in the Lower Provinces—Read Before the Enginering Institute of Canada.

By D. W. ROBB, M.E.I.C.

ALTHOUGH Nova Scotia, New Brunswick and Prince Edward Island, the Maritime Provinces of Canada, are more widely known for the extent and importance of their fisheries, lumbering, mining and some departments of agriculture, particularly apples, potatoes, etc., than for mechanical and engineering achievement, it is interesting to find that in the early development of steam engines for steamers, locomotives, and later in connection with electrical apparatus, a department of engineering which has contributed more towards the rapid progress of the world during the nineteenth century than any other; the little provinces by the sea were among the first on this side of the Atlantic.

When we remember that the first practical steam engines were built by Watt from 1775 to 1800, and that we are only now celebrating the centenary of Stephenson who started the steam locomotive on its triumphant career, it may surprise many of us to find that as early as the years 1844-48 and 1854, John Waring and John Smith, pioneer engineers of St. John, N.B., designed and built marine engines for steamers running on the St. John River. Stationary engines were built by Fleming & Humbert at St. John, N.B., as early as 1838, and locomotives were built by Mr. Fleming before 1860. One of Mr. Fleming's locomotives hauled a train for the late King Edward, then Prince of Wales, when he visited Canada in 1860.

It may be interesting to give a few particulars in regard to the steamers and engines referred to above. I am indebted to Captain R. Retallick of St. John, who has sent me, through Geo. H. Waring, grandson of John Waring, one of the pioneer engine builders referred to above, the following particulars:

The steamer "Reindeer," for service on the St. John River, was built in 1844. Her engines were compound, the high pressure cylinder being horizontal with Stephenson link motion and the low pressure cylinder oscillating. Captain Retallick states that this was the first compound engine that was run successfully (probably he means for marine service), but it must have been among the first compound engines built for any purpose. This engine was designed by Tippitts and Waring — built by John Smith at St. John, N.B., and must have been of good design and construction as it was transferred to the steamer "Antelope," also a river boat, in 1861 and later installed in the steamer "Admiral," which was broken up in the year 1915, so that this engine passed the scriptural "three score and ten."

The steamer "John Waring" was built in 1858 at Woodstock, N.B., by Mr. McConnel. The engines were built by John Waring, and had two high pressure cylinders. The boat was a side wheeler as the water is very shallow at Woodstock. The "John Waring" was launched under steam and came direct from Woodstock to Indiantown, just above the reversing falls at St. John, about 140 miles. She was considered very fast.

The next steamer, Captain Retallick states, was the "Anna Agusta," built at Fredericton. The engine was a horizontal low pressure, or single cylinder engine, placed on one side of the boat with the boiler on the opposite side and was built by Fleming and Humbert of St. John. She was a side wheeler also.

One of the earliest steamers was the "St. John," built at East St. John. She was a side wheeler. The engine was built by John Smith. Captain Retallick says it (the reciprocating part of the engine), looked like a saw mill gate or sash moving up and down. This boat was launched under steam and managed to paddle around into St. John Harbor under her own power, but the hull was so full aft that she would not steer. Later, after a new stern was added, making her about 24 feet longer, she worked satisfactorily.

George Fleming, of Dysart, Scotland, who served his apprenticeship at Dunfermline, grandfather of the present owners of the Phoenix Foundry and Locomotive Works, established at St. John in 1835, and built quite large marine engines for service on the St. John River, Bay of Fundy, and later for the Prince Edward Island service—two of these boats, the "Rothesay" and "David Weston" for river service, were famed all over Canada for their speed. The old records of the company show that Mr. Fleming supplied an engine to Brazilian Ansley in 1838, price 250 pounds, and in 1840 an engine and malt mill for 225 pounds, and an engine for George Younger, price 180 pounds. The Flemings are said to have built the first steam fog whistle used in any part of the world, which was designed by a St. John man, and was placed on Partridge Island, St. John Harbor.

In the early sixties and seventies, a number of well known engineering concerns in the Maritime Provinces built stationary steam engines for the many large saw mills in New Brunswick and Nova Scotia, as well as for factories, mines and various other purposes. Among the most prominent of these may be mentioned, Geo. Fleming & Sons, John Smith, Harris & Allen, and Allen Brothers, of St. John. The Pictou Foundry, established by Mr. Davies, Sr., in 1854, who came from the old country as master mechanic of the General Mining Association—I. Matheson, formerly located at Chatham, N.B., and later at New Glasgow, and his son W. G. Matheson. The Truro Foundry and Machine Company. The Burrell Johnson Iron Works of Yarmouth, N.S., which built tug boats and small steamers, marine engines of considerable size, waterworks engines, etc. The Montgomery Iron Works at Halifax and Moir Symonds. The Montgomery company built a few locomotives which were used on the Intercolonial Railway.

From 1885 to 1890 the use of electric power for lighting, tramways and other purposes began to develop extensively in the United States and to some extent in Canada. Among the first to foresee and take advantage of the increasing demand for improved high speed engines, suitable for driving electric dynamos direct from the engine shaft, was the Robb Engineering Company, of Amherst, N.S. This concern, working in collaboration with the General Electric Company, Westinghouse Company, and other manufacturers of electrical apparatus, succeeded in producing combined steam engines and electric machine in compact form, adapted to the various services for which electricity was required. The first of these engines was designed and built by the Robb Engineering Company at Amherst, N.S., in 1890-91 under the direction of E. J. Armstrong, who was a pupil of the late Professor John E. Sweet, of Syracuse, New York, one of the best known designers and builders of high speed engines and a great educationist in mechanical engineering.

Mr. Armstrong was able, during the few months he spent at Amherst, through his thorough knowledge of the interchangeable system used in building high speed engines and his natural ability as a draftsman and shop instructor, to organize a department of the Robb works so that they were able to build, with Maritime Province boys, engines for electric service which were equal to the best produced in the United States or elsewhere. He also enabled this Canadian shop to develop its own steam engineering and drafting departments in which engines were designed and supplied for electric work, not only throughout Canada, but, being among the first

in this field, was able to furnish engines of this type to Great Britain, Spain, Australia, India, South America, British Guiana and several of the West India islands. The exceptional compliment was paid to these works of receiving an order for a compound electric engine for use and educational purposes in the Manchester Technical School at Manchester, England.

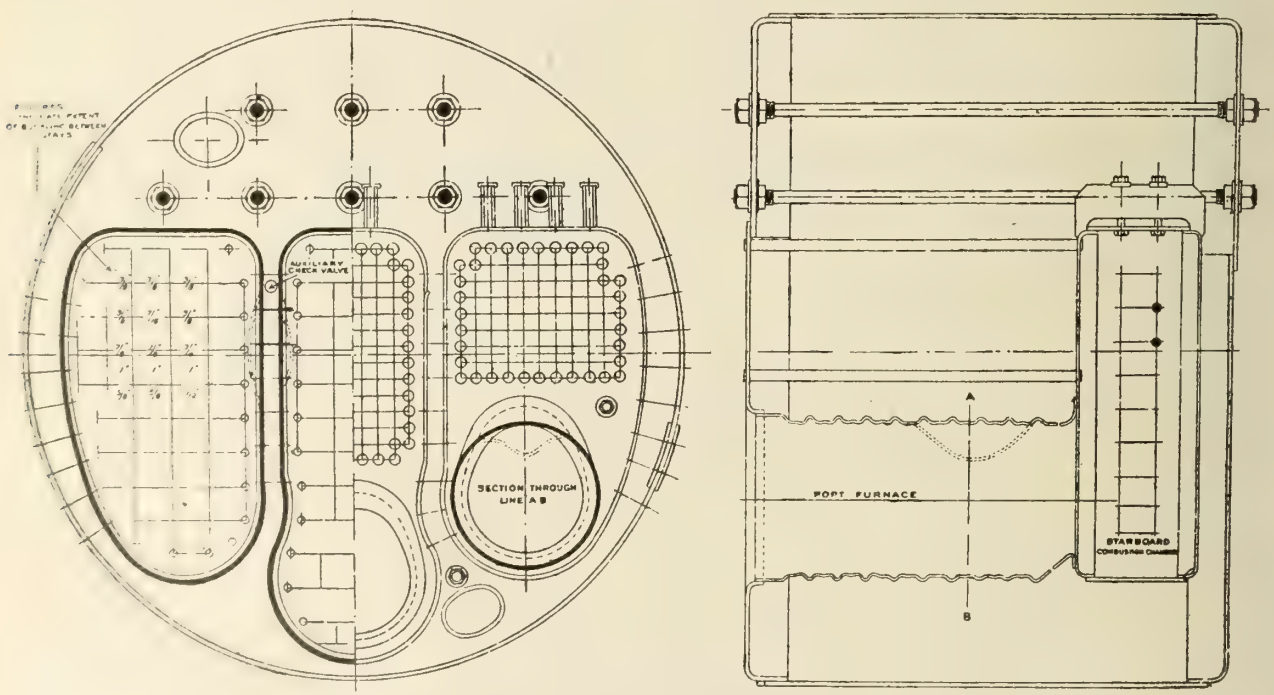
The steam turbine has to a considerable extent supplanted the reciprocating steam engine for large electric units where steam furnishes the motive power. Oil and gas engines are making considerable headway for the smaller units and to some extent for marine use.

The tremendous development of water powers in Canada has also restricted the use of steam engines for electric production, but as yet the marine field is to a very large extent held by the steam engine. In passing it will no doubt be of interest to mention that the triple expansion engines to be installed in Nova Scotia's two largest ships, 8,100 tons each, were built at Amherst. One of these ships the "Canadian Mariner" was launched from the Halifax Shipyards on the 4th of September, and the other is well advanced in construction.

There is no doubt that steam engines will continue to be built and used for ship propulsion for some time to come, or until the rapid changes constantly taking place in engineering construction bring forth something better or more efficient and economical.

Accidents to Scotch Marine Boilers

THIS report of enquiry under the Boiler Explosions Acts indicates the risk due to oil sediment deposit within the area of the heating surface and refers to an explosion from the port main boiler of the steamship "Willaston." The vessel was fitted with three single-ended boilers 15 ft. 6 in. diameter by 11 ft. 10 in. in length, each having three corrugated furnaces, 3 ft. 6 in. diameter, with separate combustion chambers, pressure 180 lbs. There was no donkey boiler. The port boiler, after being examined in April, 1919, was used during a voyage to Montreal and in port for auxiliary purposes till arrival in London on 5th July, 1919, when the fires were allowed to die out and the centre boiler was used in port. Ten days later the fires were again set away and when steam was ready this boiler was used as the auxiliary on the day before sailing from London on July 17th, when the steamer left at 3 a.m. with the gauge glasses showing nearly full up. At about 8 a.m. something went wrong with the port boiler, and the stokehold became filled with steam and dust. The chief and second engineers then tried to reach the boiler tops, but the steam drove them back at each attempt, the safety valves were eased and the engines opened out to full speed; when the steam was reduced the vessel was anchored. It was then found that the port furnace had collapsed near the tube plate end, and evidently the starboard chamber was leaking badly. It was resolved to return to London, where the boiler was carefully examined, when the wrapper plates of the centre and starboard chambers were found bulged, in addition to the port furnace damage. The demands on the steamer were such that time did not admit of the repairs being carried out then, and she sailed for Canada with the port boiler out of action. On her return a thorough investigation of the port boiler was made. The starboard and centre chamber wrapper plates were found to be bulged in from the top row of stays down a distance of about 2 ft. 4 in., the starboard chamber damage being the more severe. The flanges of the combustion chamber back plates were also set in. The starboard chamber plate had been forced over the stays, hence the serious leakage. The port furnace was pocketed about 9½ ins., starting from the back corrugation and embracing four corrugations. The heating surfaces generally were found comparatively free from scale, with no sign of corrosion on plates or stays. Careful examination of the damaged wrapper plates showed distinct signs of overheating, these being most pronounced on the starboard chamber, and there was on the right side a thin deposit of a black powdery substance. The auxiliary check valve is fitted 15½ ins. below the combustion chamber crown, on the back of the boiler between the centre and starboard chambers; no internal feed pipes are fitted, but the chest open-

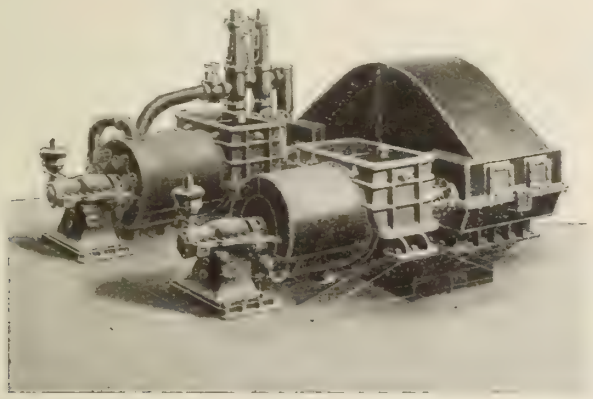


SHOWING LOCATION OF DEFECTS

ing projects about 7 ins. into the boiler with a closed end, and having four rectangular ports on the upper circumference through which the feed flows. An auxiliary condenser is fitted and the feed pump draws from it in port. It appeared from the position of the damaged plates relatively to the check valve that the feed water would be discharged so near that any greasy sediment would be deposited thereon, and the probability is that this is what happened and caused the damage. An analysis of the black deposit found on the plates confirmed this view. The deposit acting on the water side of the plates led to overheating and brought about the collapse. The damage to the furnace was due to the sudden outlet for the water at the combustion chamber plates fractured at the stays, leading to shortage of water on the furnace crown. The inquiry was conducted by Mr. A. H. Longstaffe, Board of Trade surveyor.

Geared Turbines for Swedish Battleships

EARLY in the coming fall, Sweden will try out its two new coast defense battleships, the Drottning Victoria and the Gustaf V. These vessels are 396 feet long, have beam of 64 feet, draught of 21 feet, displace 7,000 tons, and will have maximum speeds of 22½ knots. The main batteries consist of four 11-inch and eight 6-inch guns, and the main armor belt is eight inches thick.



GENERAL VIEW OF TURBINES

The propelling equipment of each of the ships consists of two Westinghouse turbines, which are rated at 22,000 s.h.p., and drive the two propellers through floating frame reduction gears. The turbines were built in accordance with Westinghouse designs by the Motala Verkstads Nya Aktisbolag, at Motala, Sweden, and the gears were designed and built by the machine works of the Westinghouse Electric & Mfg. Co., at East Pittsburgh, Pa.

Each turbine consists of two separate units, rated at 5,500 s.h.p. each, which drive a propeller through a common gear. Steam from the boiler enters the high pressure unit and passes through a set of impulse blades. It then divides into two parts, one of which continues through the high pressure unit, while the other goes into the low pressure unit. In both units the steam is fully expanded in reaction blading and passes into the condenser through a common discharge.

The chief advantage of this arrangement, which is known as the "divided-flow," is that all four units are available for propelling the ship at maximum speeds; but for ordinary cruising speeds, the low pressure units can be cut out, and the ship propelled by the high pressure units only. These, being of the complete expansion type, produce low speeds with good economy. Should an accident put a high pressure unit out of commission, the ship can be propelled by the low pressure units, which are designed to receive steam at boiler pressures. When any unit is out of use, it usually turns idly in a vacuum, but it can be mechanically disconnected.

The divided-flow turbine is not quite as efficient for full speed operation as the cross-compound turbine, in which part of the expansion of the steam is effected in the high pressure unit, and the rest in the low pressure unit. It is, however, more efficient at low speeds because one unit can be cut out, and this makes it especially applicable to naval service. In addition it can be operated at somewhat higher speeds, which tends to counterbalance its slightly poorer efficiency.

The performance of the Swedish turbines, with steam at 265 lbs., and a vacuum of 28.27 inches, is as follows:

Speed, knots ...	22½	20	12½
Propeller R.P.M.	200	177	115
Turbine R.P.M..	3,600	3,186	2,070
S.M.P.	22,000	15,000	3,150
Steam consumption—			
lbs. per S.H.P.	10.9	11.1	13.3

The water rate at 12½ knots is for operation with the high pressure units only. Were all four units, lightly loaded, used to obtain this speed the water rate would be about 17 lbs.

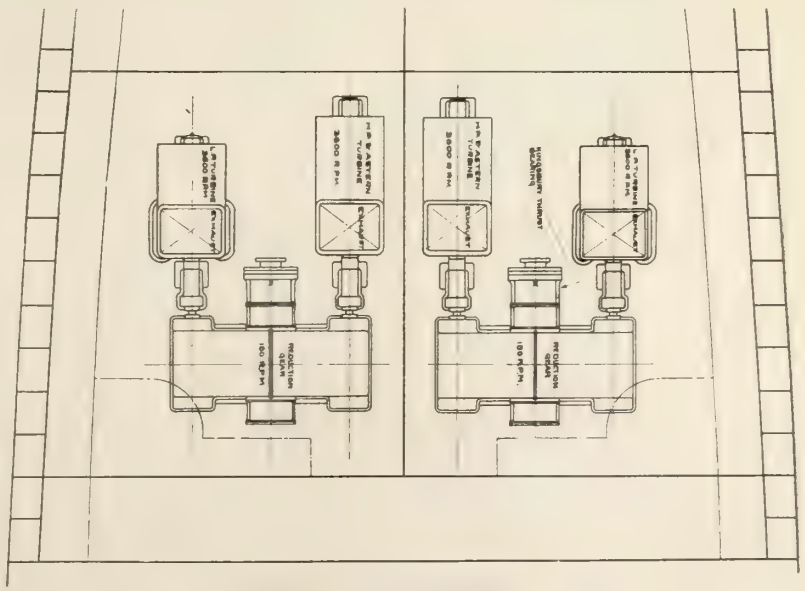
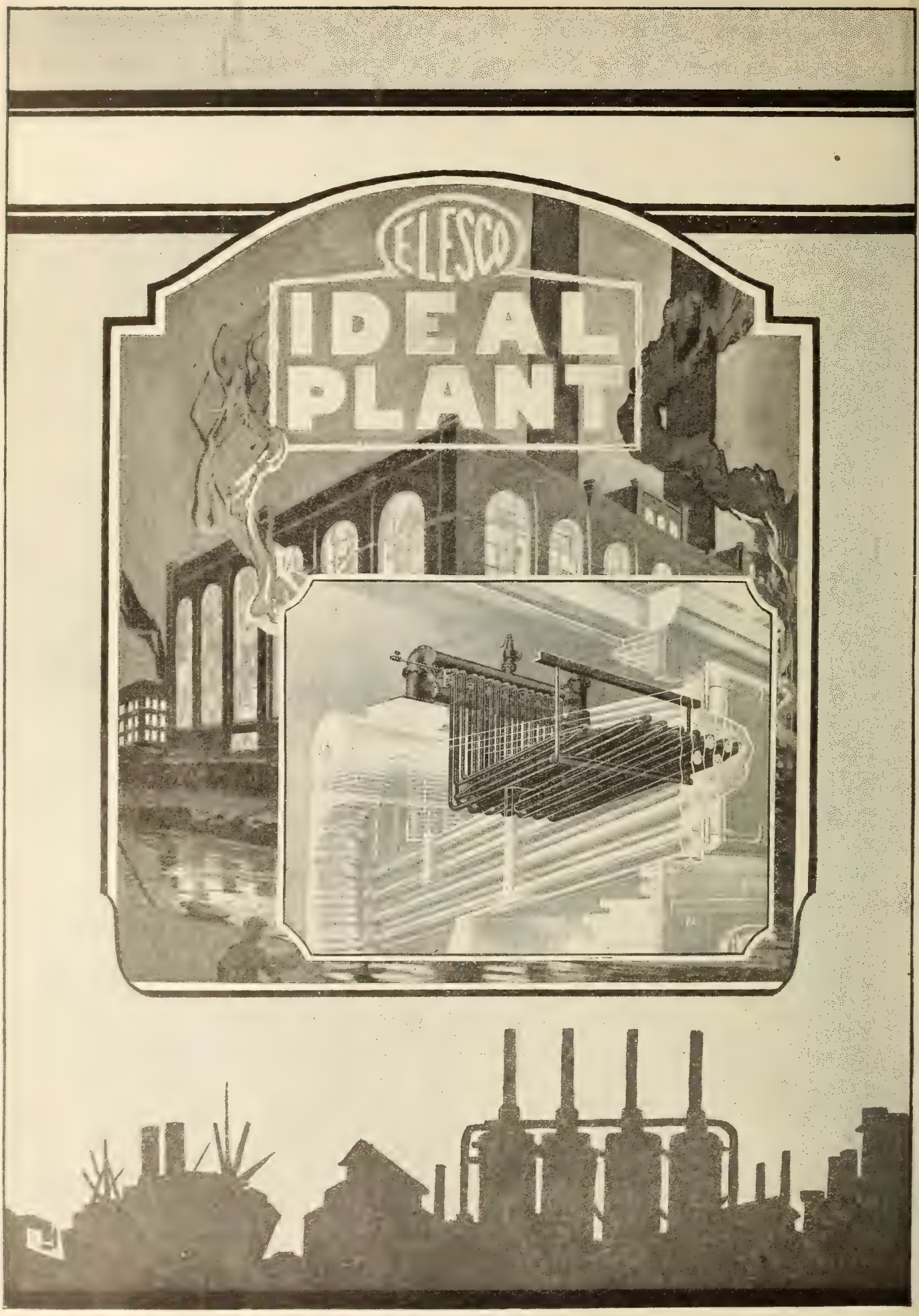


DIAGRAM OF ARRANGEMENT

BRITISH AUTOMOBILE RESEARCH

Automobile engineers in all parts of the world will await with keen interest the receipt of a report recently completed by the research committee of the Institution of Automobile Engineers of Great Britain. The report deals with the physical properties of the ten automobile steels standardized according to the recommendations of the British Engineering Standards Association. Colored charts will be given showing the result of tests of tensile strength, hardness, and other qualities as affected by heat treatment. Automobile construction is becoming more and more scientific every day, and it is evident that British designers intend to keep in the forefront of the advance which depends upon a minute knowledge of the materials employed. Only a limited number of reports will be printed and early application is therefore advised.


ELESCO
IDEAL
PLANT

MADE IN CANADA

An Ideal Attained By
ELESCO SUPERHEATERS

The Correct Application and Use of Superheated Steam

Superheating is too vital a factor in power plant design to be treated in any other way than as an engineering problem.

In the design and installation of Elesco Superheaters 26 different factors are involved. The success of Elesco installations is the result of the correct interrelation of these factors.

Elesco engineers will study your conditions regardless of the size of your plant, and will co-operate with you in order that you may attain the one ideal toward which all discriminating power plant engineers are working—the economical, practical and reliable generation of power through the correct application and use of superheated steam.

An ideal is reached in plants equipped with Elesco Superheaters because guesswork has been avoided.

The Superheater Company,
Limited
Transportation Building
MONTREAL

Works at Sherbrooke, Quebec

Send for Bulletin T-5

Designing engineers and manufacturers of Elesco Steam Superheaters and pipe coils—for all purposes.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE have now got the shell of the boiler complete, except as regards the circumferential seams. In the earlier articles, it was shown that the stress on the circumferential seams was only half of that on the longitudinal seams. Therefore, we have to provide only for an efficiency of something less than 50 per cent. This means that we shall require only single riveted joints on the circumferential seams. Needless to say the circumferential joint is always a lap joint. The rivets should be spaced as closely as possible to maintain a steam tight joint, while still conforming to the requirements of strength. We must figure on having three diameters between centres of rivets, and with ⅞ rivets this would be 2⅝ inches, which would be the pitch. This would give a percentage of 66 per cent., which is ample, and the spacing would allow of a good steam-tight joint. It must be remembered that with a ⅞ rivet the diameter of the head will be about 1¼ inches. The space between rivet heads would then be 1⅜, which is not bad proportion. A larger pitch would increase the percentage of strength, but this is ample. It might be better to use a 15-16 rivet instead of ⅞, as this would allow more metal in the rivet head, which is subject to corrosion, especially on the two end seams. This would still leave ample strength in the seam, for with the same pitch, we would have 64 per cent., which is considerably more than half the strength of the longitudinal seam.

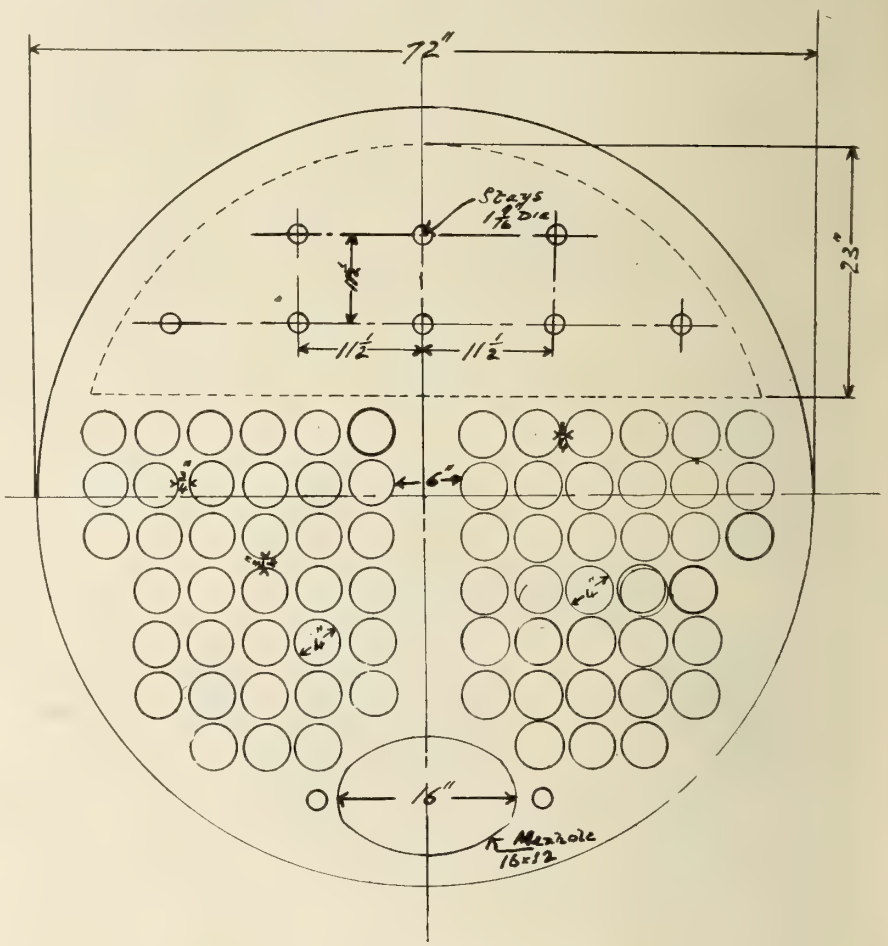
Laying Out Tube Sheet

We can now go about the laying out of the tube sheet; and the staying of the head above the tubes. Referring to our earlier articles, we arrived at 72 as the number of tubes required, and the diameter as 4-inch. As this size of boiler requires a manhole in the front, we have to allow room for this, and also for a man to enter the boiler and reach the back head. He should also have sufficient room to move with some degree of comfort.

The total area of the head or tube sheet of the boiler will be

72 x 72 x .7854 = 4071.5 sq. inches

while the area required by the tubes alone will be 4 x 4 x .7854 x 72 = 906.752 square inches. The minimum width of the ligament between tubes must be ¾ inch, or the sectional area of the ligament, which is width by thickness, must be at least 1-3 square inch, whichever is greatest. The manhole in the front head must be 12 x 16 inches, the long diameter, of course, being the horizontal one. The diameter of the boiler being 72 inches, we may consider the steam space as being 24 inches in height, or one-third the volume of the boiler. As the lowest point of water level must be always at least four inches above the top row of tubes, that will place the height of the top row of tubes at 28 inches below the top of boiler, approximately, or say eight inches above the centre line.



ARRANGEMENT OF FRONT HEAD.

In considering the area available for the tubes, it must be remembered that a certain amount of space is necessary between the tubes and shell, to allow for an ample circulation. This space should not be less than three inches. A certain amount of the head is supposed to be amply supported by the flange, and this amount, as found by the rules given, is also a fair guide for the space to be left between the outside tubes and the shell. This, of course, will reduce the area of head to be considered.

Area to be Stayed

The tubes are all that are necessary to hold the head where they are fitted, but the space above them must be supported by stays, and the area to be supported in this manner is also found by hard and fast rules laid down by the regulations.

Now the height of the unstayed portion of the head above the top row of tubes, we saw, was 28 inches, but this is not the height to be considered when finding the area to be stayed. The allowance made for the support of the flange, and a further allowance made for the support given by the top row of tubes must be deducted. The allowance for the flange is found by the following rule

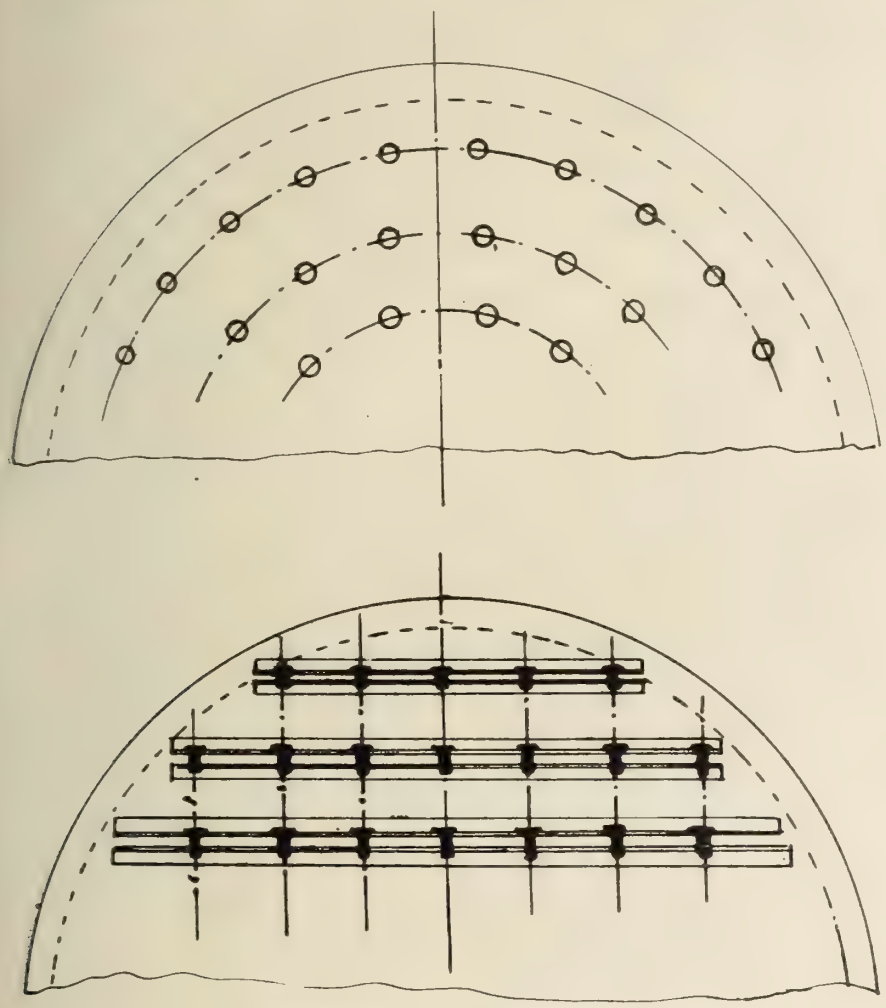
$$\frac{1}{2}\sqrt{\frac{112 \times t^2}{B}}$$

where t=thickness of head in sixteenths
B=working pressure.
If the value given by this formula is

less than the radius of the head flange, the latter value is to be used. We have so far not mentioned the thickness of the head. The thickness of the tube sheet or head is usually made 1-16 larger than the shell plate, so that we shall have a ½-inch head in this case. We then get

$$\tfrac{1}{2}\sqrt{\frac{112 \times t^2}{B}} = \tfrac{1}{2}\sqrt{\frac{112 \times 8 \times 8}{125}} = 3.78$$

or say 3¾ inches.



ALTERNATIVE STAYING METHODS.

The allowance for the support given by the top row of tubes is

$$\tfrac{1}{2}\sqrt{\left(\frac{112 \times t^2}{B}\right)} - \frac{d}{2}$$

where d=diameter of the tubes (outside).

This gives us 1¾ inches as the portion of the shell supported by the tubes. The area of a segment of a circle is obtained by the rule

$$\frac{4L^2}{3} \times \sqrt{\left(\frac{d}{L} - .608\right)}$$

where h=height of segment
d=diameter of circle.

Now our head is 72 inches diameter, but from this we must deduct 3¾ x 2 = 7½ inches, and from the height of 28 inches we must deduct 3¾ x 1¾ = 5½, which leaves us 22.5 inches as the height.

The area of the segment to be stayed will then be

$$\frac{4 \times 22.5 \times 22.5}{3} \times \sqrt{\left(\frac{64.5}{22.5} - .608\right)}$$

= 1012.5 square inches, say 1013.

The total pressure on the unstayed head will be 1013 x 125 = 126625 lbs. The stress allowed per square inch on steel stays is 9000 lbs., if above 1½-inch diameter, or 8000 lbs., if under 1½-inch diameter. Then the total area of stays required will be

$$\frac{126625}{9000} = 14.069$$

say 14.1 square inches.

If we are going to use direct stays we will be able to get in only about eight, and still leave room for a man to enter the boiler. Suppose we take a diameter of 1½, the area of which will be 1.7671 square inches. This, divided in 14.1 will be $\frac{14.1}{1.7671} = 7.9$, or a little under eight stays required.

We can also use the formula

$$\frac{A \times B}{N \times C} = \text{area of one stay}$$

where A = Area of segment;
B = Working pressure;
N = Number of stays;
C = 9000 for steel 1½ square inches net sectional area or over;
8000 for steel under 1½ square inches section;
7000 for iron unwelded;
5000 for iron welded.

$$\frac{1013 \times 125}{8 \times 9000} = 1.76 \text{ square inches.}$$

or 1.49 inches diameter, say 1½ inches. The area to be supported being 1013, and the number of stays eight, the area supported by one stay will be 1013 ÷ 8 = 126.625, and the pitch will be equal to the square root of that area. The square root is 11¼ inches, and in order to get a little more room we can make the pitch 11½ inches. In order to have a margin in the stays to allow for waste of material through wear and tear, the diameter may be increased to 1 9-16 instead of 1½.

Diagonal Stays

Instead of using direct stays we could use diagonal stays, of either round or rectangular section, and in some cases the gusset stay is used, although this is fast disappearing from use. When diagonal stays are used their area must be greater than that of the same number of direct stays. The reason is that the stress on the stay when diagonal is not a direct pull, but a combination of bending and tensile stress. The area of the diagonal stay will then be to that of the direct stay as the base of the triangle made by the diagonal stay is to its hypotenuse. In other words if the height from the stay on the head to top of head is say 20 inches, and the length from head to point of securing stay on shelf is 42 inches, then the length of the stay will be

$$\sqrt{(20 \times 20 + 42 \times 42)}$$

which is 46½ inches. Now if a direct stay would be good for 9000 lbs. per square inch stress, then the diagonal stay would be good for only $9000 \times \frac{42}{46.5}$ = 8130 lbs. per square inch. Taken another way, we might say that we have a direct stay of 1½ inches diameter, to be replaced by a diagonal stay. The diameter required for the diagonal stay will be greater. We may state it thus

1.5² x .7854 : area of diag. stay :: 42 : 46.5
= 1.959

and the diameter will be 1.579, or almost 19-32 inch.

Diagonal stays possess one advantage over direct stays, in that they leave the larger portion of the boiler over the tubes clear. This facilitates examination, which means very often

that the boiler receives better care than it would with direct staying, where moving around inside is difficult. When diagonal stays are used they are secured to the head and shell by riveting, double angle bars are riveted to the head, and the stay secured, by making an eye in its end, and passing a pin through angle irons and stay. These angle irons also serve to stiffen the head. Another method of staying is by gusset stays, where the angle irons are secured to both head and shell, and a triangular plate riveted to both angles. This method is but seldom used, and is mostly found in old boilers. A diagonal stay much used now is known as the Heuston stay, and is made of pressed steel of peculiar formation. It is of rectangular section, but a portion of the stay is doubled over on itself, longitudinally, as shown, which gives the stay a greater flexibility than a plain stay, while retaining its strength.

Stays that are secured by rivets to head or shell must have enough rivet area to be 20 per cent. greater than the stay section. When stays are secured by a pin passing through angle bars and stay the pin is in double shear, and can be reduced to 25 per cent. less area than the stay. This is not particularly good practice, as by leaving it the full size ample material is left to make up for wastage by corrosion.

When diagonal stays are used they are usually laid out on concentric circles round the head. As they are much smaller in diameter than the direct stay more of them must be used. In a boiler of the size we have been considering we would require about 15 or 16 stays.

Supposing we were to use diagonal stays of round section, with the feet welded to the stay. We could only allow 5000 lbs. per square inch on these stays, and we would therefore require 29.325 square inches. That would require about 20 stays 1⅜ diameter. As these stays would not be all at the same angle to the head, the relative value of

$$\frac{H}{L}$$

would be different at different rows and these would have to be reckoned on after their position was determined.

If gusset stays are used, they must have an area of 10 per cent. greater than that required for diagonal stays. The area of a gusset stay is the thickness of the plate, multiplied by it at the narrowest part. There must, of course, be sufficient rivet section securing the angles to head and shell to equal the stay.

The most satisfactory diagonal stay to use is the Heuston, on which the full value of 9000 lbs. per square inch may be allowed. By this method the least number of stays are required, and the requirements of ample strength combined with plenty room are fully met with.

It may be added here that when direct stays are used various allowances are given according to the method of securing them. If fitted with nuts inside and outside, and when washers are fitted, or doubling plates, the highest allowance is granted. The various allowances are stated in the Ontario boiler regulations, and will, of course, be available to candidates for examination when they are required for the problems.

POSSIBILITIES OF IMPROVED REFRACTORY MATERIAL

THE deterioration of refractory materials in boiler furnaces interests the operator primarily from a dollars and cents standpoint. The usual causes of failure whether they be physical or chemical seldom arouse a deep enough interest on the part of the engineer to determine the underlying reasons with a view to improvement of the product. If one material does not measure up to the standard of usual operation other brands are used, this cycle being repeated until something is obtained that suits. During this course of events if any real effort is made to solve the causes of deterioration, the effect on the industry is not particularly visible.

The reasons for this are probably many, but a few are ventured here. The development of more efficient furnaces in recent years has brought about higher maintained temperatures and other conditions of more or less increased severity. The refractory manufacturer on the other hand has apparently failed to parallel this development in the production of a material of a higher degree of refractoriness. Whether this is due to self-interest or because of the limitations of the fundamental principles of ceramics and chemistry involved, is hard to state, but the opinion of many engineers is that it is a little bit of both. Also it can be said that most engineers are more familiar with the physical performance of refractory material than with the chemistry involved, the latter being generally considered far-fetched. In consequence the co-operation between user and manufacturer toward improved material is limited in this respect, and it furthermore appears that the chemistry involved in the manufacture and use of refractory material is the province of the maker entirely. The ultimate service durability of the material is in the final analysis the gauge of its fitness.

The requirement of a high grade refractory material for boiler furnaces are probably quite familiar to most engineers and need no detailed explanation here. However, the chief requirements are physical and those dependent upon chemical phenomena appear secondary as far as actual practice indicates. The problem then is to obtain the limit of possibilities with the materials available and in this research chemistry is probably the best guide.

The refractoriness of a fire brick depends on its fusion point, in fact, the terms mean the same thing. The service of fire brick often depends on the percentage of silica and alumina in their composition and the conditions under which they are used. In some cases a high silica would be preferable and in others not, excess of silica in brick under conditions where there is excess heat with frequent coolings, failure is caused not due to refractoriness but to the destruction of the bond caused by the frequent expansion and contraction. The conclusions drawn from laboratory experiment tell us that the fusion point of a material is function primarily of the relative proportions of silica and alumina contained, and that the maximum possible is when certain definite percentage of these elements are combined. Also the amount of silica free or combined in the form of kaolin enters as a factor. The percentage of fluxing impurities if exceeding a certain degree affects the fusibility of a material adversely. Other compounds such as ferric and titanium oxides are supposed to exert certain specific influences depending on the amounts of each present. It is thus evident then that even with the highest grade of fire clay from a chemical standpoint there is an absolute limit to the possible refractoriness in fire brick due to the nature of things.

The experiments of Segar using pure mixtures of silica and alumina indicate that the maximum fusing point is about cone No. 32 (about 3,200 deg. F.), but this would be under circumstances that would not be likely with natural clays, due to impurities and the difficulty of obtaining uniform proportions. Actual practice in the later furnace development now has to deal with temperatures of 3000 deg. F., and over. The theoretical working margin of refractoriness is under these circumstances seen to be about 200 deg. and as a matter of fact, it is probably much less than this. All this would be the case where all requirements from a chemical or analytical standpoint were fulfilled to the highest degree possible.

These limitations do not take into account those that can be classed as physical, such as strength, texture, bond and uniformity of mixture, and of all the causes of deterioration and failure, more are traceable to these and other physical conditions than to chemical phenomena. A fire brick may fulfill all the requirements of laboratory and chemical tests and still be unfit for the service required of it. If, on the other hand, all physical requirements were fulfilled, the margin of refractoriness of a material is after all not necessarily increased.

Much has been said of the chemical deterioration of refractory material but the support of these contentions with coal burning stokers is rather vague. In the actual observation of performance, the general opinion seems to be that cause and effect from this source is minor and beside the real effects, the action of slag and spawling are perhaps the most objectionable conditions where

(Continued on page 475.)

The Operators' Point of View

RECHARGING DRY CELLS

While considering the making of things electrical, what about the dry cell? Numerous descriptions of how to recharge such cells with an electric current have been published. I have yet to see such a cell properly recharged by such means. The easy, best and cheapest way to recharge dry cells is as follows: Remove the filling, including the paper around the inside of the zinc shell. Save the carbon. Place three thicknesses of blotting paper around inside the zinc case. Dissolve some ground salammoniac in water and saturate the paper with the solution. Place the carbon in the centre and fill the space between the carbon and blotting paper with powdered coke, or even sawdust if coke is not to be had. Fill around at the top to a depth of 1-4 inch or so with wax, pitch or shellac. Solder any holes there may be in the zinc and the battery will be as good as ever.—J. N.

THE BELL RINGING TRANSFORMER

The article by Robert G. Flavius on page 448, Oct. 5th Power House, describing how to make a bell ringing transformer makes interesting and profitable reading for the man who has never studied such transformers. However, anyone who does not take a pleasure in building such articles will find that outside of the cost of material considerable work is necessary, and when work is not a pleasure it is simply labor. Such men can make a "spark coil" bell ringing transformer. An old spark coil can be secured from any auto repair shop for a small sum for much less than the material would cost to build one. By removing a few turns of the secondary winding, a perfectly satisfactory bell ringing transformer can be made about two layers of the outside winding removed would be about right. Although such a transformer will work all right in bell ringing it will not light a 10-volt lamp, but it will light a 2-volt lamp and will drive small electric toys. It is obvious that it will not be so powerful as the one described by Mr. Flavius.—J. E.

THREADED FITTINGS

Question:—Kindly let me know up to what size of steam pipe can threaded fittings be used, for a working pressure of 125 pounds per square inch.

Answer:—There is no limit as to size in using screwed fittings, provided they are of suitable material. The pressure you mention only calls for standard fittings. For convenience in erection, and in making repairs, connections between lengths of pipe are made with flanges instead of unions in all sizes above 2 1-2 inches, but the flanges themselves are of course screwed onto the pipe. Large fittings such as elbows and tees for pipe above 8 inches diameter should always be flanged instead of screwed. It is a matter of selecting the most convenient type of fitting for the job in hand.

HAMILTON NO. 2 LODGE MEETING

The last meeting of the Hamilton Lodge of the C. A. S. E. was favored by some distinguished visitors, in the persons of Grand Lodge President R. C. Leach, of Toronto, Past President A. M. Wickens and F. C. Harding, also of Toronto. During the evening two candidates were initiated and one new application was received. The educational side of the meeting was furnished by a paper on Combustion read by Grand Lodge Secretary L. J. Ellis, which will be taken up and discussed on the 1st November next after the regular meeting of the lodge. The visiting brothers addressed the lodge, and urged the Hamilton members to give Toronto a hustle. A committee was appointed to make arrangements for a return visit to Toronto.

SAYS COAL PRICES NOT JUSTIFIED

Values Should Come Down in a Short Time Is the Claim Now Made

Washington.—Reductions in coal prices may be expected soon, Charles L. Couch, president of the American Wholesale Coal Association, announced.

Mr. Couch, following a meeting of the executive committee of the organization at which the entire coal situation was canvassed, declared that it is the opinion of the committee that a great change in the whole coal market situation is imminent. He suggested to buyers of bituminous coal who have a month's supply in storage to confine their purchases to immediate needs.

MONEY FROM "WASTE" COAL

Close to the pit-head of many coal mines there lie huge "tips" of small coal. When coal of good quality was cheap, these tips were looked upon as waste because the heating value of the stuff was so small that no one would pay enough to cover the carriage. The huge increase in the cost of coal has, however, turned attention to the economic possibilities of these heaps of low-grade fuel. A large company has been formed to acquire the heaps and to transform the coal dust into briquettes of a form and composition suitable for domestic and industrial purposes.

May Buy Blower.—City Engineer Gray of Toronto urges that the city purchase a soot blower for the boilers at the beach pumping station. Mr. Gray contended that it would lessen the time needed to clean the boilers at the station. The recommendation was referred to the chairman and controller of the works committee and the city engineer.

POSSIBILITIES OF IMPROVED REFRACTORY MATERIAL

(Continued from page 474.)

the fusion point and all other properties of the material are satisfactory. It seems a rather imaginative deduction to connect these actions with chemical deterioration. Chemical analysis on material before and after failure is too inconsistent to allow of reliable conclusions. A favorite excuse of the manufacturer for premature failure of refractory material is that there is a chemical reaction between some element in the brick and some constituent of the flue gas. If this were true, no doubt some revision of the laws of chemistry would be in order.

The refractoriness of a fire brick cannot be entirely judged on chemical analysis of the material, although in a general way they should indicate whether the same is of a high or low degree. It is often the case that deductions from a chemical analysis are flatly contradictory to actual performance.

It would in general appear that the solution of the problem of making material of a higher degree of refractoriness is in some new compound having all the physical qualifications of natural clays with increasing fusion point. This means a manufactured substance. Some effort has been already made along this line, and many engineers look with increasing interest to the possibilities in the development of the new carborundum products.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)

A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York. Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, OCTOBER 20, 1920 No. 20

PRINCIPAL CONTENTS

The Utilization of Low Grade Peat for Fuel	457
The Advantages of Superheated Steam	460
Development of Long Distance Transmission	463
Theoretical and Practical	465
Steam Engine Development in the Maritimes	467
Accidents to Scotch Marine Boilers	468
A Course of Instruction	472
Editorial	476
Progress in New Equipment	478

100,000 Revolutions Per Minute

THE present-day tendency towards ever increasing speed has been often deplored by the more staid and conservative elements of the community. Where the endeavor to procure speed has only been actuated by a desire for new sensations, this disapproval is, perhaps, well merited. All speeding-up processes are not developed with such meretricious objects, and in the field of industry speed is a desirable thing, both in general production and in the details which make rapid production possible. From this necessity have arisen the various high speed machine tools, and high speed cutting steel, with which we have all become familiar in recent times.

To what extent this tendency has developed was forcibly brought home to us by an account of a high speed grinding spindle attachment recently exhibited by a well-known British firm of tool makers. Grinding is one of the operations in metal working where speed is of great value, and especially on small internal work, such as lapping gauges, internal tapers, bushings for precision tools, etc. The wheels employed are of necessity very small, and this permits of the attainment of high speeds. The higher the speed of the abrasive surface, the less tendency will there be for the surface of the metal being dragged, and thus roughened, a condition strictly to be guarded against.

Practice in grinding had reached a point where these wheels had been revolved at 75,000 revolutions per minute, which is a very respectable rate for any spindle to revolve. The spindle we are alluding to exceeds this speed by 33 1-3 per cent. That is, it is guaranteed to be capable of running safely at 100,000 revolutions, and has been run at a speed of 104,000 revolutions per minute.

This is getting to a point where the mind fails to grasp the significance of the figures involved at the first glance. Try to picture a small spindle and the wheel mounted on it which makes a complete revolution in just .0006 of a second. If the spindle on which the wheel is mounted is one-half inch in diameter, its circumference would cover a distance equal to 13,090 feet, or almost 2½ miles per minute. A locomotive with a 5 foot diameter driving wheel would have to turn that wheel 833 times a minute to attain the same distance in the same time. The spindle, of course, will, on the smaller sizes of wheels, be of less diameter than one-half inch, because it is very obvious that with a wheel of ½ inch or ⅝ inch diameter, one could not well have a ½ inch spindle.

The wheels for this speed must be of good construction, for they will have to resist the force tending to tear them apart, due to the speed. Of course, they will be of no great weight, probably averaging 2 to 4 ounces. Suppose the wheel weighs only 2 ounces, and is of one inch diameter, the force tending to make it fly off at a tangent, or the centrifugal force would be equal to about 18,000 lbs.

These figures seem hard to realize, and they serve to show what has been reached in engineering practice when such speeds can be employed with perfect safety. There can be no doubts as to the material employed, or the manufacturing methods used, when speeds of one hundred thousand revolutions per minute can be guaranteed.

Spontaneous Combustion in Coal Piles

EVERY year a considerable amount of heat units are lost by the heating and partial combustion of coal contained in storage piles. A large amount of this loss, like so many of the other wasteful losses, can be prevented if proper measures are taken in time. With the object of finding the proper preventive measures, the engineering experiment station of the University of Illinois has been conducting an investigation into the storage of bituminous coal, and has published a bulletin of the information thus obtained. The book is entitled "Bituminous Coal Storage Practice," and is Bulletin No. 116 of the Engineering Experiment Station. The authors are H. H. Stock, C. W. Hippard, and W. D. Langtry.

From a vast number of observations and answers to questionnaires from coal users all over the United States, a number of general conclusions have been drawn, and the suggestions contained in these conclusions will, if observed, tend to reduce the danger of spontaneous to a minimum. Those users of coal who store large amounts should procure this bulletin and read it carefully, but the general conclusions drawn should be of value to all coal consumers. The bulletin points out that storage is a good thing, in that it stabilizes the operation of coal mines, assists in equalizing freight traffic, and ensures the consumer a regular supply of coal. Attention is drawn to the necessity of preparing the ground for coal storage. This should be dry, with good drainage, although if it is necessary to instal artificial drains, these should be made around the pile and not through it, as putting a drain pipe through a coal pile is only a way of supplying air to support combustion, should it get a start. Furthermore, the ground should be well cleared, as this assists in reclaiming, and prevents the pucking up of a large amount of refuse when the bottom of the pile is reached. This is very wise advice. Space should be left, if possible, around the pile, so that the coal can be easily moved should it be necessary to uncover the seat of a fire. The summer months are

naturally the best time to store coal, but these are also the hottest months, and coal is likely to be at a high temperature when it is unloaded from the cars. Being a poor conductor of heat, the lower layers retain their high temperature, and are very liable to spontaneous combustion. Coal should, if possible, be piled in equal sizes, and sized coal should not be piled on top of slack or screenings, so that it is advisable to keep the piles as clear as possible of this class of coal. Of course, some piles are composed entirely of small sizes, and these require watching.

Coals high in sulphur are not desirable for storage, as sulphur, while not the chief cause of spontaneous combustion, as was previously thought, yet the oxidization of the sulphur not only produces heat, but also breaks the coal up into small pieces, thus indirectly assisting the heating by exposing more surface. There is no definite knowledge as to the effect of moisture in coal, the evidence being contradictory, but the repeated wetting and drying of coal increases its tendency to spontaneous combustion. It is suggested that it is not wise to put wet coal in a pile, or to store coal on a damp base, and, furthermore, a coal pile should be carefully watched after a snow or rain storm.

When fire is discovered the coal should be removed till the heated part is found, and this should be used at once if possible, or, if not, removed to another place. Only in case of actual necessity should water be used, although it is considered advisable to have hose laid handy in case of need. It is noted that according to American practice, ventilating the piles has not proved advantageous, but in Canadian practice it has. This is attributed to the fact that the Canadian system is more perfect. The advice regarding inspection is the most valuable part of these conclusions. The only real indicator of the condition of the pile is that of temperature, and when this approaches 140 degrees F. the pile should be carefully watched.

If the temperature continues to rise it should be moved when the thermometer shows 150 to 160 degrees, and the coal thoroughly cooled before being replaced in storage, or better still, be used right away. If the temperature rises very slowly, the pile must be watched carefully, but it need not be moved at as low a temperature as 150, as with a slow rise it may recede again. Coal is said to commence to smoke at 180 degrees, but it should be moved before smoking actually occurs, as when the coal is smoking combustion is pretty well advanced, as may well be imagined. Steaming is not to be confused with smoking. In fact, temperature tests should be carefully made at frequent intervals, and these alone used as a guide.

The bulletin not only contains much information on precautionary methods, but also on methods of unloading and reclaiming coal to and from the storage piles. The University of Illinois is conducting a very valuable work in the various engineering investigations they are conducting, and in making the results available to the whole engineering public.

An Unpleasant Experience

A RECENT news item contained an account of an action brought by the parent of a boy who had been inadvertently locked in one of the cold rooms of a packing plant for a period of twenty-four hours. The result of his imprisonment was to make him lose his reason, and substantial damages were sought by way of compensation. Of course, no monetary compensation could ever make up for the loss of reason, though it might, to some extent, for loss of earning power. The item recalled another incident of the same kind which did not end fatally, but gave the actors in it a very bad time for a few hours. The manager of a packing concern and his consulting engineer were making a tour of the cold rooms in the plant, and towards late afternoon entered a room the temperature of which was about 4 degrees above zero. The room was entered through an air lock, the doors being without handles on the inside, and as they did not intend to be more than a very few minutes inside, the doors were just pulled lightly to, without being fastened. Evidently no one saw them enter, but someone passing by noticed the doors were not tightly closed, and very carefully entered the air lock, and closed the inner door, and retired, closing the outer door after him. The two men inside having finished their inspection, arrived at the door on their way out and found to their horror that they were imprisoned. There was no means of communicating with the staff in the engine room, and no likelihood of anyone visiting the room for the next eighteen hours. There was, on the face of it, an excellent probability of their frozen carcases joining those put in there on purpose. The plant manager, unused to facing emergencies, promptly collapsed and became, for the moment, incapable of thought or action. The engineer, possessing a greater amount of self-reliance and initiative, promptly began to canvass means of escape. The doors were of one-inch wood, laid on studding, with an air space, making two thicknesses of one-inch flooring board, and the air space was tightly packed with insulation. Looking around the room, they were fortunate enough to find a piece of 4 by 4 lumber, which had been left inside by a providential piece of carelessness on someone's part. With this as a battering ram the inside door was attacked, and, after working in relays for about two and a half hours, an opening was made in the inner door large enough for them to reach through and knock the handle open. They were thus half-way out, and by this time fairly well exhausted. Their exertions with the battering ram had, of course, served to keep them from freezing, but in the intervals of working they cooled off rapidly, and while at work carried on with feverish energy. The same good luck which had attended their finding of the batten, again came to their aid, for the first thing the engineer saw when they got in the air lock was an expansion valve on the cooling coil for that room. Here he had an excellent means of calling somebody's attention to their plight, and he promptly availed himself of it. He opened the expansion valve wide, and the natural results in the engine room brought a puzzled engineer in quick time to look for the trouble. His surprise when, on opening the door, he was confronted with his bedraggled and very much frightened employer may well be imagined. That particular plant manager will not go into a cold room for any consideration that can be mentioned since that day, and he was many weeks before fully recovering from the experience.

Neither of these cases should have happened if ordinary precautions had been observed. It should be a fundamental principle among men whose vocation takes them into such positions to observe ordinary precautions. No man should enter a vault, cold room, steam boiler, gasoline tank, or any other place where he is liable to be inadvertently locked in, or become overcome with gas fumes, or scalded by the opening of a valve, without stationing a man at the entrance, with instructions to stay there till they come out. It is not always convenient to do this, but a bit of inconvenience is not to be balanced against danger to human life. Safety first is an excellent motto, even though, like many other good things, it is carried to ludicrous lengths by some enthusiasts. Presence of mind and resourcefulness are excellent qualities to get one out of a tight hole, but the same qualities exercised before getting into the hole obviate the necessity of getting out. Prevention is better than cure.

Cheapening Propulsion

THE progress that has been made in increasing the efficiency of ship propulsion, is well pointed out in connection with the launching of the Cunarder Scythia, at the yards of Messrs. Vickers, Ltd.

The old Scythia, which was in use in 1875, required 17 pounds of coal to move 100 tons of cargo one mile, whereas the new vessel burns only four pounds of coal or three pounds of oil while conveying the same weight at the same speed for the same distance.

Progress in New Equipment

FLUE CLEANING RATTLER

The Baird Pneumatic Tool Co., Kansas City, U.S.A., have placed on the market a flue cleaning rattler and unloader as shown in accompanying sketch. This machine is a friction and not a drop rattler. It cleans by friction, first removing the scale, then using this scale in powdered form as a scouring medium.

It is capable of handling, at one rattling, a full set of boiler tubes averaging 250 to 300 flues, cleaning them throughout their entire length inside and out, in from one to six hours, depending upon the hardness of the scale. Any length flues up to 24 feet can be cleaned, the adjustment for length being obtained by a moveable piston head in the drum. A six-inch play permits of a slight lateral motion, but not enough to allow the flues to become tangled and destroyed.

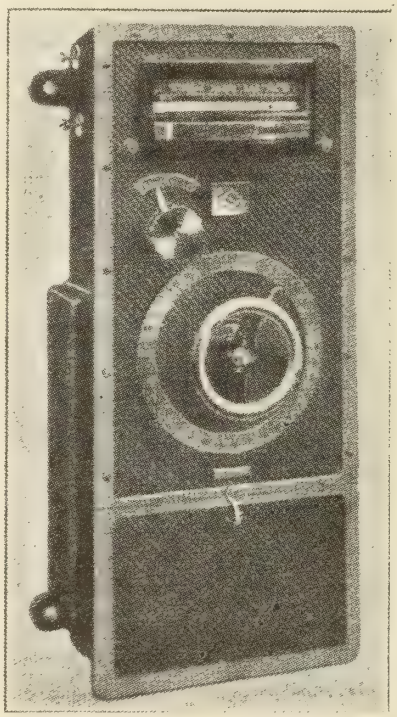
No dust is allowed to escape into the shop as the scale is gradually worked to either end of the rattler, and from there into the dust rooms provided for its accommodation.

The cleaned flues are unloaded by being pushed from the rattler by compressed air out through an end door into a push car, ready to be safe ended and installed.

Power is applied to rattler by either belt or chain, and in some cases by direct motor drive. The machine is adapted for all classes of fire tube boiler flues, handling large diameter super-heater flues as efficiently as the smaller sizes.

AN ELECTRICAL CO_2 RECORDER

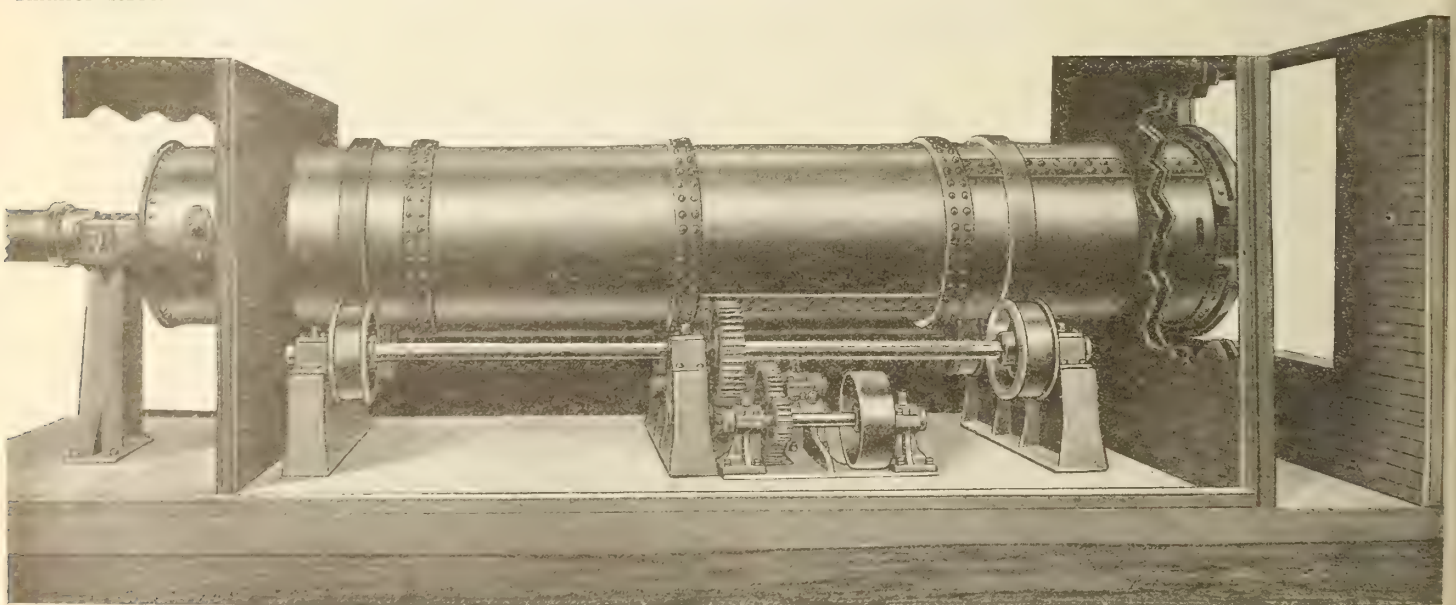
The Cambridge and Paul Instrument Co., of Cambridge and New Southgate, London, England, have been exhibiting



ELECTRICAL CO2 RECORDER

at the machinery exhibition at Olympia, London, a novel CO_2 recorder which uses no chemical absorbent. The method has been devised by Dr. Shakespear, of Bormingham University, and employs an instrument known as as a katharometer, which compares the composition of the flue gases to that of air. The instrument consists of two spirals of platinum placed in two cells formed in a copper block, and each spiral is connected in such a manner that it forms one of the arms of a Wheatstone bridge. If a current of sufficient magnitude is passed through this circuit the platinum spirals will be heated and impart heat to the cells, and if these cells contain gases of different thermal conductivities the spirals will give off their heat at different rates. The resistance of the spirals will vary with their temperature, and this property is taken advantage of by connecting a galvanometer across the circuit. This will give a deflection depending on the difference in the rate of coolint of the spirals, or in other words, the difference in conductivity of the gases in the two cells. If one cell contains a pure gas, and the other the same gas with a further additional constituent, the amount of the deflection of the galvanometer will be a measure of the additional gas. The difference in the thermal conductivity of air and CO_2 makes it possible to employ this method to determine the amount of CO_2 in the flue gases. The machine is described in detail in the "Engineer," as follows:

The katharometer and water aspirator are the two principal arrangements used. One of the cells of



FLUE CLEANING RATTLER AS INSTALLED INSIDE A PLANT WITH DUST ROOMS ON THE END.

the katharometer communicates with a chamber through which the flue gases are drawn by the water aspirator, whilst the other cell, which is filled with air, is connected to a tube which contains some water, so that the air in the katharometer is saturated. The method of applying the instrument to a boiler is clearly shown in the cut, from which it will be seen that a soot filter box containing glass wool is connected in circuit with the katharometer—for the purpose of cleaning the gas supplied to the instrument—by the vertical pipes projecting into the side flues. Details of the soot filter are also shown. A final filter is also fitted, as shown, next to the katharometer. The aspirator, it will be noted, is connected up to the water supply and works on the well-known principle. When a sufficient drop in pressure can be obtained behind the economiser a vertical pipe, shown dotted above the aspirating device can be carried directly to the chimney stack instead of using the aspirator for drawing the gas through the meter. Assuming the aspirator to be used, however, the flow of water is adjusted so that it runs freely out of the fine tube at the bottom. The function of the U tube shown on the front of the aspirator is to indicate the presence of any obstruction in the gas supply pipe, and when the aspirator is not working it indicates the chimney draft. The water consumption amounts to approximately five gallons per hour.

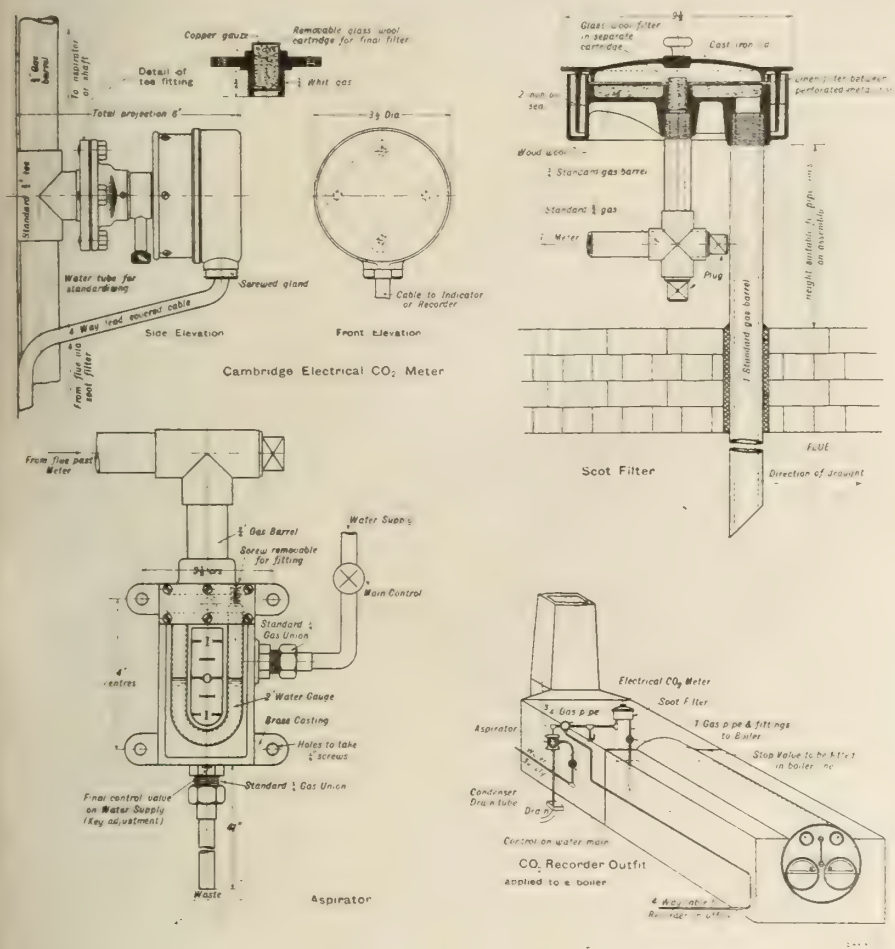


DIAGRAM OF METER CONNECTIONS.

The records are obtained by means of a recording thread galvanometer having a suspended coil and a pointer, which is depressed every minute and a-half on to a thread placed just above the revolving drum. This thread is impregnated with ink and every time it touches the chart it makes a mark which records the position of the pointer at the moment it touches the thread. Between the times of marking the pointer is allowed to swing freely to take up its new position. The series of dots obtained forms a record of the varying positions of the pointer, and because of the manner in which the charts are calibrated gives the percentage of CO_2 in the gas tested. The katharometer terminals are connected to the recorder by four-strand lead-covered leads, which may be of any desired length. Current for working the instrument is obtained from a 2-volt, 4-ampere-hour battery.

Electrical Distance Thermometer

Reference should also be made to the company's electrical distance thermometer, an example of which is shown. These thermometers may be used for measuring all kinds of temperatures, such as steam, oil, and air temperatures. Though the instruments were originally introduced for steamship use, they are equally applicable to ordinary power plants and, in fact, may be used in all places where temperatures have to be measured. The instrument from which the temperature is read can be fixed in any position, such as in an office, and by means of a plug switchboard or dial switch, as shown, a number of different circuits connected up to electrical thermometers can be joined to the instrument in succession, so that the switchboard operator can readily ascertain various temperatures without leaving the office or other place in which the indicating instrument is fixed. Other exhibits of the Cambridge and Paul Instrument Company included resistance pyrometers, thermo-electric pyrometers, an electrical pyrometer for locomotives, radiation and optical pyrometers, mercury-in-steel thermometers, dial thermometers of the vapour tension type, draught and pressure gauges, etc.

RISKED HIS LIFE TO SAVE WORKER

Construction Foreman on Steel Work Rescues Worker From Sure Death

It is understood that the name of Joseph Mouldey, 32 Carlton Street, Toronto, is to be submitted to the Royal Canadian Humane Society for an exceptionally brave act in saving the life of Frank Carvell, a fellow-employe of P H. Secord & Sons, where that firm is building the extension to the King Edward Hotel.

Carvell had ascended the 150-foot mast of the steel hoist to oil the mechanism at the top. While he had his hand in the machinery, the men below started the hoist going. Carvell's little finger and the ends of all the other fingers on his left hand were taken off.

Saved by His Glove

He shouted frantically, attracting the attention of the workers on the ground. Mouldey, who is foreman, immediately started up the mast, having only the cross iron work to climb on. Well before he reached the injured man the latter had fainted. His glove catching on a projecting piece of metal, he was hanging in the air.

Mouldey caught the senseless form, released the glove and started to carry Carvell down in his arms. Very slowly, Mouldey succeeded in getting down to within some thirty feet of the nearest platform, when other workers reached him to assist. He was so exhausted that he had to be practically carried down the rest of the way himself. When he reached the platform his face was bleached and he could not stand.

Men who saw it done did not believe that Mouldey could complete such a difficult journey with his heavy load, as the means of climbing were so awkward.

Cutting of Steel Plates, Castings and Billets

Rapid Cutting of Metals by Radiograph and Oxy-Acetylene Torch Are Described—This Matter Should Interest Steel Mills, Boiler Shops, Shipyards, Locomotive Shops, and Machine Plants.

By J. H. MOORE

TO the uninitiated, the accompanying illustrations will cause considerable surprise, and believing an article dealing with the details and uses of such a machine would interest our readers, we have prepared the following:

The machine to be discussed is known as a radiograph and is manufactured by the Davis-Bournonville Co., Jersey City, N. J. It is used for varied purposes as the photos will clearly show. To convey an adequate idea of the power adaptability of such a tool is impossible by illustrations alone. Seeing the machine in actual operation is a very different matter. Were one to go through some of the large shipbuilding plants and watch these machines cutting plates, angles, billets, heavy forgings, etc., etc., they could then realize its wonderful power.

Briefly the machine is of portable nature, weighing about 50 pounds and designed for cutting all thicknesses of steel from ¼ inch to 20 inches, or more. The speed of cutting varies with the thicknesses, but not directly. For instance, the cutting of billets 10 inches thick is accomplished at a rate of about five inches per minute and approximately the same rate is employed on thicker sections up to 12 or 15 inches. A billet 18 inches square was cut off at the League Island Navy Yard in 6½ minutes, and about the same rate would be used for cutting billets 20 inches thick. The reason for this is that higher oxygen pressures are employed and the combustion rate is maintained throughout the kerf of a heavy section at nearly, if not quite, the same rate for all thicknesses from 16 to 24 inches.

We do not know what the ultimate limit of thick cutting with this machine really is. It might be placed at 24 inches, but development now in progress will probably make it feasible to cut 30 inches, if not 36 inches. A reason for this indefinite limitation is an indefinite demand. The construction of large battleships and fast cruisers now in progress requires the use of forgings much heavier than ever used before, and this method of cutting is widely employed for such class of work.

The machine is used to cut either straight or curved lines, using a grooved track to guide for straight cutting, and a

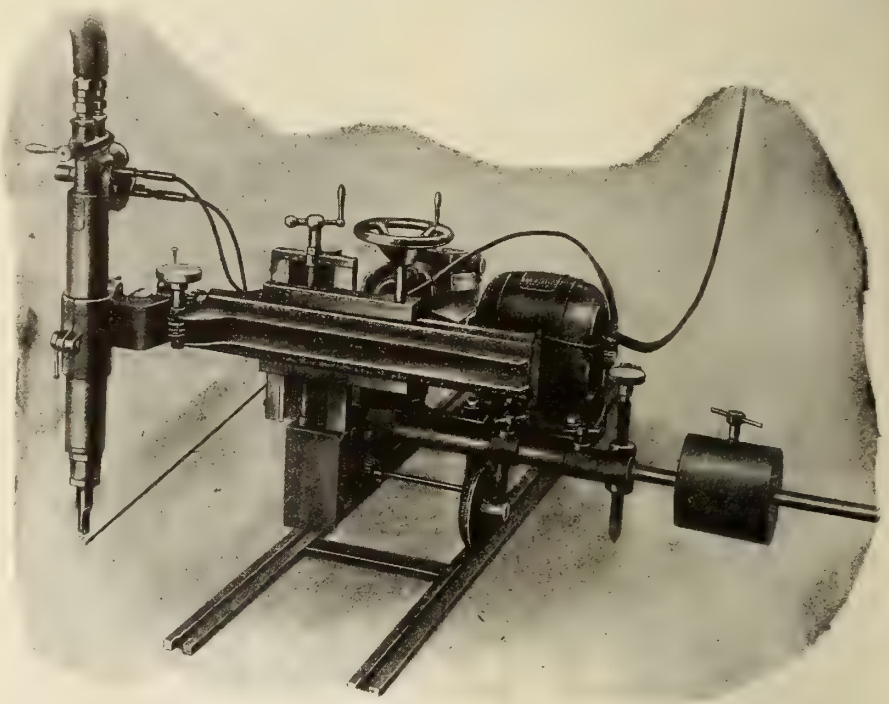


FIG. 1—FRONT VIEW OF MACHINE SET UP TO CUT TO STRAIGHT LINES.

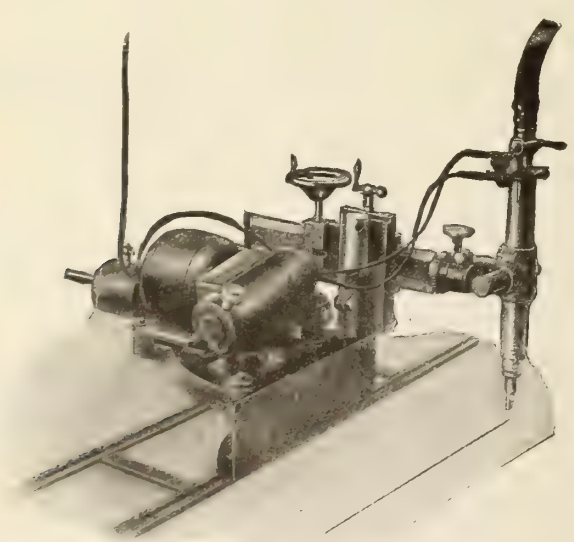


FIG. 2—REAR VIEW OF THE MACHINE SET UP TO CUT TO STRAIGHT LINES.

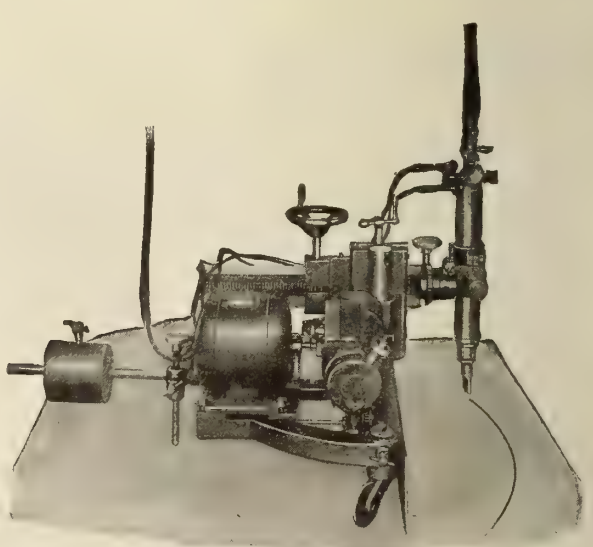
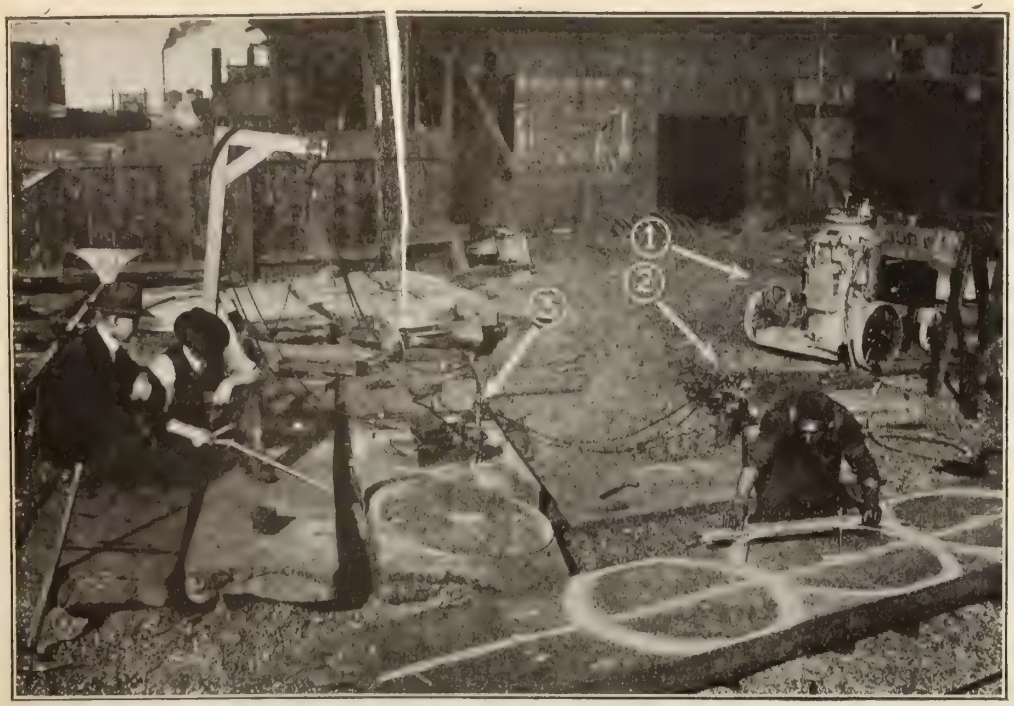


FIG. 3—THE MACHINE SET UP TO CUT CIRCULAR PATHS, USING SCREW POINT AS A POINT.



CUTTING DISCS 31 INCHES DIAMETER AND 9 INCHES THICK.

FIG. 5—A CLOSE UP VIEW OF DISCS SHOWN AT FIG. 4.

FIG. 6—CUTTING STEEL PLATE IN NEW YORK SHIPBUILDING YARD.

FIG. 8—TRIMMING HEAVY 24" "I" BEAMS. USING THE MACHINE FOR THIS PURPOSE HAS CUT THE FORMER COST IN SIX.

radius bar and center point for circular cutting. It is supported on three wheels, two of which are tractor wheels and the third a caster wheel. It carries a machine cutting torch and is fed along at a uniform rate by an electric motor working through a train of gears and driving the tractor wheels. A change gear feed box provides for various rates of speed suitable for cutting ¼-inch up to 20 inches thickness or more.

It might be well to add that the machine is fully covered by patents, both as to design and basic principle. Referring to Figs. 1, 2 and 3, we see the outfit set up for cutting to both straight and curved lines.

Cutting Straight Lines

Should readers ever use one of these machines, they should keep the following in mind. When a steel plate is to cut, it should be supported on blocks or horses a few inches from the floor. The supports should be so placed that the torch flame will not strike them in its path and the machine will not fall when the cut is finished. In some cases, it may be advisable to mark the the line to be cut with chalk, and prick punch it at intervals of a few inches, but generally this is unnecessary for straight cutting. The track supporting the machine should be laid on the plate parallel to the line to be cut and set six to eight inches away. When the position of the rack has been determined, a chalk line may be drawn along the side so that in case of being shifted accidentally it can be replaced to the original position.

The machine is now placed on the grooved track and connected to the motor with a flexible electric cord to the nearest lamp socket or source of 110 or 220-volt current, according to the winding of the motor.

The machine operates in either direction, depending on the setting of the reverse gear knob. The torch should be adjusted horizontally and vertically on the cross arm so that the tip is directly over the line to be cut and with the end about ¼ inch above the surface of the plate. The vertical adjustment depends on the style of tip and thickness of cutting. The acetylene and oxygen cylinders are placed alongside in convenient positions where the pressure gauges can be seen. The cylinder valves are next cracked and attached to the regulators. Connect the hose to the torch, red hose to acetylene and black hose to oxygen, taking care to blow out first to free the hose of dust.

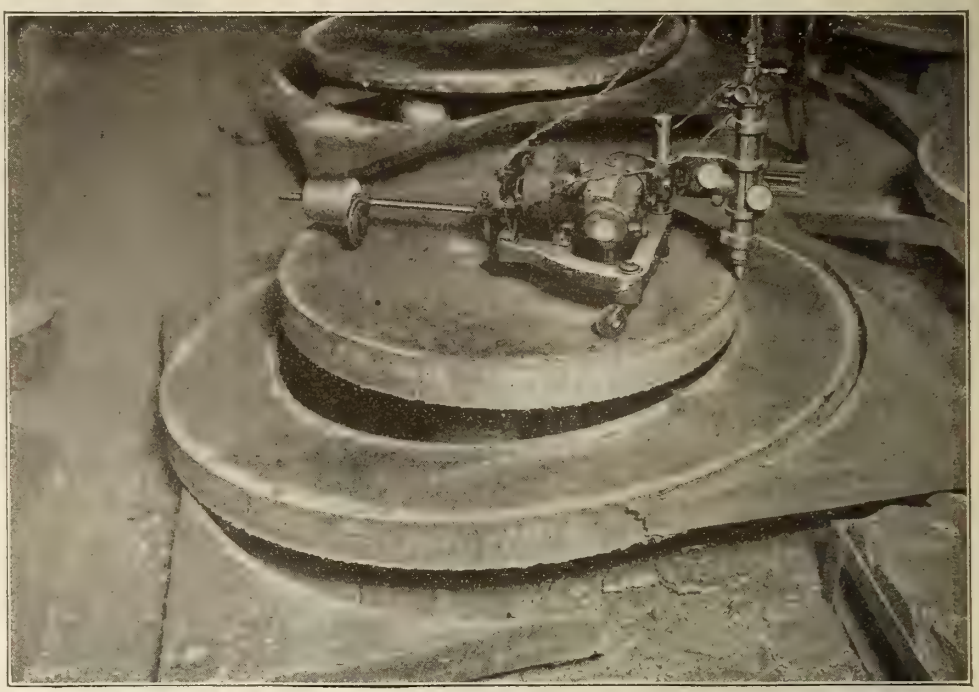


FIG. 9—AN EXAMPLE OF CIRCULAR CUTTING. THE PLATE IS 2½" THICK AND WAS CUT AT A SPEED OF 6" PER MINUTE.

Open the gas cylinder valves carefully, turning on the oxygen valve first. The regulator adjusting screw should be in the "off" position. Open the valve in the torch, adjust the acetylene working pressure with the regulator screw, and light the torch with the sparklighter. Then open the oxygen valve, and adjust the oxygen working pressure.

Next, adjust the preheating flame with the oxygen needle valve, making it neutral, or slightly oxidizing. Open the cutting oxygen valve when making this adjustment. Cutting should begin at the edge of the plate wherever feasible but if the pattern to be cut is some distance from the edge, the plate may be perforated with the flame. Preheat the plate to a high red or white hot temperature and then turn the cutting oxygen valve handle. Opening the cutting oxygen valve operates the switch turning the current on to the motor. The motor starts to feed the machine along at a rate that will depend on the setting of the gears in the feed box. The feed rate varies with the metal thickness, size and style of tip and oxygen pressure, and it should be determined before starting to cut the material.

Should the flame cease to cut, it may indicate that the travel rate

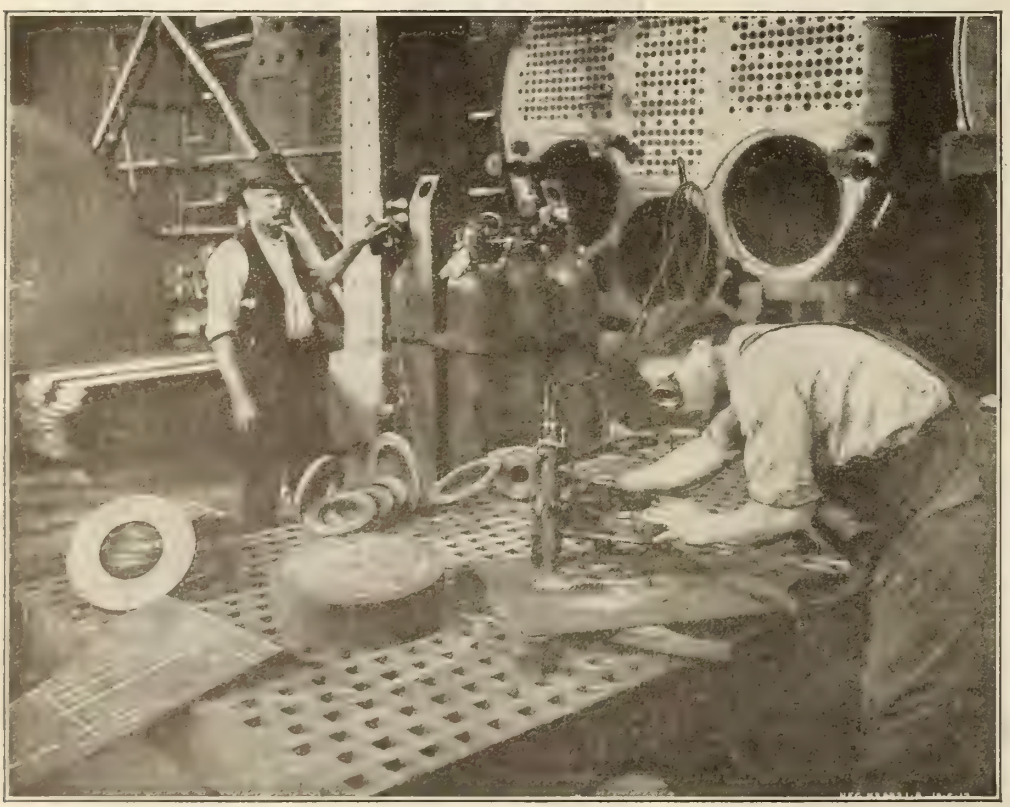
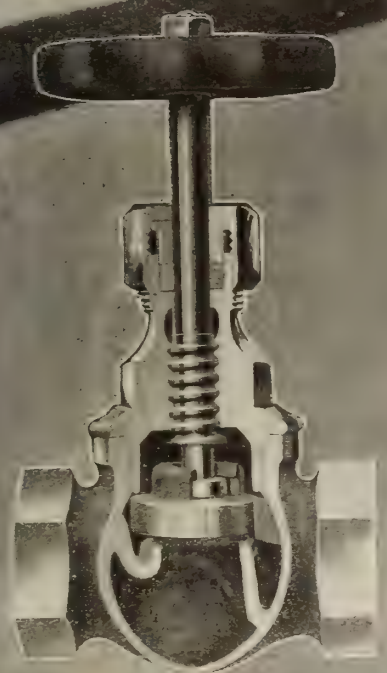


FIG. 7—CIRCULAR CUTTING. (Note the true shape and thickness of finished pieces.)

FAIRBANKS-MORSE



An Achievement in Mechanics

EACH individual department of The Canadian Fairbanks-Morse Company, Limited has given industrial Canada a new conception of achievement in mechanics. Each department has established a 100% quality and service standard. This is what enables Fairbanks valves to stand pre-eminent wherever valves are used.

When an engineer specifies Fairbanks valves, he knows that he has selected not only quality of material but workmanship that guarantees perfect operation.

He is satisfied with the reputation and service of the institution that stands behind them. He acknowledges an achievement in mechanics.

Wherever pipe lines are laid—in Canada's great industrial plants—in her immense water systems—in mines and mills—Fairbanks valves are giving a service that is marked by the 100% seal of quality, the standard of The Canadian Fairbanks-Morse Co. Limited.

Our nearest branch will give you the benefit of this service, Our experts will help you in selecting valves and everything mechanical that you require. Make our catalogue your buying guide.

The Canadian Fairbanks-Morse Co.
Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

5

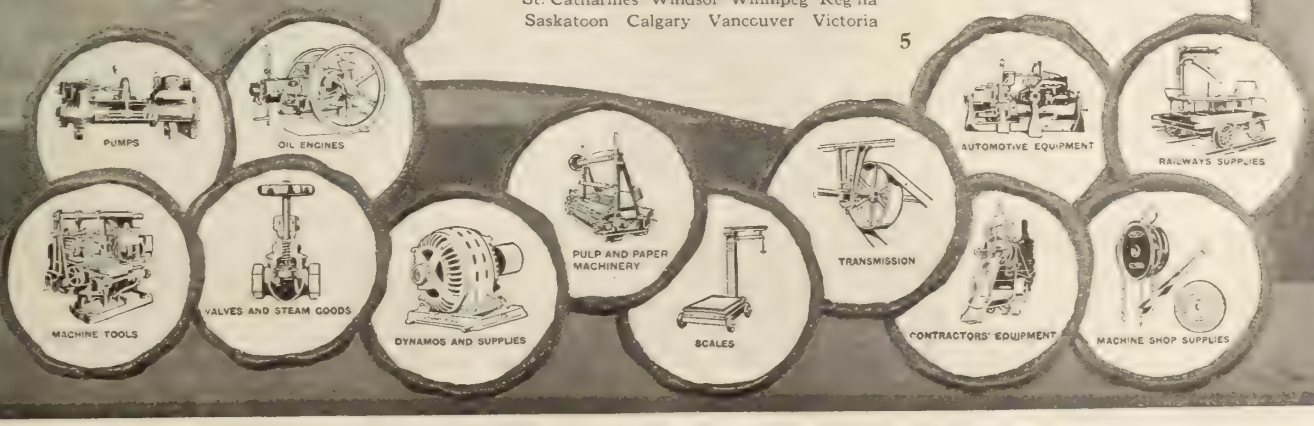


FIG. 10—AN 108,000-POUND STEEL CASTING. (Note the 36" main riser, also four smaller 8" ones.)

is too fast, in which case move the machine back to the termination of the cut, and start cutting again at a slower speed. On the other hand, too slow a speed may cause the cut to stop, and then the remedy is to increase the feed rate. The act of turning on the cutting oxygen starts the motor into operation, therefore do not turn on the cutting oxygen until the preheating flame has raised the metal to the burning temperature.

If the length of cut requires more than one section of grooved track, two may be used, which will serve for any length of cut, the first section being taken up when the machine has passed over it, and laid down in front of the one in use. In case of cutting that requires the machine to travel off the plate, it will be necessary to provide support for the track by laying another support alongside at the same level. To bevel a plate when cutting, adjust the torch sideways by loosening the swivel and clamping the torch at the desired angle. Notched, stepped or offset cuts can be made by stopping the feed motion by disconnecting one of the motor feed wires and feeding the torch sideways by hand the required distance, and then starting the feed again for straight-away cutting. Any combination of right-angle cuts can be made in this manner.

When starting a cut at the edge of a billet having a sloping side, the torch should be inclined parallel to the slope. When the cut has been started, the torch should be gradually brought to an upright position for straight-away cutting.

To Cut Curved Lines

Curved line cutting is done without using the grooved track, the machine being guided by a radius rod set in a punch mark at the center of the desired circle or arc. Lay off the required arc with dividers or a trammel bar, and prick punch the center of the arc to be cut. Set up the machine with the center point in the punch-marked centre, then adjust for the required radius.

The third wheel of the radiagraph (not shown in the illustration) is a caster that is locked with a set-screw for straight cutting. The set-screw should be loosened for circular cutting so that the caster will be free to swivel. Set the counterweight on the radius rod beyond the centre point and clamp it. The purpose of the counterweight is to hold the centre point down in the punched centre. If trouble is caused by the centre point slipping out of the centre, move the counterweight further out on the radius rod, and thus bring more pressure to bear.

Turn on the gases as directed for straight cutting and start the same as for straight lines. The radiagraph will automatically follow the curved line, swinging about the centre point. The machine is traversed by the outer tractor wheel. The rate of torch travel will vary with the setting of the cross arm and the position of the adjustable leg on the radius rod. It may be necessary to do some experimenting before the proper setting of the feed box gears can be determined. Remember that the torch, when outside of the tractor wheel, will move at a faster rate than on straight cutting, and it will generally be necessary to provide for slower feed rate, or to increase the oxygen pressure.

A circle having a radius greater than about 51 inches requires special radius rods made to order. Circles of very short radius are cut by setting the center point close to the frame and

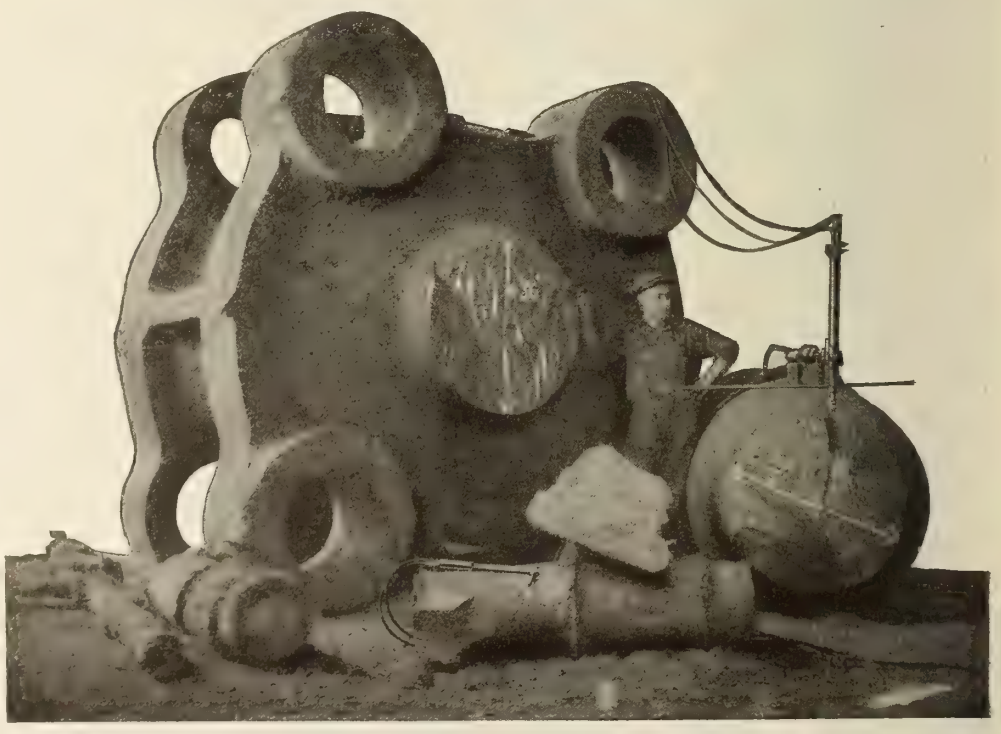


FIG. 11—THE RESULT OF A LITTLE OVER AN HOUR'S WORK. (Note the machine on top of larger riser to right.)

swinging the cross arm around the vertical post until the tip is on the inside of the radiagraph frame with the center point. This is done by unclamping the cross arm, litfing it up off the post, turning around over the frame and then slipping the socket down on the post and clamping. If the center point cannot be moved in to the desired position because of interference with the tractor wheel, remove it by loosening the clamp, holding it to the radius rod. The center point clamp can then be set close to the frame. This will usually give the short radius of action required.

It is possible to place the torch within about two inches of the center point but it is rarely feasible to cut circles of much less than six inches radius or twelve inches diameter. A faster feed rate must be set on the feed box than for straight cutting as the torch is traveling at a slower rate.

Cutting Combination Straight and Curved Lines

The path to be cut should be laid out and marked with the prick punch. The centers of the arcs should be punched and circled with chalk so that they can be readily located as the work proceeds. Lay out the work to make the straight cut first. Clamp the bracket on the radius bar at the correct position for cutting the arc of required radius, and screw the center point up so that it runs about 1-16 inch above the plate. The grooved track is not used when cutting to straight and curved lines on steel plate. The straight line cut is first made and as the center point reaches the punch mark it is quickly screwed down, catching the point in the plate. The machine then swings around the center, cutting to an arc without stopping and interrupting the cut. To cut to a straight line from the termination of an arc, unscrew the center point when the end of the arc is reached, which will permit the tractor wheel to rest on the plate, and then the machine will carry the torch forward in a straight line.

Having commented on the machine and how it should be used, let us discuss the illustrations shown. At Fig. 4, we see the machine cutting steel discs, 31 inches diameter, 9 inches thick, at the rate of five lineal inches per minute. This means that a cut is completed in 20 minutes. Some of the discs shown were 9 inches thick, others 5 inches, and from 25 to 36 inches diameter. At 1 is illustrated a D-B portable acetylene generator. At 2, some manifold oxygen tanks, and the radiagraph itself is shown at 3. A close-up of some of these discs is shown at Fig. 5.

Cutting steel plate with the oxy-acetylene flame in a New York shipbuilding yard is shown at Fig. 6. The machine can be clearly noted, and these plates were cut at speeds varying from 18 inches to 2 inches per minute on plate from ¼ inch to 20 inches thick.

Fig. 7 illustrates some circular cutting in the New York shipbuilding yards. The true and finished cut is self-apparent in this view, and the thickness is also considerable.

At Fig. 8 is illustrated the work of trimming heavy 24 inch. I beams, while Fig. 9 shows a good example of a circular cut in steel plate. Fig. 10 depicts a 108,000 pound steel casting with a riser 36 inches in diameter, weighing about 30,000 pounds. Two of the four smaller 8-inch risers can be noted clearly.

MALE HELP WANTED

MECHANICAL ENGINEER, PREFERABLY technical graduate, having steam-power-plant experience to assist in the preparation of technical-book manuscripts and in other steam engineering work largely of desk and detail character. Ability to write pure, simple, expressive English is essential. Teaching experience desirable. Must be accurate and thorough. We desire to locate a steady, well-balanced, painstaking engineer who does not ordinarily answer advertisements. To one who can satisfy our requirements we can offer a good future. Apply by letter only, in your own handwriting, giving age, education, experience (when and where you worked and what you did) and salary expected. Terrell Croft Engineering Company, 6600 Delmar Ave., University City, St. Louis, Mo. (p10h)

WANTED

WANTED AT ONCE—POSITION AS ENgineer. Hold 2nd class certificate. Steady, reliable man. Will go to any place. Box 101220. (p10h)

Get Bigger Pay through **ELECTRICITY**

You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination **Hawkins Electrical Guides** (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

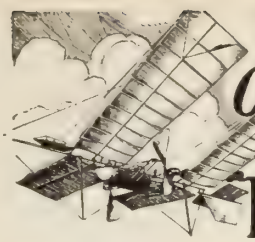
Signature_____

Occupation_____

Employed by_____

Residence_____

Reference_____



Don't Let *Old-Fogey* Ideas Rob You

Professor Langley, who invented the first heavier-than-air flying machine, used a propeller as the means of propulsion because, as he explained, there was no more sense in equipping an aeroplane with flopping wings, to imitate a flying bird, than there would be in using legs on a railroad train, to imitate a running animal.

He cut loose from a traditional fogey idea that a flying machine must flop, and his flying machine **flew.**

Our notions of steam trap construction were akin to Professor Langley's theory. We cast aside the old ball-float and other time-honored devices that often fail to operate—**and did some thinking for ourselves!** The result is the compact, dependable, highly efficient Steam Trap Sarco, designed on **logical lines.**

The Sarco is operated by expansion and contraction of a very sensitive liquid which opens the valve and drains condensate as rapidly as it collects, returning it to the hot well while hot. It closes immediately when condensate has drained, without loss of live steam.

Because it requires no storage space, for condensate, the Sarco needs no costly, complicated levers, gauges, packing or stuffing box. Simplicity of construction reduces its cost to about **one-third the price** of bucket or float traps.

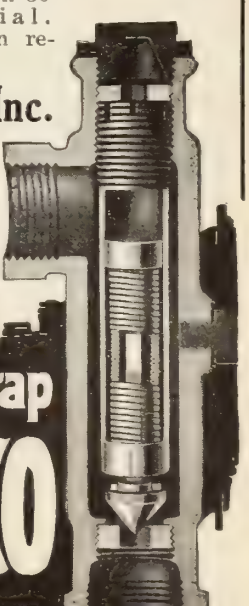
You can install a Sarco anywhere on the line at any angle without change of piping. No supports, platform or floor space required. Sizes ⅜ in. to 3 in., for pressure up to 200 lbs.

Stop paying high prices for old-fashioned traps. Let us send you the Sarco on 30 days' free trial. Booklet J-12 on request.

Sarco Co. Inc.

239 Broadway
New York

Buffalo Chicago
Cleveland Detroit
Philadelphia
Peacock Bros., Montreal



Steam Trap SARCO

Detroit Stokers

"Adding Service to Service"

The Burroughs Service Organization Slogan is *"Always on the Job"*

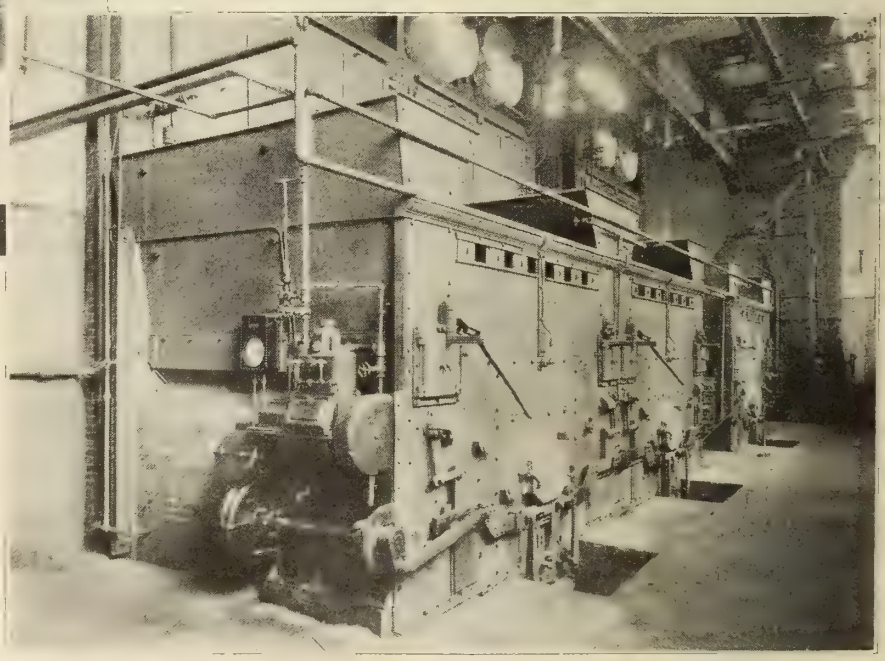
The photograph shows the first installation of 3-413 h.p. Boilers with Detroit Stokers. Burroughs later added 1-600 h.p. Boiler with Detroit Stoker.

4

DETROIT STOKERS

In the Burroughs Plant at Detroit are

"Always on the Job"



Quite naturally Burroughs Adding Machine Company chose Detroit Stokers. They are as efficient and simple as A. B. C. Putting the best possible stoker on the job was just as much the business of Burroughs engineers as it is in putting the best possible adding machine on your job. Detroit Stokers, like Burroughs adding machines, once on the job, keep on the job.

Write for Your Copy of Catalog P.

DETROIT STOKER

DETROIT STOKER COMPANY

DETROIT, MICHIGAN

BRANCHES: Chicago, Cincinnati, Pittsburgh, Philadelphia, Cleveland, New York, Atlanta, Boston

BOB LONG

Union-Made
Overalls
Shirts and Gloves

BOB LONG Overalls and Shirts improve with washing. They are made specially for the man in the Power House and Machine Shop.

You cannot wear them out.

Insist on overalls, shirts and gloves of the BOB LONG Brand.

Bob Long Says:

"My overalls and shirts are the best made, because—they stand the test of the wash-tub. No starch filler or cheap dyes to wash out. Insist on 'Bob Long' brand and ask for Big 11—the big grey overalls—the cloth with a test."

BOB LONG

Known from Coast to Coast

R. G. LONG & CO., LIMITED

727 King St. West, Toronto

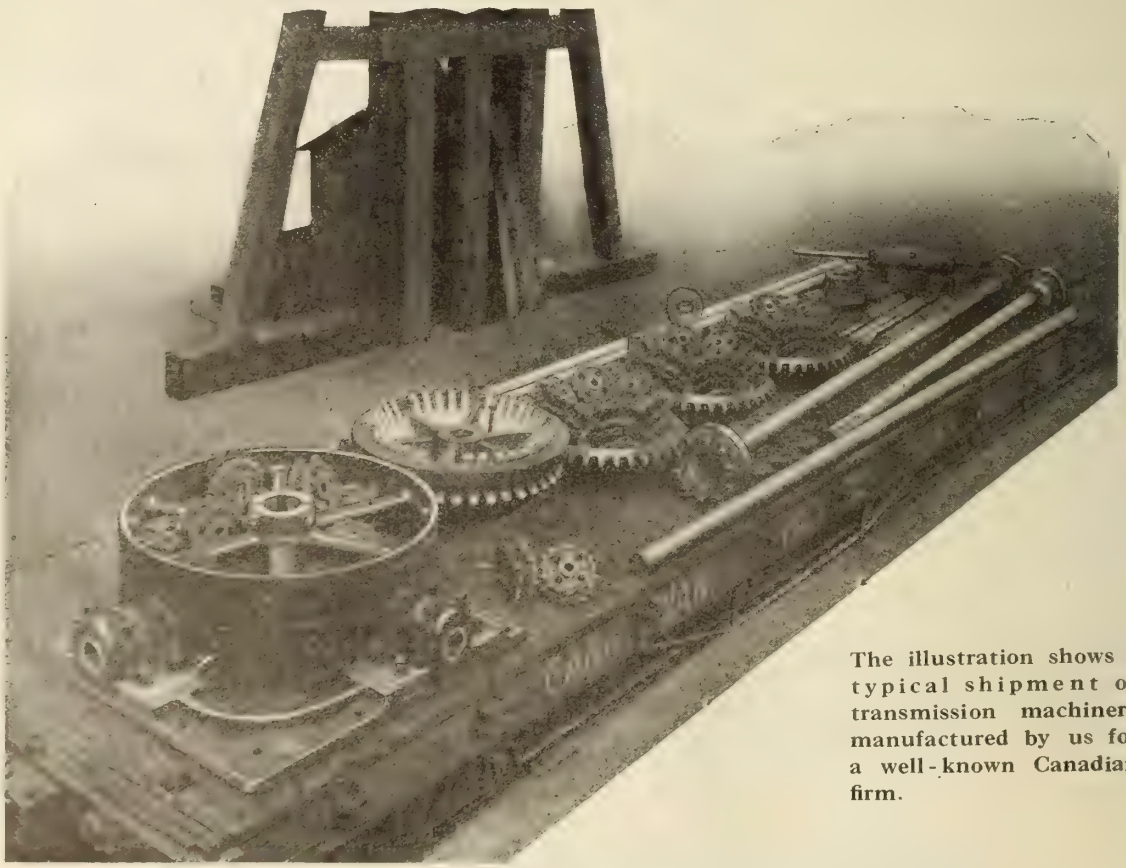
VICTORIA PRODUCTS

Victoria products cover requirements for pulp and paper mills, saw mills, stamp mills and mining machinery, special machinery, such as match, mica, paper box, etc.

The plant to-day consists of pattern shop, foundry machine shop, forge shop, heat treating and engineering department.

Speed on Rush Orders

The Victoria Foundry Company is famous for the care and speed which it bestows on all rush orders. This is one phase of Victoria service.



The illustration shows a typical shipment of transmission machinery manufactured by us for a well-known Canadian firm.

Victoria
Stop Log Winches

They are favorably known throughout the Dominion and may be seen doing satisfactory service at Magog, Buckingham, Temiskaming, High Falls, Latchford, Jonquières and Vancouver.

The Catalog of Victoria Foundry Products illustrates the Victoria Stop Log Winch and gives interesting information about its construction. Why not send for this catalog to-day?

Flutter Valves

We are prepared to supply these valves to suit almost any requirement. They are reasonably tight, positive in action, have a high safety factor and are easy to operate. See the Victoria Catalog for fuller details.

When You Have a Break-Down Try
Victoria Service—Always Available

VICTORIA FOUNDRY COMPANY, Limited

Established 1846

General Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

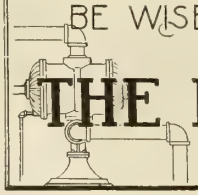
HINTS TO BUYERS

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

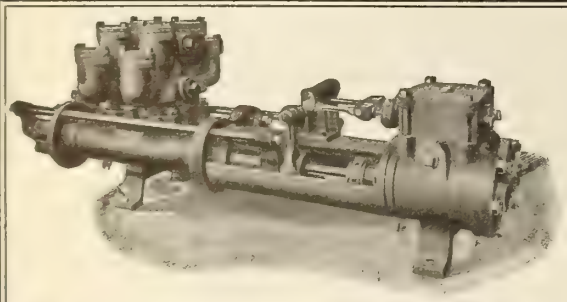
LADD
WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

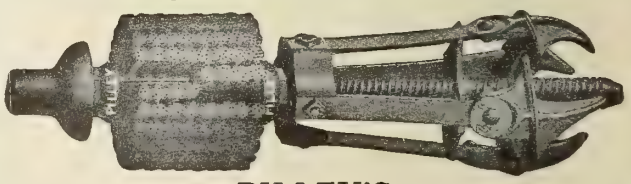
THE GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN., U.S.A.

WE WELD
EVERYTHING
Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded
WELDING REPAIRS TO ALL MACHINERY GUARANTEED
The Electric Welding Co.
178 Bleury St., Montreal. Phone Main 2300



PUMPS
that give
Better Service Longer Service
THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

The Simplest and Best Cleaner on the market is



PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Largest manufacturers of white metals in the world
Solder
Wire Solder
Ingot Metals
DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings
Lead Wool
Lead Sheets
Lead Traps
and Bends
HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

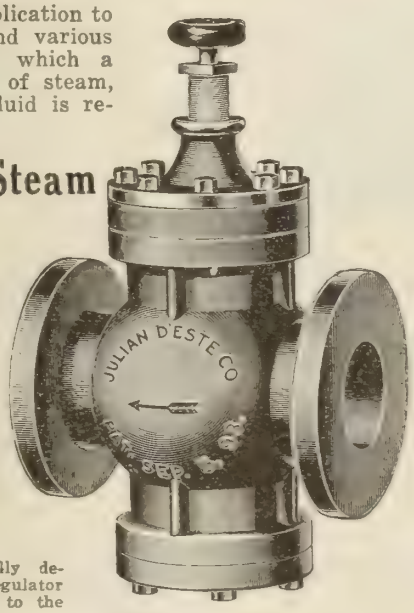
SAN FRANCISCO
RIALTO BUILDING.

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'
Pneumatic
Tube-Scaling
Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman
(SOLE MAKER)
9, Westfield Road Birmingham Eng.

Plibrico is molded into place; needs no forms and H requires minimum time and labor.

PLIBRICO Makes Air Tight Furnace Linings

Air leaks in furnace lining joints, boiler settings and baffles are the greatest preventable losses in a boiler plant. No argument should be necessary to establish the fact that **An Air Tight Furnace Lining** is a great fuel economizer.

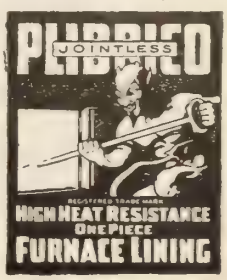
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Send for book on furnace building.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

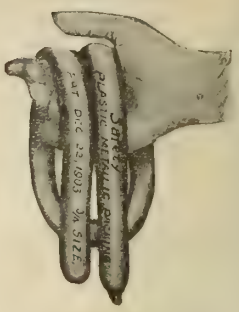
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing

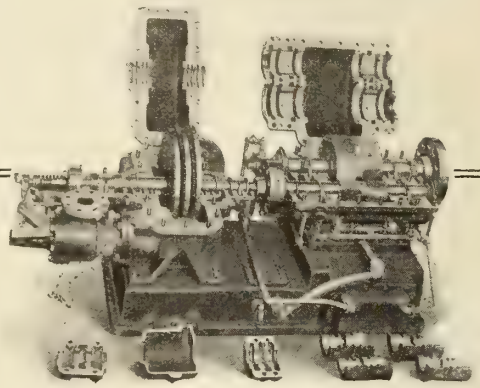
STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes



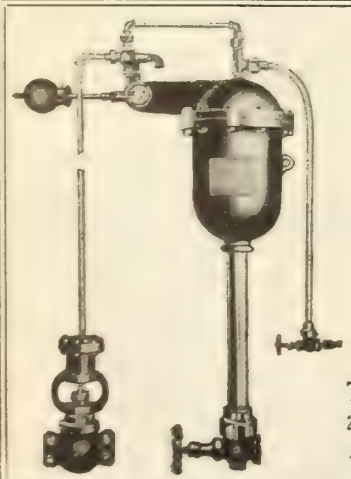
The Design of Moore Steam Turbines Prevents Steam Leaks

Ample surfaces at the joints have been provided to prevent leakage of steam—also the number of vertical joints have been reduced to a minimum. In a turbine having numerous vertical joints it is almost impossible to prevent leakage and consequent loss of efficiency in operation.

The careful designing to prevent all steam leakage is but one feature of Moore Steam Turbines. Send for our booklet. It explains fully the others.

Moore Steam Turbine Corporation

Wellsville New York U.S.A.



Safety or Worry?

CHOOSE

Would you rather worry about your fireman's inattention to the boiler feed water, or be absolutely assured of continuous middle gauge lever control by VIGILANT FEED WATER REGULATORS?

We will gladly furnish full information

The Chaplin-Fulton Mfg. Co.

28-34 Penn Avenue, Pittsburgh, Penna.

Also Manufacturers of the Fulton Pump Governor

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for

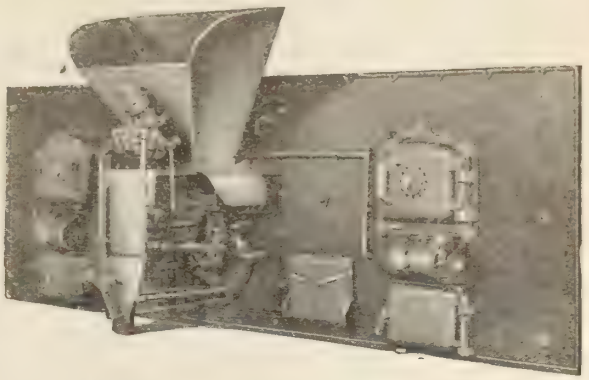
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

S. & C. BISHOP & CO., St. Helens, Lancashire.

GREEN'S ECONOMISERS

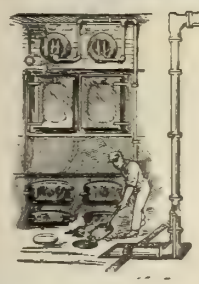
For Greater Economy in Your Boiler Plant



Green's Fans and Economisers

Type E—Under-Feed Stoker

STANDARDIZED STEAM CONVEYOR

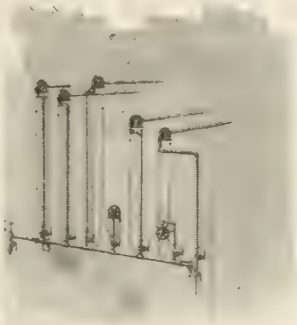


Girtanner Ash Conveyors

UEHLING
CO2 Recording Equipment CO2
CO2 Recorder For Office or Chief Engineer
CO2 Indicator for mounting on Boiler Front
CO2

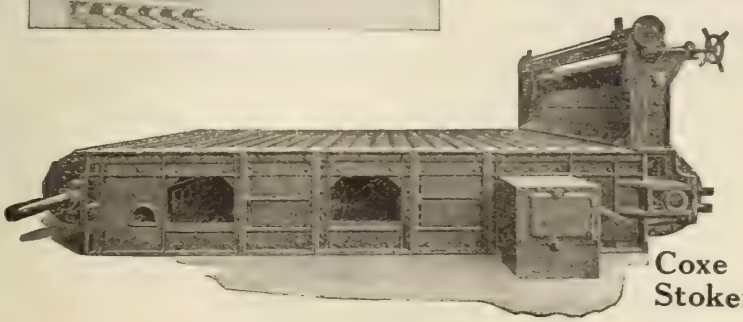
Roto Tube Cleaners

Liptak Double Suspension Arches



Vulcan Soot Cleaners

Custodis Radial Brick Stacks



Coxe Stokers

GREEN'S ECONOMISER, LIMITED.
TORONTO

FOR SALE—USED MACHINERY

One Goldie-McCulloch, Jerome-Wheelock 13″ x 33″ horizontal steam engine in first-class condition.

One No. 389 Webster Feed Water Heater and Purifier, complete with all fittings.

One 8 x 10 x 10″ horizontal simplex steam vacuum pump complete with Rochester automatic lubricator and Webster 1″ diaphragm automatic vacuum pump governor, including two 5″ vacuum gauges mounted on slate slab.

IMMEDIATE DELIVERY
Any reasonable offer will be accepted.

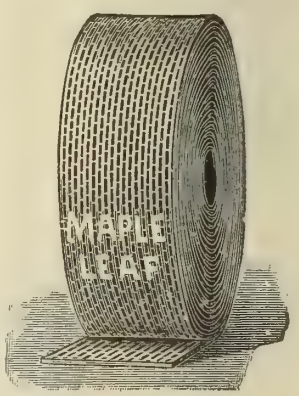
THE PEDLAR PEOPLE LIMITED
Established 1861
MANUFACTURERS OF SHEET METAL PRODUCTS
Executive Office and Factories - OSHAWA, ONT.

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



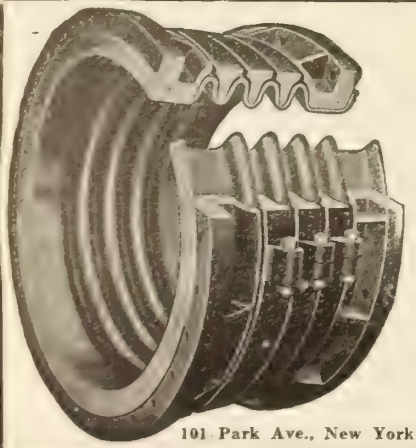
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal



101 Park Ave., New York

BADGER QUALITY

famous since 1850
is now applied to

BADGER SELF-EQUALIZING EXPANSION JOINTS

Have you read our new book?

E. B. BADGER & SONS CO.

Pitts St., Boston
616 S. Michigan Ave., Chicago

QUALITY YORK SERVICE

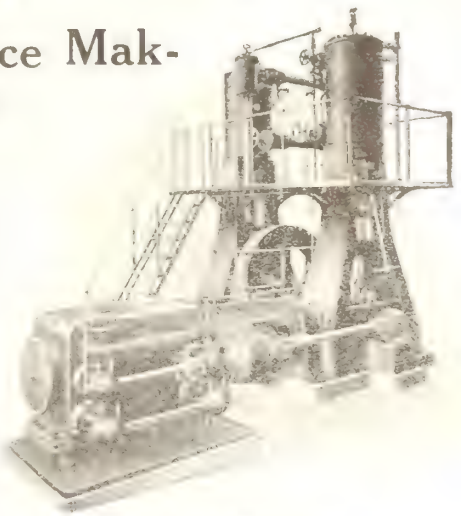
York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

The Uniflow Steam Engine presents itself as the best solution of this difficulty

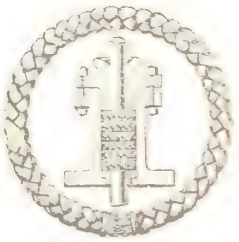
York Mfg. Co., York, Pa.



Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St West
WINNIPEG: 85 Lombard St
CALGARY: 605 Second Street

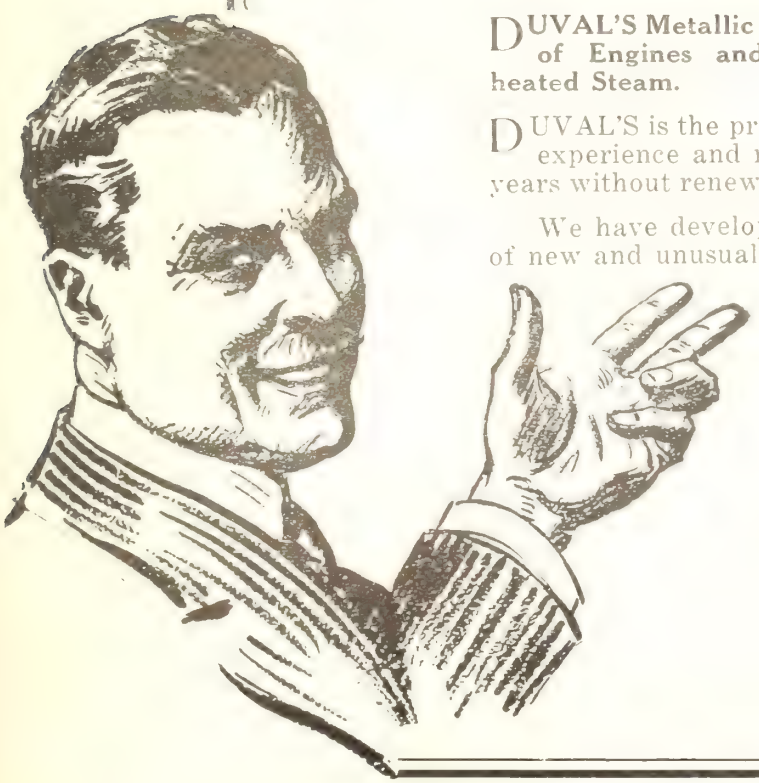
Why It Lasts Longer



DUVAL'S Metallic Packing for All Classes of Engines and the Highest Superheated Steam.

DUVAL'S is the product of many years of experience and rigid tests. It lasts for years without renewal and keeps the rods in perfect condition.

We have developed it to its present stage by the addition of new and unusual features which make it the best possible packing you can buy. It is placed in the glands the same way as ordinary soft packing. Over 600,000 glands packed.



"Benhyco" Jointing for Steam and Hydraulic Joints

Supplied 48 in. square, 1-32 in. thick and up.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

Assured

in driving generators, centrifugal pumps, fans, blowers and other auxiliaries goes hand in hand with

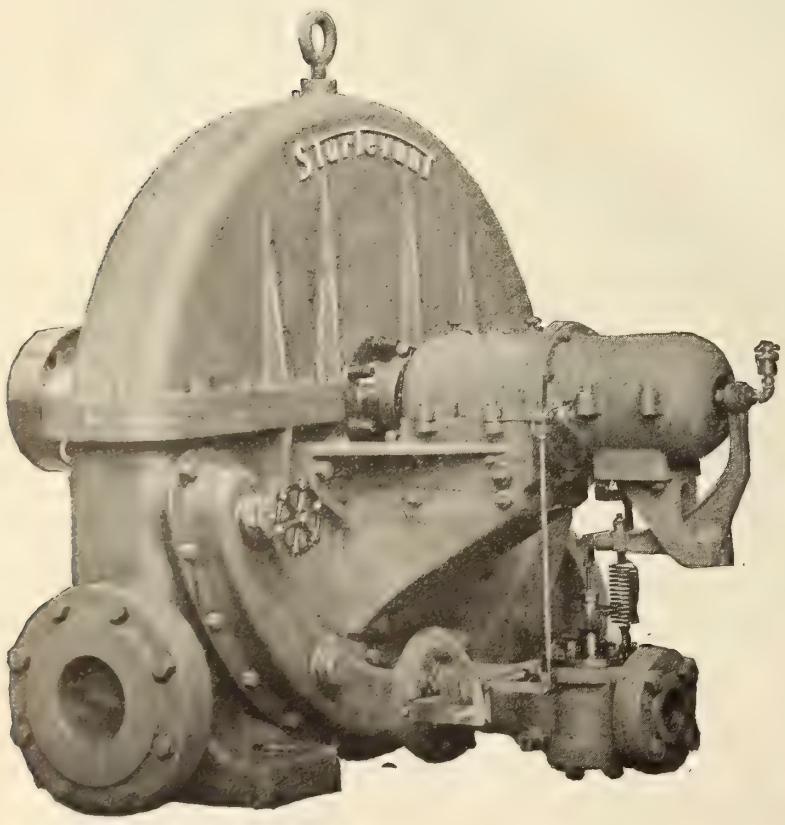
Sturtevant

(TRADE MARK)

Steam Turbines

They will operate continuously at a low steam consumption and very little wear.

The open hearth forged steel rotors are accurately balanced by scientific methods under skilled technical supervision. The buckets are carefully milled at an angle which has been determined by many years experience to be correct. They are smoothly finished to minimize steam friction.



The nozzles and reverse buckets are machined from tobin bronze and carefully fitted by ground joints. And one of these nozzles can be cut out of service by closing a hand valve in case less power is required, thus enabling the lighter loads to be carried without throttling the main steam supply. This insures good economy over a wide range in load.

Special attention has been given to the bearings which are self-aligning and provided with a liberal amount of oil storage to operate continuously over long periods without replenishing the oil.

The speed of the turbines is controlled by a centrifugal governor operating on knife edges which require no lubrication whatever.

B. F. STURTEVANT COMPANY

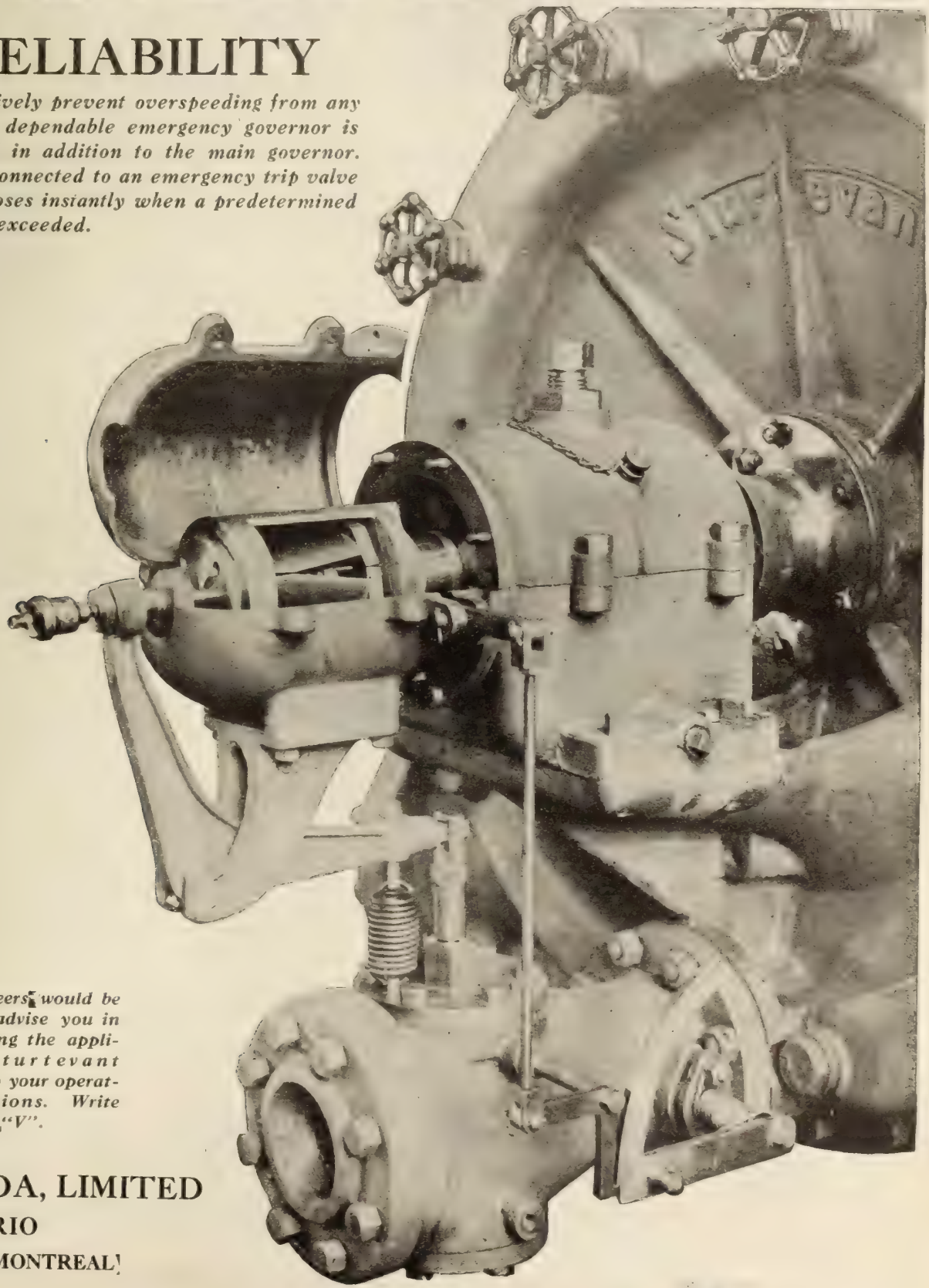
HEAD OFFICE AND WORKS,

SALES OFFICES:

Satisfaction

RELIABILITY

To positively prevent overspeeding from any cause, a dependable emergency governor is provided in addition to the main governor. This is connected to an emergency trip valve which closes instantly when a predetermined speed is exceeded.



Our engineers would be pleased to advise you in full regarding the application of Sturtevant Turbines to your operating conditions. Write for Catalog "V".

OF CANADA, LIMITED
GALT, ONTARIO
TORONTO AND MONTREAL

COPES BOILER FEED REGULATORS

Made in Canada
For Canadian Power Plants

The World's Largest Manufacturers of Feed Water Regulators Are Now Ready to Supply Canadian Power Plants with Regulators Made in Canada

The Canadian demand for efficient, up-to-date steam power plant equipment has grown steadily in the past four years. In the past year, the increase has outdistanced all others. At the present time more Copes Boiler Feed Regulators are sold per month in Canada than were ever sold in a year.

Hereafter the regulators used in Canada will be made in Hamilton, Ont. During the past few years the Canadian sales organization of the Northern Equipment Co., manufacturers of Copes Boiler Feed Regulators, has been materially strengthened. They are now

Represented in Canada by

ALLEN GENERAL SUPPLIES, LTD.
205 Yonge St., Toronto, Ontario

MASON REGULATOR & ENGRG. CO., LTD.
153 Dagenais St., (St. Henry) Montreal, P.Q.

H. N. BROWN
P.O. Box 620, New Glasgow, N.S.

C. C. MOORE & CO., ENGRS.
618 Mutual Life Bldg., Seattle, Wash.
(Representatives in British Columbia)

The Copes Regulator Saves Both Fuel and Labor, and Increases the Peak Load Capacity of a Boiler Plant

It also reduces the wear and strain on boiler equipment and increases safety. The operation is entirely automatic. It is not affected by variations in the steam pressure, drafts or climatic changes. The rate of feed is varied to insure the highest economy in steam making where furnace conditions are bound to lag behind extremely irregular and unexpected fluctuations in boiler load, as is common in paper mills, steel mills and many other industries. No other regulator is so simple in construction and operation.

Ask for Bulletin D, giving full description, detailed information and technical data.

NORTHERN EQUIPMENT COMPANY

112 West 11th St. **ERIE, PA.**

World's Largest Manufacturers of Feed Water Regulators

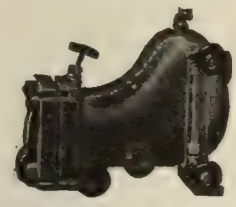
MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

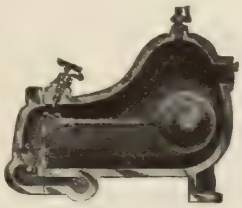


McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



Send for Catalogue

THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL, CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freigh Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*

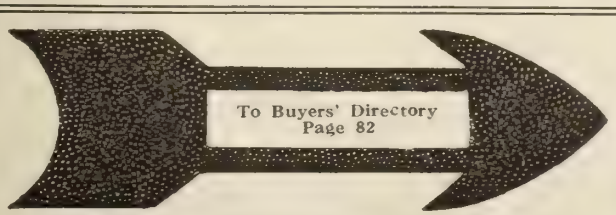
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

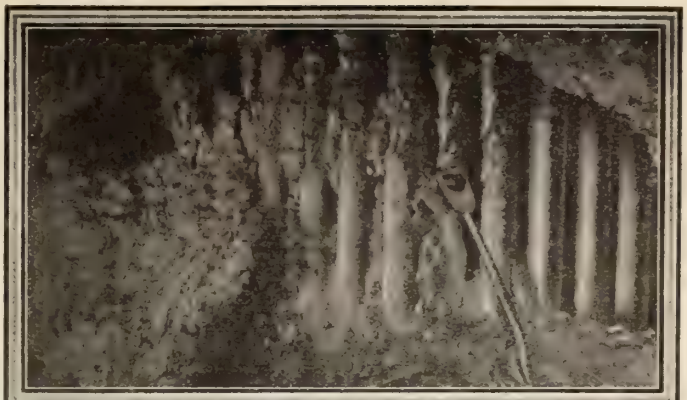
Send Blueprints for Quotations. *Write for our latest catalogue.*

Patterns *Machine Work*

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co
27 COTE St MONTREAL, QUE





Can YOU Afford It?

Soot and ash deposits on the fire surface of boilers cause a loss of millions of dollars annually.

Your proportionate share in this loss depends upon the number of boilers you operate, the cost of coal, and the degree of cleanliness obtaining.

Suppose you have four 500 H.P. boilers. Normally these will require 4 tons of coal per hour, or 20,000 tons of coal per year on a 5,000 hr. basis. At present prices, this coal probably will cost you $100,000 per year.

If you customarily allow your boilers to get in the condition shown in the picture before cleaning them, your loss is anywhere from $10,000 to $20,000 or more per year.

If you clean your boilers regularly and conscientiously with the hand lance, your loss is from $4,000 to $8,000 per year, depending upon the skill of the fireman.

If you clean your boilers with Diamond Soot Blowers you incur no loss, but get value received in steam (within the limitations of your furnaces and boilers) for every dollar spent for coal.

Best of all, Diamond Soot Blowers cost but a fraction of the annual saving.

Ask for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ont.

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane, Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
International Chemical Co., Toronto, Ont.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

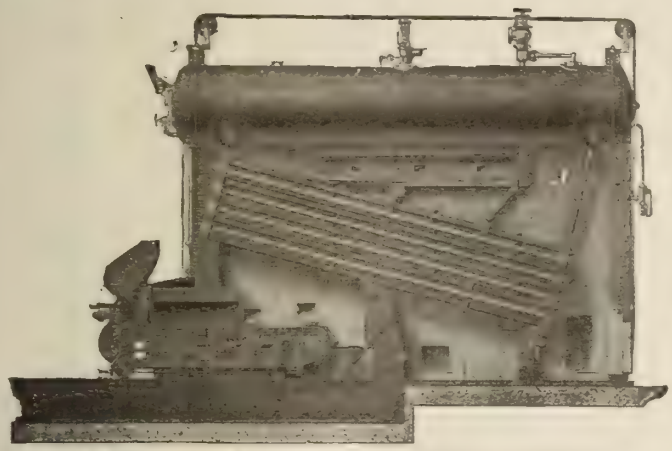
CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler. Superheater and Mechanical Stoker.

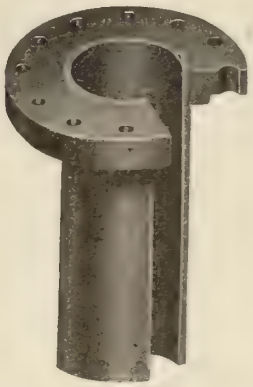
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

P&H FLANGED PIPE JOINTS



SCREWED

P-H LAP

P-H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

Made in Canada by

PAGE-HERSEY IRON, TUBE & LEAD Co. LIMITED

Head Office : 100 CHURCH STREET, TORONTO, ONTARIO

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
Jointless Fire Brick Co., Chicago, Ill.

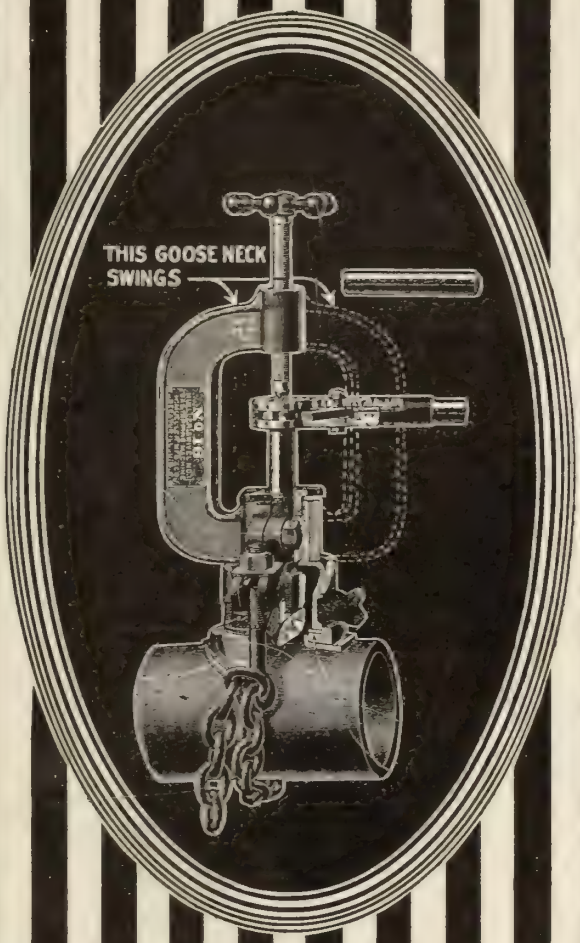
FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.



Mueller Tapping Machine No. L.

Makes taps from ⅜ to 2 inches in all sizes of pipes under pressure. The Goose Neck is swiveled, turning to any position to allow ease in operating the Ratchet Handle. The special Mueller Oiling Device supplies oil to the tool through the Gas Cylinder.

Mueller Gas Tapping Machines are made in eight different patterns for tapping open gas mains, or mains under pressure. Over 90% of Tapping Machines in use are Mueller built—proof of their efficiency and superiority.

Write today for detailed descriptions and prices.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools

American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMEL-WARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.

GASOLINE ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co Waynesboro Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall. Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

H. W. PETRIE LIMITED

New and Used

Power Plant Equipment

Horizontal Boilers Up to 200 H.P.
Vertical Boilers from 1 to 75 H.P.

Partial List of
Boilers and Engines
in Stock

Firebox Boilers
12 h.p.

Horizontal Boilers
200 h.p., 125, 100, 80, 60, 50, 35, 18, and 15.

Marine Boilers
2 Internal Fired.

Vertical Boilers
75 h.p., 15, 16, 12, 10, 8, 6, 5 and 4.

Automatic Engines
450 h.p., 90 and 60.

Horizontal Slide Valve Engines
40 h.p., 20, 15 and 5.

Marine Engines
1 Steeple Compound.

Vertical Engines
75 h.p., 20, 10 and 7.

STEEL TANKS
Any Capacity for Any Purpose

STEAM ENGINES
Slide Valve, High and Slow Speed Types

AUTOMATIC ENGINES
Up to 125 H.P.

VERTICAL ENGINES

WHETHER the equipment you purchase from us be **new** or **used** you can depend upon its serviceable qualities. We handle only reliable lines, a fact which has become traditional among the trade in Canada through half a century of fair dealing. **Let us tell you fully about the equipment you are interested in.**

CANADA'S DEPENDABLE MACHINERY AND SUPPLY HOUSE

H. W. PETRIE LIMITED

TORONTO and HAMILTON

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal.

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, GAS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
Republic Flow Meters Co. of Canada, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Koob Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd., Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co. Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

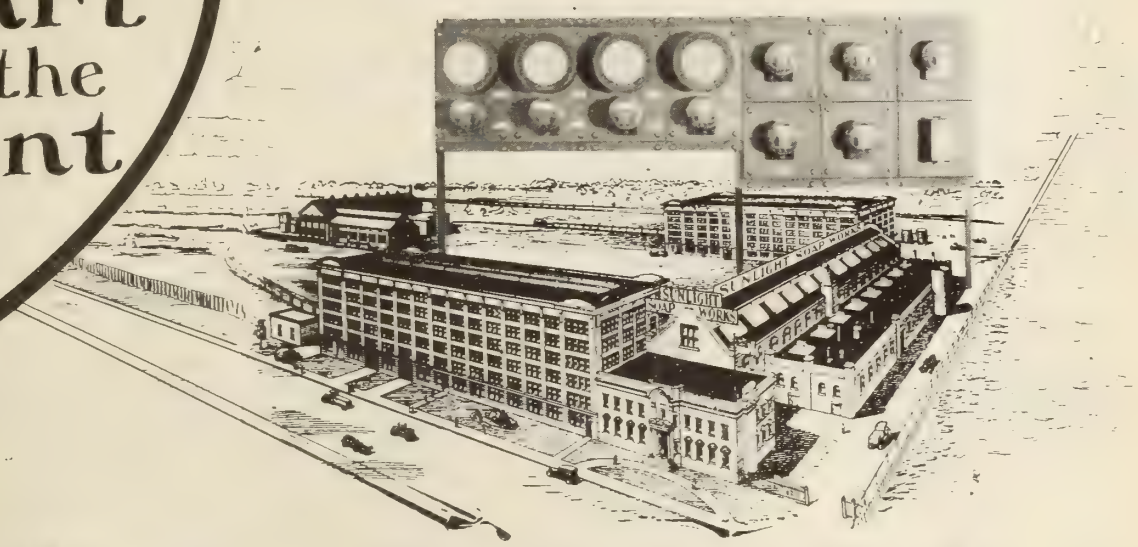
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek

Republic

FLOW METERS

The Heart of the Plant



Good Results at Sunlight Soap Works

The great advantages of the Republic principle of electrical operation are well illustrated in the power plant of the Sunlight Soap Company, Limited, Toronto. The superintendent and the engineer should know what Republic Flow Meters have accomplished; read what they have to say:

Less Fuel Consumed

October 12th, 1920.

The Republic Flow Meter Co. of Canada, Limited,
145 Wellington St. West,
Toronto.

Dear Sirs,—We wrote you some time ago, shortly after your Meters were installed, advising that we were getting good results. The installation is now complete and we have many good figures to work with.

We have located leakages of steam which it would have been impossible to discover without the use of your Meters.

Our fuel consumption is being reduced daily and we hope by the end of the year to have yet more complete and lasting results.

The Meters paid for themselves the first week they were in operation.

We would be glad to furnish particulars to any of your customers who may require information.

Yours very truly,
LEVER BROTHERS, LIMITED,
(Signed) James Mess,
Works Superintendent.

One Boiler Less Needed

October 1st, 1920.

The Republic Flow Meter Co. of Canada, Limited,
145 Wellington St. West,
Toronto.

Gentlemen,—In reply to yours of the 29th enquiring as to the results we have had from Republic Flow Meters, I beg to state that since we have had the meters in operation I have been enabled to cut one boiler from use, and also by discovering leaks in lines, I have been able to carry over the week ends with one boiler instead of two as formerly.

We have been able to make great progress with the conservation of fuel by the application of the meters, and I am convinced that a plant without them cannot be economically run.

I shall be glad to show any person you may refer to me the charts, and prove to them the indispensable value of Flow Meters.

Yours truly,
LEVER BROTHERS, LIMITED,
(Signed) Wm. S. Ball,
Power Engineer.

The departmental lines are all metered, making possible a systematic distribution of steam costs. **Flexibility plus accuracy** is briefly the result of electrical operation. It means that Republic Flow Meters will conform to your plant conditions—it means that you can rely on the indications of the reading instruments. **Write for complete information of the benefits of the Republic Flow Meters in your plant.**

Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

Republic System

145 Wellington Street West
TORONTO

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SOOT CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 34 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

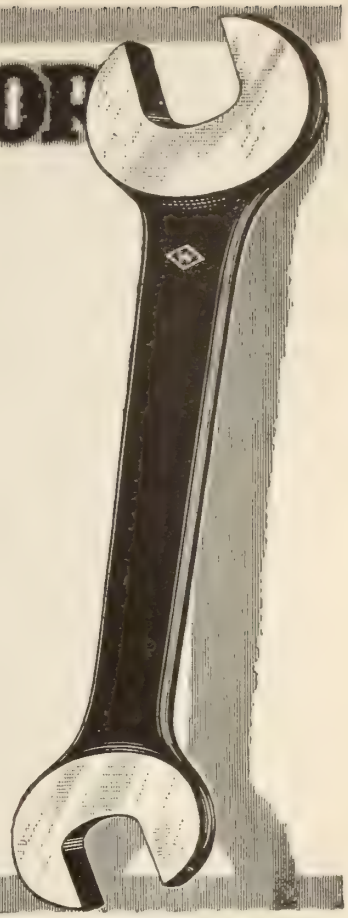
TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES



Better tools make better workmen—

And you can't buy a better wrench than a Williams

J. H. WILLIAMS & CO.
"The Wrench People"

CHICAGO	BUFFALO	BROOKLYN
1078 W. 120th St.	78 Vulcan St.	78 Richards St.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mech. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

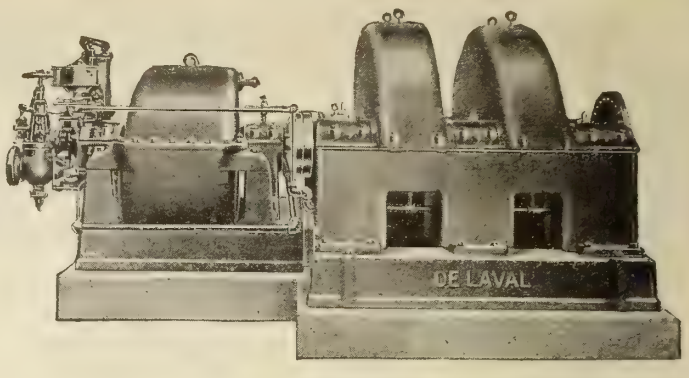
WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

DRIVE YOUR MACHINERY WITH DE LAVAL GEARED STEAM TURBINES



The De Laval Double-Helical Gear makes a highly efficient turbine drive possible and is not a new or experimental development, as many De Laval geared turbines have been in use for more than 25 years.

They are produced in a shop devoted exclusively to precision manufacture on a limit-gage, interchangeable basis. Conservative tooth pressures and velocities are adhered to in their design, which, with the best materials and workmanship, results in smooth, quiet running and long life.

Regardless of what you require power for, whether it be driving ships' propellers, steel mills, paper mills, centrifugal pumps and blowers, electrical machinery, or mill shafting, the De Laval turbine can be adapted to show the most economical results.

State conditions fully and our engineers will submit their advice and suggestions

Ask for Bulletin N-100

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LTD., 73 King St. W., Toronto
THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING COMPANY, LTD., Vancouver, B.C.

26

INDEX TO ADVERTISERS

A

Anderson Co., V. D. 23
Audel, Theo. 67

B

Babcock & Wilcox 83
Badger & Sons, E. B. 76
Betson Plastic Fire Brick Co... 28
Bishop Co., S. & C. 74
Brown, Wm. J. 26
Bowser, S. F. 29
Busch-Sulzer Bros. 73

C

Canadian Fairbanks-Morse Co. 65
Can. Link-Belt 31
Can. Mead-Morrison Co., Ltd... 9
Can. Steam Boiler Equipment.. 22
Cole Ltd., Geo. W. 22
Chaplin-Fulton Mfg. Co. 74
Coppus Engineering and Equipment Co. ..... Front cover
Crane Ltd. 26

D

Darling Bros. 81
Dart Union Co. 27
D'Este Co., Julian 73
Detroit Stoker Co. 68
DeLaval Steam Turbine Co..... 92
Diamond Specialty Co. 81
Dominion Belting Co. 76
Dunlop Tire & Rubber Goods Co. 12
Durabla Mfg. Co. 2

E

Electric Welding Co. 72

F

Federal Engineering Co. 72

G

Gates Refractories 26
Garth Co., The 81
Gilman, Frank 73
Goldie & McCulloch 38
Goodyear Tire & Rubber Co.... 16
Green's Economiser 75
Gutta Percha 14

H

Holden Co., Ltd., The 37
Homestead Valve Mfg. Co. 23
Hoyt Metal Co. 72

I

Imperial Oil Ltd. 3
Inglis Co., John ..... Inside back cover

J

Jeffrey Mfg. Co. 5
Jenkins Bros. 20
Johns Pratt 13
Jointless Fire Brick Co. 73

L

Ladd Co., G. T. 72
Laurie & Lamb 17, 77
Leitch, The Arthur S. .....
Inside front cover
Leonard & Sons, Ltd., E..... 6
Long, J. T. 66
Long, R. G. 69
Lunkenheimer Co. 1
Lyman Tube & Supply Co..... 30

M

McLaren's, D. K. 11
Manny Co., E. S. 72, 74
Mason Regulator & Engrg. Co. 18
Ministry of Munitions 19
Moore Steam Turbine Corp..... 74
Morrison Brass Mfg. Co., Jas.
Outside back cover
Mueller Mfg. Co., H. 85
Murphy Iron Works 15

N

Northern Equipment Co. 80
Nicholson, J. B. 24
Norwalk Iron Wks. Co. 21

P

Page Hersey Iron & Lead Co., Ltd. 83
Peacock Bros. Ltd. 10
Pedlar People, The 76
Petrie, H. W. 87
Pilley Packing & Flue Brush Mfg. Co. 72

R

Republic Flow Meters 89
Robb Engineering Co..... 2

S

Sanford Riley Stoker Co..... 15
Sarco Co., Inc. 67
Sexton Boiler Setting Co. 7
Scaife & Sons Co., Wm. B. 92
Shell Bar Boico Supply Co. 26
Smart Turner 72
Starrett Co., L. S. 28
Sturtevant, F. B. 78, 79
Steel Mill Packing Co. 74
Sterling Engine Co. 23
Superheater Co., Ltd., The.470, 471

T

Tagliabue, C. J. 21
Taylor Instrument Co., The..... 28

U

Under-Feed Stoker Co. of Can., Ltd., The 33-36

V

Victoria Foundry Co. 70, 71, 81
Vulcan Soot Cleaner Co. 8

W

Wall, W. J. 81
Waterous Engine Works 1
Watson & McDaniel Co. 81
Williams & Co., J. H. 91
Hamilton Co., Wm. 27
Weir, G. J. 10
Williams, A. R. 25
Worthington Pump & Machine Co. 32

Y

York Mfg. Co. 77

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

BOILERS

TANKS AND ENGINES

Of All Kinds for Any Service

Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.

14 Strachan Ave., TORONTO

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada:
JAMES W. PYLE & CO., LIMITED
232 St. James St., MONTREAL

MORRISON

Steam Goods

Profit by the experience of others!

Had not Morrison Steam Specialties demonstrated their superiority on all kinds of installations, they would not have won their present prestige among the engineers of Canada.

"Every Installation is a demonstration of merit"

The James Morrison Brass Mfg. Co., Ltd.

93-97 Adelaide St. W. TORONTO

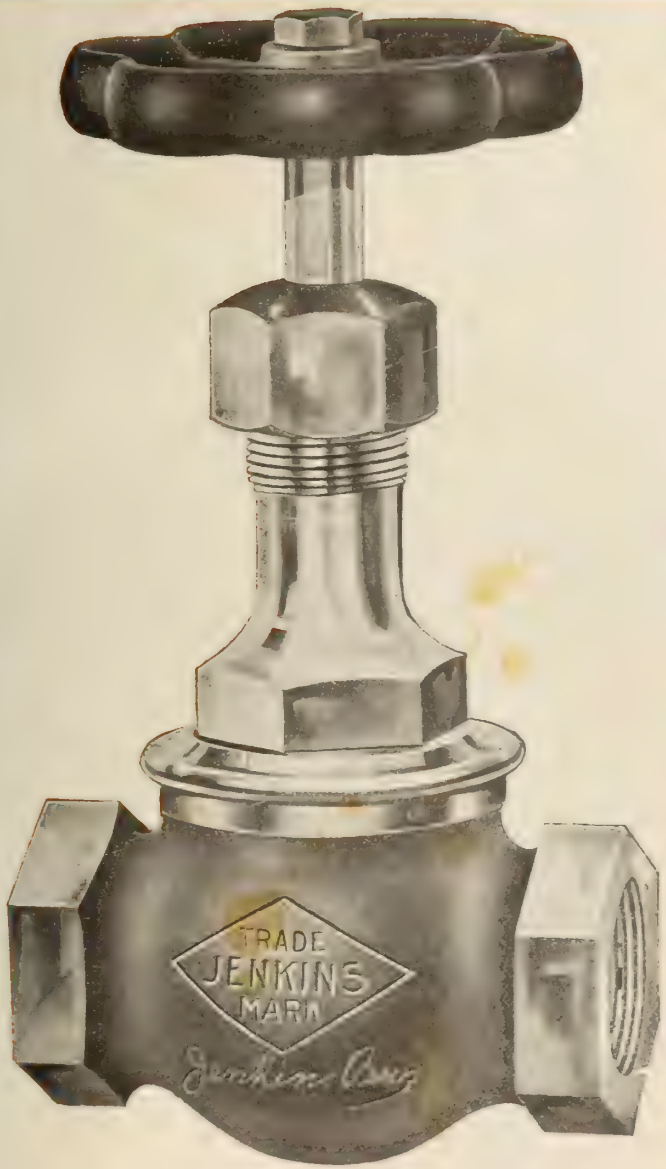
POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, E ectric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 21. Publication Office, Toronto—November 5, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year



Cutting Out Unnecessary Costs

The efficiency of a plant is determined to a very large extent by the dependability of its valve equipment.

If valves break down before other items of equipment an injustice is done to the entire plant, because valves should last as long as good plant equipment.

Good Valves Do.

JENKINS VALVES

are good Valves and the Diamond Trade Mark (cast upon the body) assures continued operation —even where the conditions of usage are most severe.

Their 56 years' service record guarantees that.

The time, labor and expense involved in "shut-downs" for repairs and replacements are entirely eliminated in plants equipped with Genuine Jenkins Valves.

TRADE JENKINS MARK
Jenkins Bros

The Diamond Trade Mark is a guarantee of the Genuine. Look for it when buying.

Catalog No. 8, which pictures and describes the complete line of Jenkins Valves, will be sent you on request.

Jenkins Bros.
LIMITED

TRADE JENKINS MARK Jenkins Bros

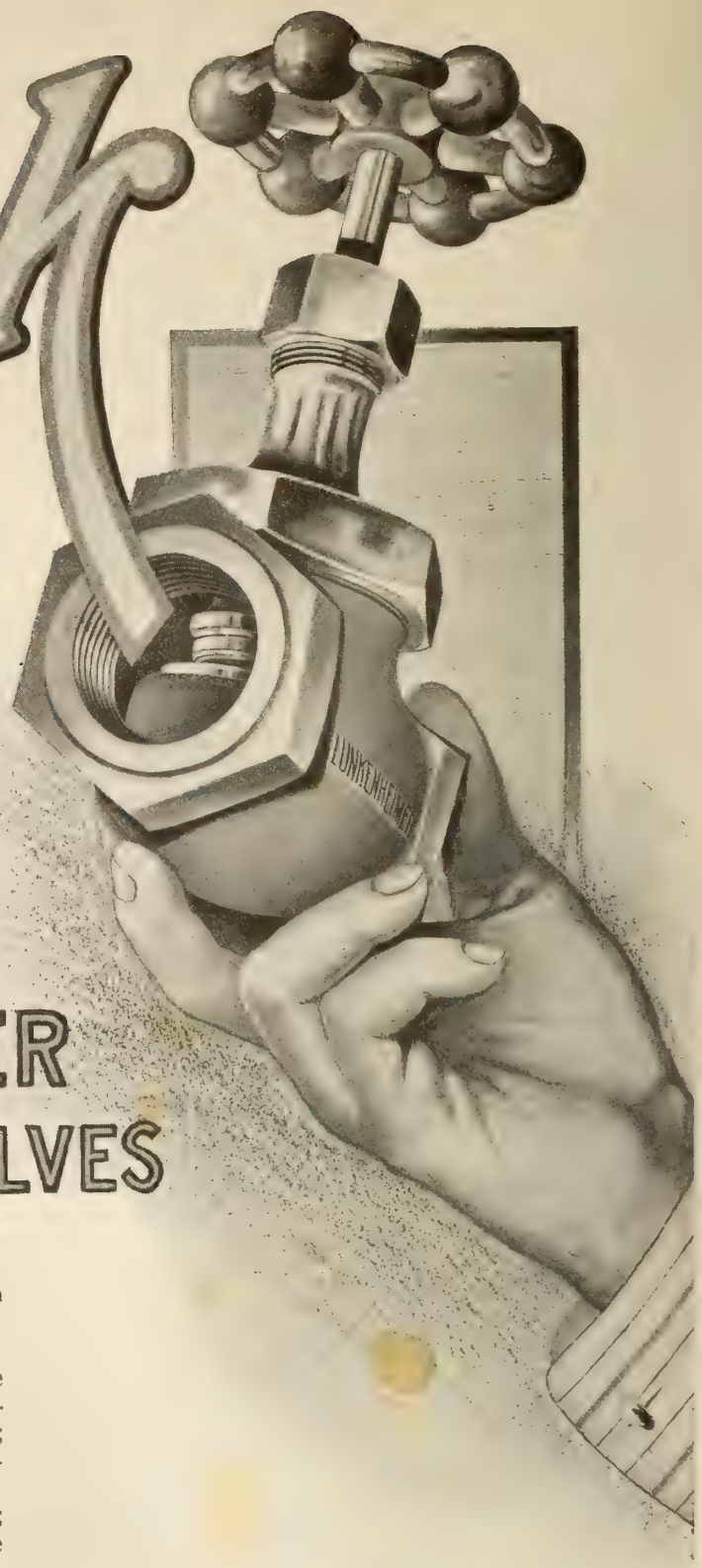
Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO European Branch 6 Great Queen St., Kingsway, London, W.C.2. Eng. VANCOUVER

AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

TRADE JENKINS MARK Jenkins Bros

Look



and satisfy yourself of the many advantageous features embodied in

LUNKENHEIMER "FERRENEWO" VALVES

The body is made of a Ferrous Composition specially alloyed for these valves.

Note the **seat ring** and **disc,**—both of which are made of Lunkenheimer "Valve-nickel," a material having exceptional wear-resisting qualities; the regrindable seating surfaces, the renewability of all parts, including the **seat ring** and **disc;** the full areas through the body; union bonnet; special composition stem, which insures long life to the stem threads; deep stuffing box, etc. These features combined with Lunkenheimer "quality" materials and workmanship make the "FERRENEWO" **the** valve of exceptional merit. Globe, Angle and Cross, and Horizontal and Angle Check Patterns, for working steam pressures up to 150 pounds.

Your local dealer can furnish them; if not, write us. Write for descriptive Booklet No. 576-DC.

2-11-43

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the world

New York Chicago **CINCINNATI** Boston London

Waterous

BRANTFORD, ONTARIO, CANADA

Steel Plate Work

We have made a success of building Steel Plate Work by specializing in it. The recent additions to our boiler shops, with the installation of new and most modern equipment, have put us in a better position than ever to handle this sort of work promptly and efficiently.

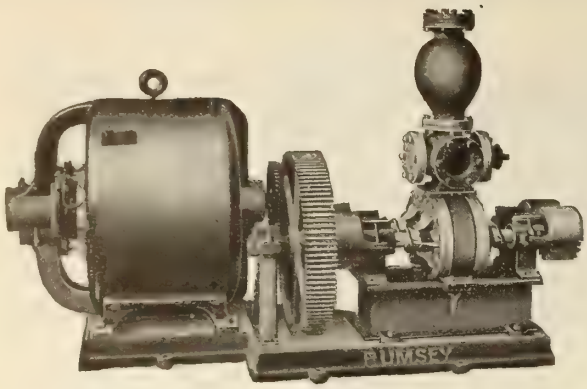
We use the best material only, build right up to specifications, and turn out this work in a modern shop by modern methods.

The name WATEROUS on your Steel Plate Work is your guarantee that it is built upon all the experience that the past can contribute to the needs of the present.

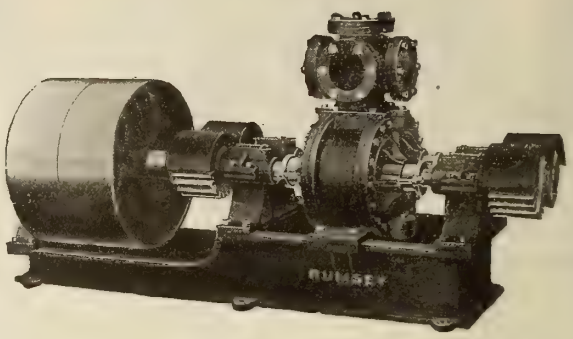
The Waterous Engine Works Co., Limited, Brantford, Canada

MOLSONS BANK BUILDING, VANCOUVER, B.C. BRANCH: WINNIPEG, MAN.

POWER HOUSE. November 5, 1920. Vol. XIII., No. 21 Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



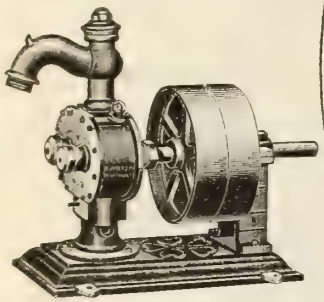
Rumsey Electric Rotary Fire Pump. Designed for general service as well as fire duty. For fire service, 100 pounds pressure is recommended and for general service 75 pounds.



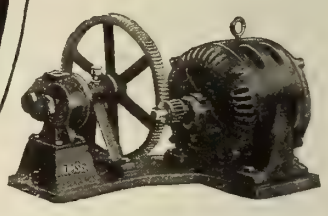
Rumsey Power Rotary Force Pump. Designed for water supply, oils or special liquids for elevations up to 170 feet and pressures up to 75 pounds. A moderately priced pump of large capacity.

RUMSEY ROTARY PUMPS

SENECA FALLS, NEW YORK



Rumsey Rotary Power Force Pump. An inexpensive pump of large capacity in great demand in industrial plants for elevations up to 80 feet. For handling water, oil, paint, varnish or special liquids.



Rumsey Rotary Power Force Pump. A light duty machine designed for returning oil to reservoir from drip pan, also for pumping lubricants for cutting tools, lathes, or other light work where a small pump is required.

Sectional View of Heavy Service Rotary Pump, showing the arrangement of the packing strips with which the toes of the cams are provided.

For general water supply, pumping to sprinkling systems, handling special liquids and for fire protection in mills and industrial plants.

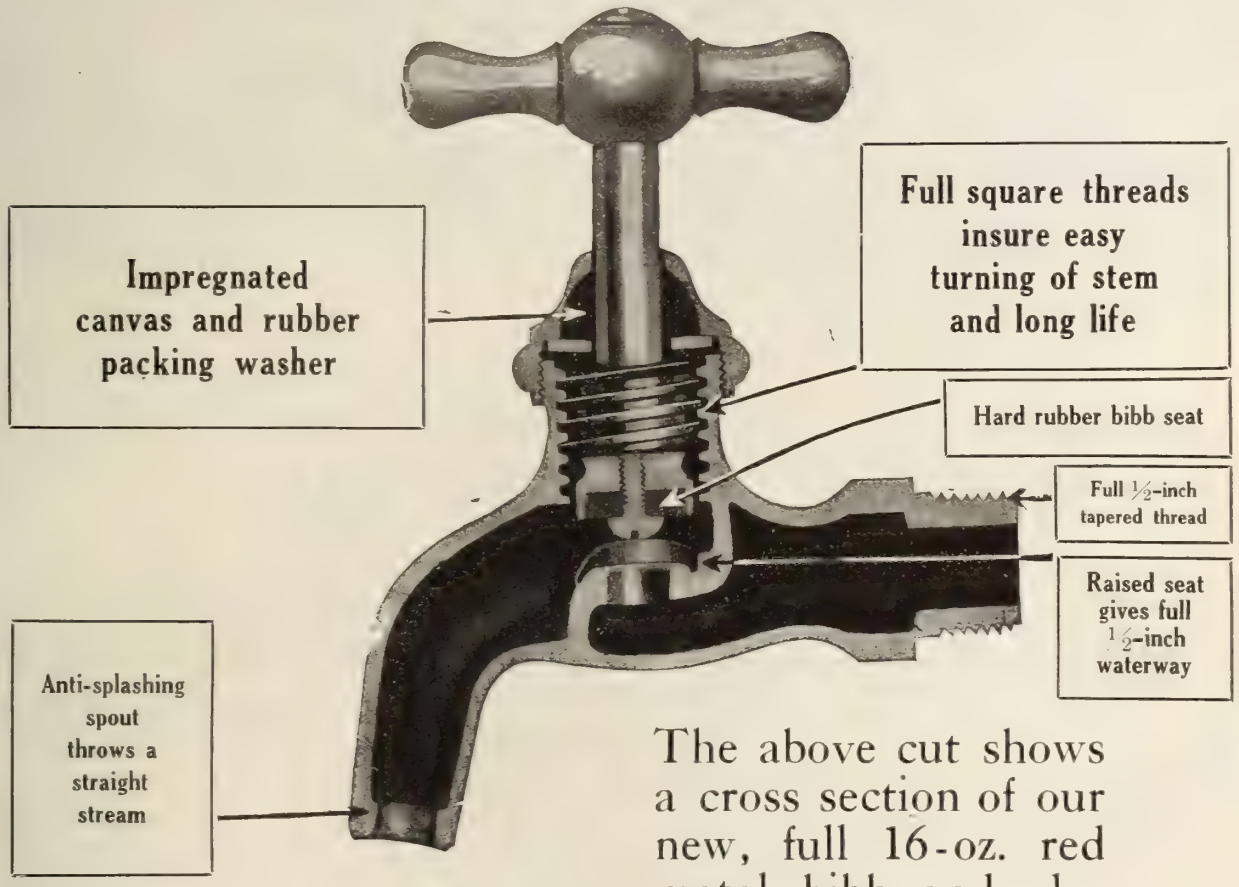
The compactness and convenience of Rumsey Rotary Pumps, their large capacity and low cost make them preferred for all kinds of general pumping. Rumsey Hand and Rotary Force Pumps will handle almost any liquid that will flow—water, oil, paint, varnish, gasoline, grease, tar, ink, extracts, sizes, soaps, chemicals, and commercial liquids of all kinds—liquids of a gritty nature and those corrosive to iron or bronze being excepted.

Is there anything further you would like to know about Rumsey Pumps? Full information gladly furnished by

THE ARTHUR S. LEITCH CO.

1001-2 Kent Bldg., Toronto, Ont.

Durable Anti-Splash Empire Bibb


Impregnated canvas and rubber packing washer
Full square threads insure easy turning of stem and long life
Hard rubber bibb seat
Full ½-inch tapered thread
Raised seat gives full ½-inch waterway
Anti-splashing spout throws a straight stream

The above cut shows a cross section of our new, full 16-oz. red metal bibb and also some of its outstanding features.

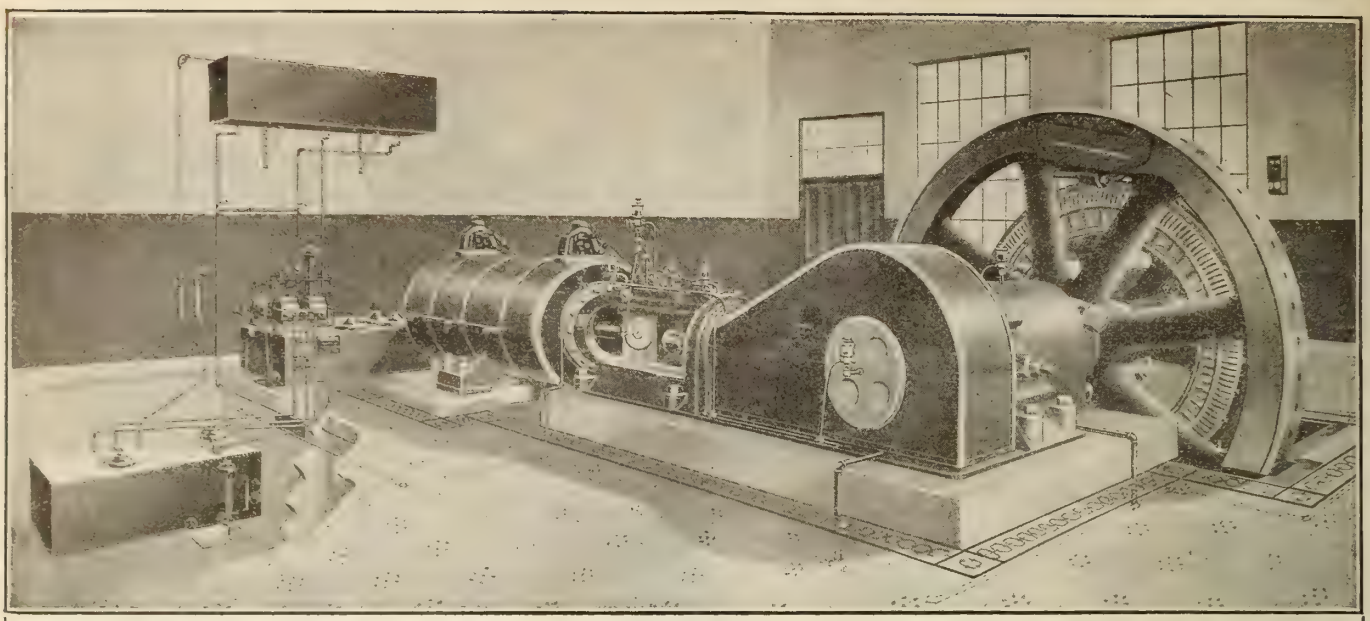
EMPIRE BIBB

We supply rigidly tested and guaranteed bibbs, any style, promptly. Write for Empire Catalog or specify your needs. We can be of special service to you.

When buying, specify our lines. Carried in stock by the largest and most progressive jobbers in Canada.

EMPIRE BRASS MANUFACTURING CO. LIMITED

London and Toronto, Canada



Above picture shows a practical application of a Bowser 6-F Oil Filtering and Circulating System. It can be used with engines and other machinery where the filtration of dirty oil is essential.

Write for our Booklet on Oil Filtration.

CONSERVATION OF OIL

The consumption of mineral oil products is increasing faster than the production. Consequently engineers are beginning to realize how important and necessary it is to conserve these oils.

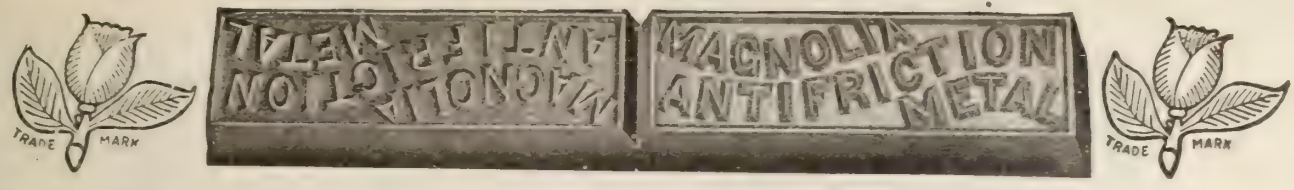
A Bowser Oil Filtration System will assist you in doing this.

By filtering oil with a Bowser System it can be used over and over again---or indefinitely. The installation of a Bowser Complete Oil Filtering and Circulating System generally results in a saving of over 50 per cent. on your oil bill.

S. F. BOWSER COMPANY, LTD.

66-68 Fraser Avenue

Toronto - - Canada



New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

The best bearing metal may come to grief through mechanical defects, which no babbitt could withstand, or by reason of faulty lubrication, as a grease that is too heavy for a light-running bearing, or an oil too thin for a heavy bearing, will invariably cause heating.

A highly fusible alloy rarely, if ever, gives timely warning before running out, whereas a Magnolia-lined bearing heats so slowly that it permits of either shutting down or cooling off the bearing, while running, without injury to shaft or bearing, and we shall recite cases where entire lack of lubrication has done no harm.

Tin is not the only metal that lowers the melting point of an alloy.

It is most natural to suppose that the melting point of a lead-antimony mixture would not be lower than lead, but that the addition of antimony would even make it higher. The eutectic of this series is 87 per cent. lead and 13 per cent. antimony and the melting point is 447° Fahrenheit, or 212° Fahrenheit less than the mean of the two metals.

It is a common practice to guarantee the melting point of babbit metals to be 600° Fahrenheit, and over, and to view this practice from a charitable standpoint, this guarantee is doubtless given because it is taken for granted that such ought to be the melting point. It is quite evident that the guarantors are not hampered by facts and have no definite knowledge upon which to base their assertions, but they run no risk of detection as buyers are just as much in the dark.

We have a Die-Casting Catalogue of recent date in which is given the melting point of their Genuine Babbitt as 810° Fahrenheit. We believe these figures were obtained from a college laboratory, which gives absolution from intentional misrepresentation, as it is highly improbable that such a wonderful alloy exists, but like many other babbitt manufacturers, they don't know any better.

(Continued next month.)

For copy of complete article :
"New Truths and Old Fallacies"
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.
OF CANADA, LIMITED
Office and Factory:
Montreal : 37-39 Shannon St.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

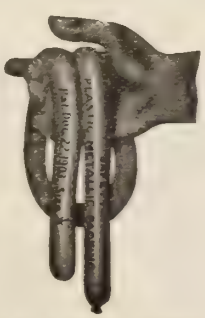
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

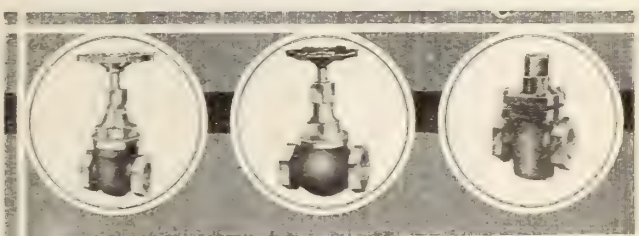
Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes



Million-Dollar Companies Use Products of

PRATT & CADY

During the past five years 27 per cent. of our out-put has been purchased by concerns rated at a million dollars or more—big concerns like Colgate & Co., Standard Oil Co., Victor Talking Machine Co., Ford Motor Co., Woolworth Bldg., Metropolitan Life Insurance Co., Bethlehem Steel Co.

Big companies can afford to hire big men to select their valves and asbestos packed cocks. And big men, like big companies, don't make many mistakes. They know what they're doing when they place an order.

Practically all of these firms have been using P. & C. Products for years. Many have used our goods for nearly half a century, or as long as we have been in business.

When concerns like these use Pratt & Cady Products, isn't it a pretty safe guide for you to follow?

Catalog sent on request.

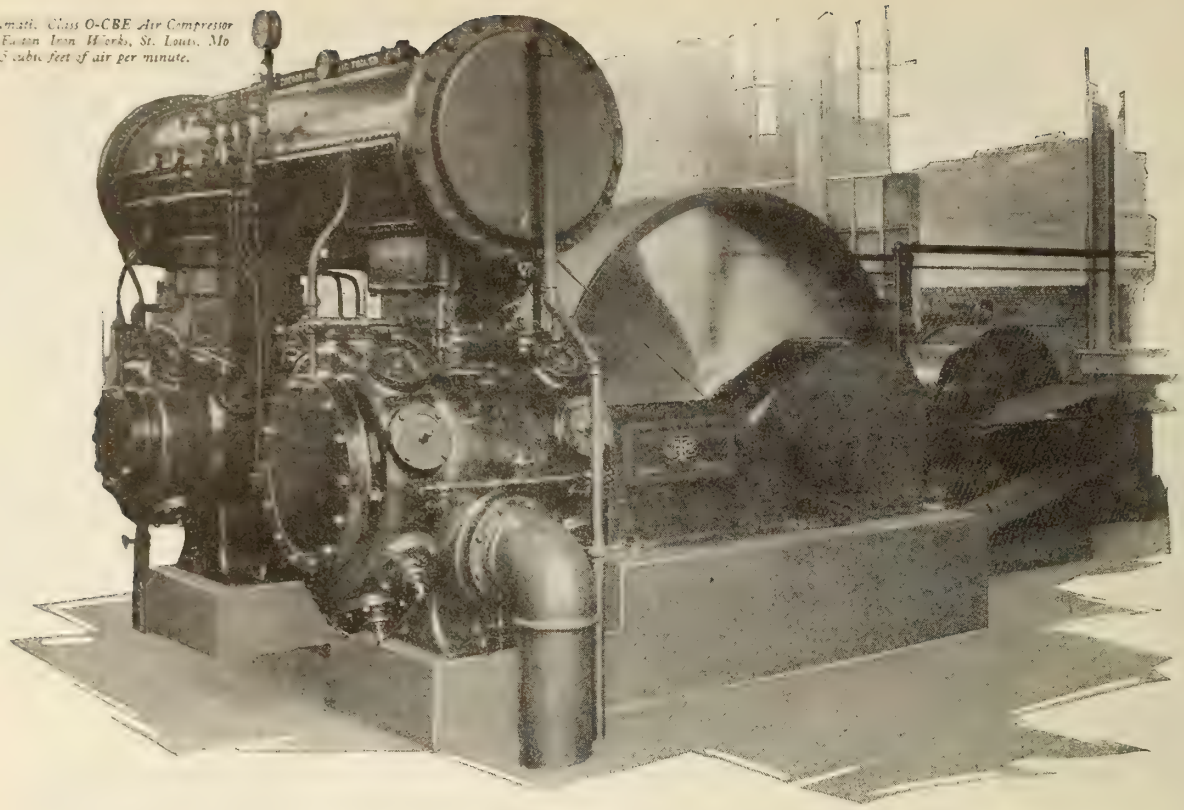
PRATT & CADY CO., Inc.

Manufacturers of Valves, and Asbestos Packed Cocks.

Factory: Hartford, Conn.

The Canadian Fairbanks-Morse Co., Ltd., Halifax, St. Johns, Quebec, Montreal, Ottawa, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

P&C CO



Chicago Pneumatic Class O-CBE Air Compressor motor-driven by Easton Iron Works, St. Louis, Mo Capacity 1145 cubic feet of air per minute.

Is your air compressor sometimes a vacuum pump?

IT IS when the inlet is *choked* in connection with the unloading mechanism.

Choking the suction of an air compressor at no load forms a partial vacuum and *wastes power.*

Contrast this with the operating principle of a Chicago Pneumatic Air Compressor. At no load the valves are automatically held open, permitting free air *without vacuum*—gaining a distinct power-saving over compressors using the choked intake system of unloading.

Standardize with Chicago Pneumatics—"the Compressor with the Simplate Valve." Ask for Bulletin 400.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

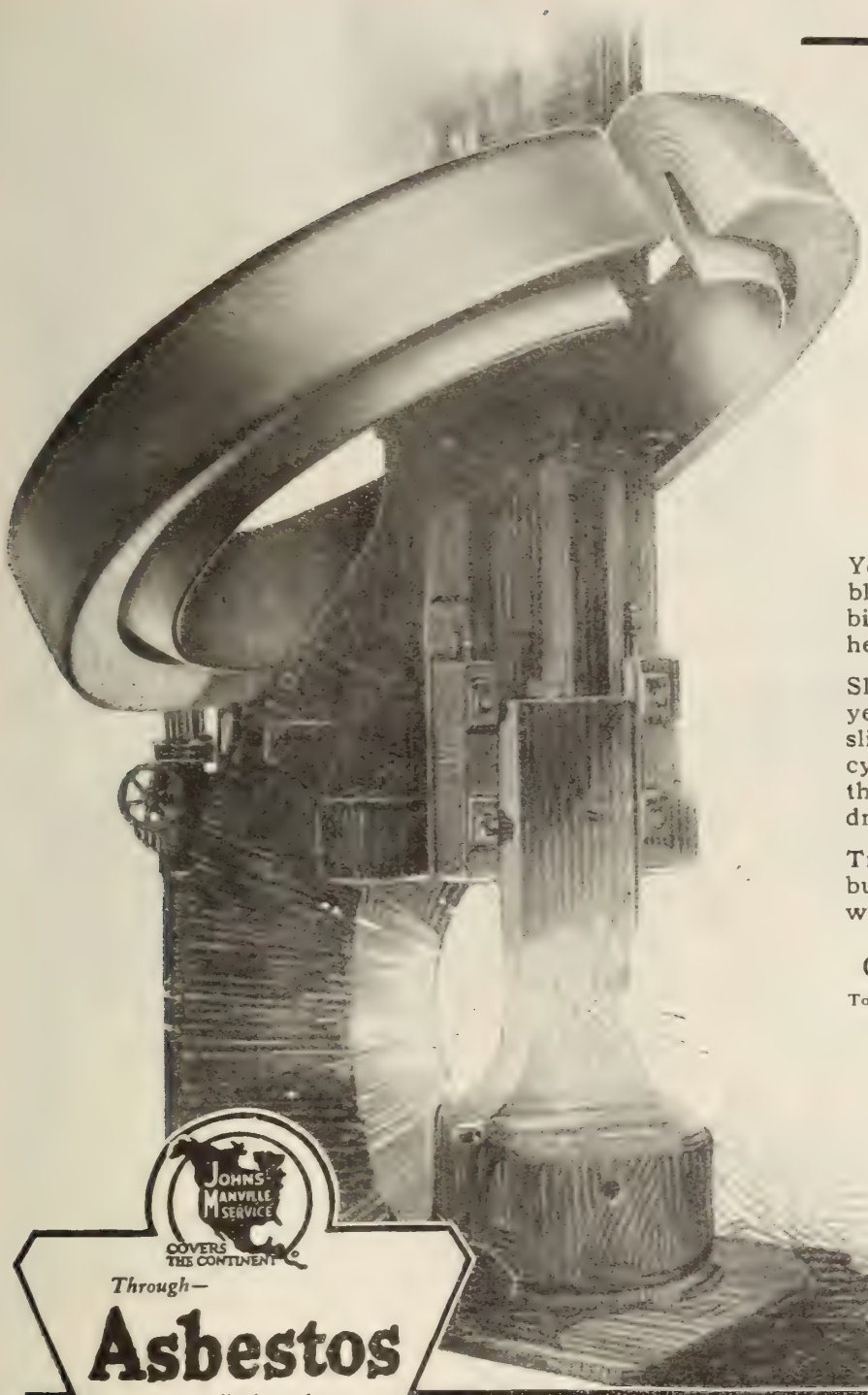
C 72 H

BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

The blow of a giant —or the touch of a baby



DULL, heavy thuds that send the white sparks flying—that beat the unwilling metal into useful forms. Swift, gentle taps that finish off the work.

The steam hammer is a marvel of responsive obedience to those who treat it properly. Keep it oiled, keep it clean and pack it right.

You can't expect instant response on light blows or full force on heavy ones if you bind the rod with inert packing, jammed and held steam-tight by powerful gland bolts.

Slip in a set of Sea Rings, they can't bind yet their pliant lips act instantly to stop the slightest loss of steam. The higher the cylinder pressure, the tighter they pack, but they ease off the moment the pressure drops, and never cause unnecessary friction.

Try Sea Rings, not only on steam hammers, but on pumps, engines, air compressors or wherever a rod or plunger has to be packed.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa Windsor

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

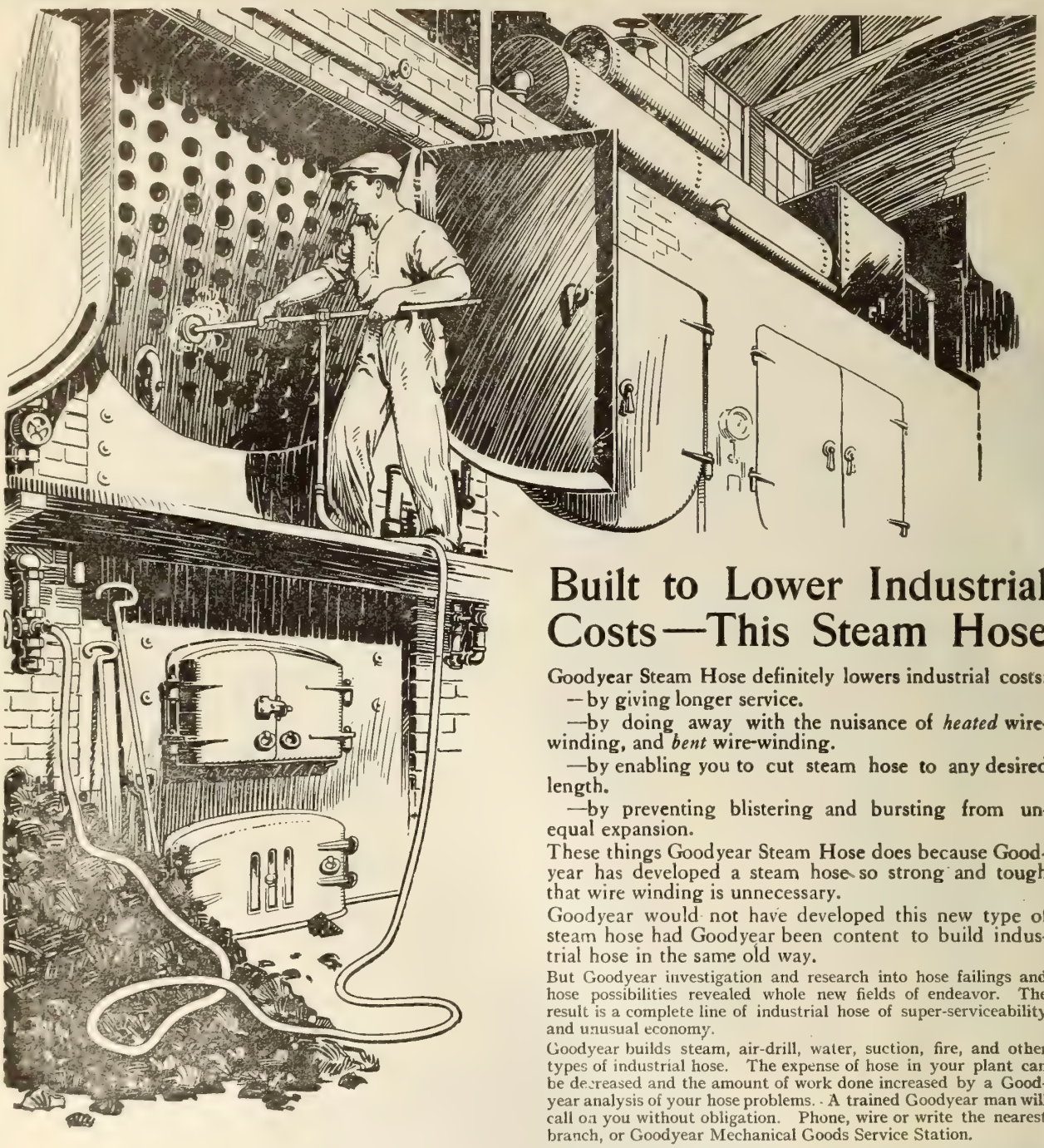
and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE

POWER PLANT MATERIALS



Built to Lower Industrial Costs—This Steam Hose

Goodyear Steam Hose definitely lowers industrial costs:

—by giving longer service.

—by doing away with the nuisance of *heated* wire-winding, and *bent* wire-winding.

—by enabling you to cut steam hose to any desired length.

—by preventing blistering and bursting from unequal expansion.

These things Goodyear Steam Hose does because Goodyear has developed a steam hose so strong and tough that wire winding is unnecessary.

Goodyear would not have developed this new type of steam hose had Goodyear been content to build industrial hose in the same old way.

But Goodyear investigation and research into hose failings and hose possibilities revealed whole new fields of endeavor. The result is a complete line of industrial hose of super-serviceability and unusual economy.

Goodyear builds steam, air-drill, water, suction, fire, and other types of industrial hose. The expense of hose in your plant can be decreased and the amount of work done increased by a Goodyear analysis of your hose problems. A trained Goodyear man will call on you without obligation. Phone, wire or write the nearest branch, or Goodyear Mechanical Goods Service Station.

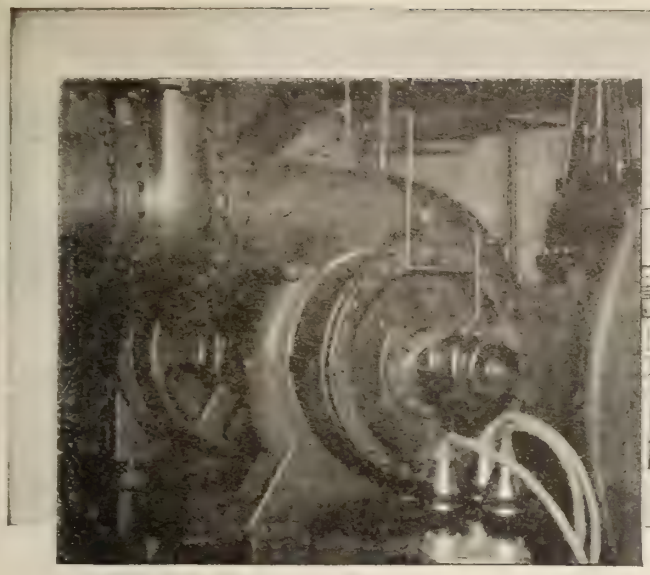
The Goodyear Tire & Rubber Co. of Canada, Limited

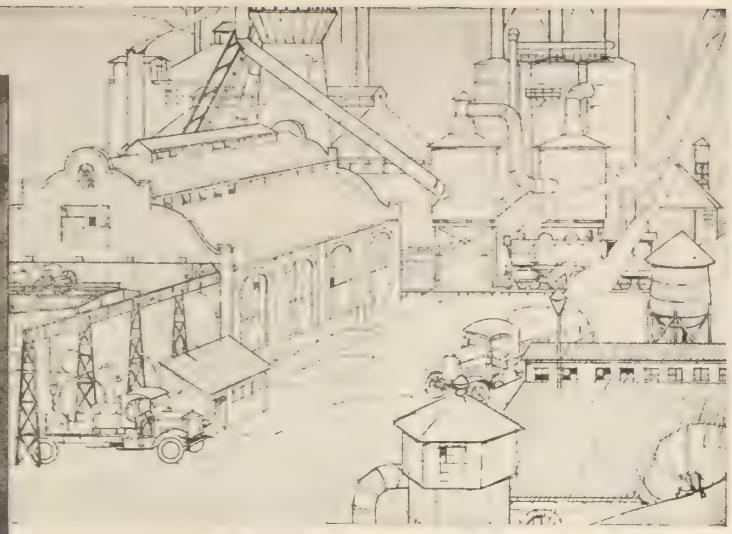
Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, Vancouver.

GOODYEAR

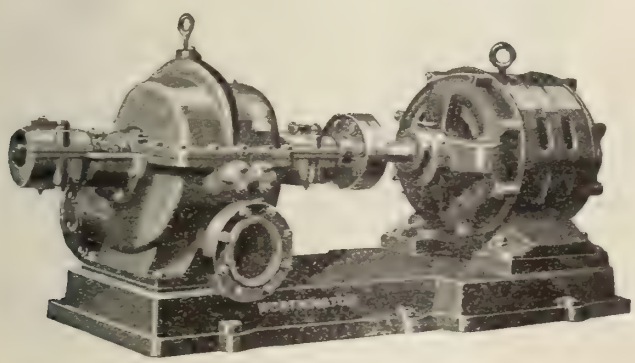
MADE IN CANADA

INDUSTRIAL HOSE





20" class B Worthington Double Suction Volute Pump, direct connected to 350 H. P. 500 R. P. M. 25 cycle motor, having a capacity of 18,000,000 gallons of water per day of 24 hours against a head of 70 feet.



Worthington Split Case, Double Suction Volute Pump

Other Worthington Products:

Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

The original of this installation photograph

. . . is working today and has been working continuously, 24 hours a day, 7 days the week for 9 years as one of two main water supply pumps of the central plant of the American Rolling Mill Co., Middletown, Ohio.

And the separate pump pictured is the improved today's model—Worthington Double Suction Volute Pump. This pump incorporates many particular Worthington refinements and delivers a very efficient, economical pumping service. For none of the good points of the older model have been omitted, and every new construction feature has been added only after extensive experimental work, and intensive research by our corps of engineering experts.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: **115 Broadway, New York City**
Branch Offices in 24 Large Cities

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*

LINDE

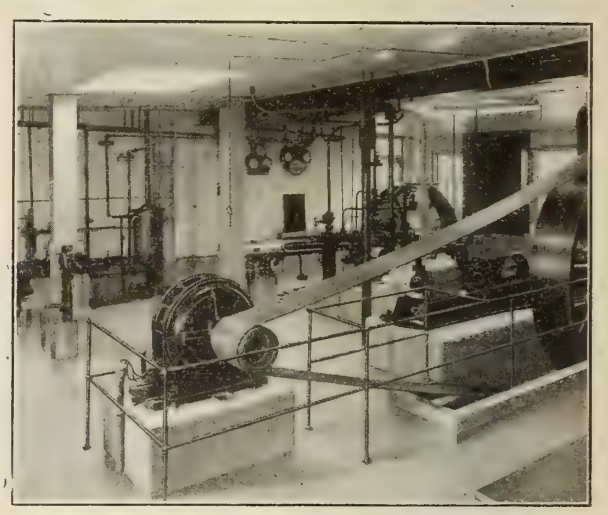
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.

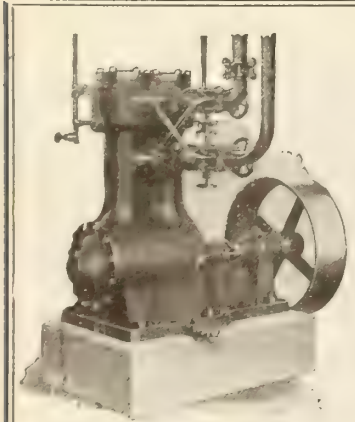


This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

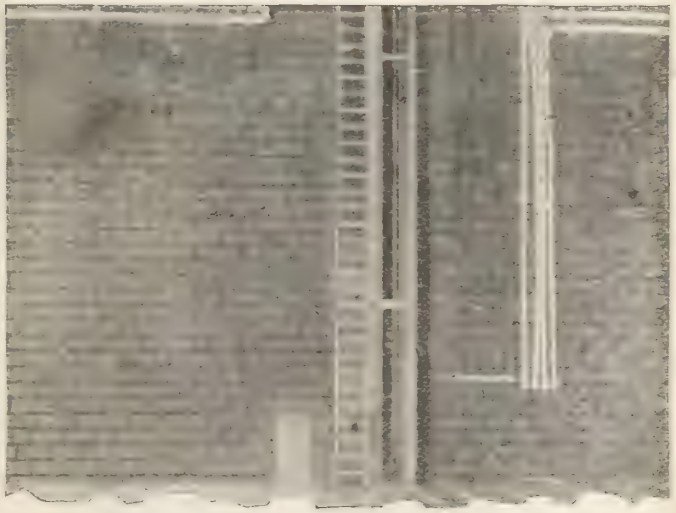
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Next Summer's Prices for this Winter's Ice

THE economy of ice storage has been conclusively demonstrated. Storage of slack season production means reduced cost because of continuous operation. Furthermore, it insures an ample hot weather supply and increases plant capacity without additional machines.

The important consideration is the cost of refrigerating the storage room, and that depends largely on the quality of insulation used. With Nonpareil Corkboard in sufficient thickness, very little refrigeration will be required; operating cost will be low, making the storage profitable.

An ice storage should not require re-insulation every few years. And it won't if Nonpareil Corkboard is used. For not only is Nonpareil Corkboard most efficient in retarding the inflow of heat, but it is non-absorbent and non-decaying. Properly installed, it should last as long as the building.



Peoples Ice Company, Wichita Falls, Tex. Insulated with Nonpareil Corkboard, mastic finish

The Company's engineers will gladly furnish you with reliable data on the construction and economy of an ice storage for your plant. If interested, write for information and a copy of the book, "Nonpareil Corkboard Insulation." No charge or obligation for either.

ARMSTRONG CORK & INSULATION COMPANY, 504 McGILL BUILDING, MONTREAL, QUEBEC, CANADA

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

NONPAREIL CORKBOARD INSULATION

For Ice Storage Rooms

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative:

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.
CALGARY: 605 Second Street

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

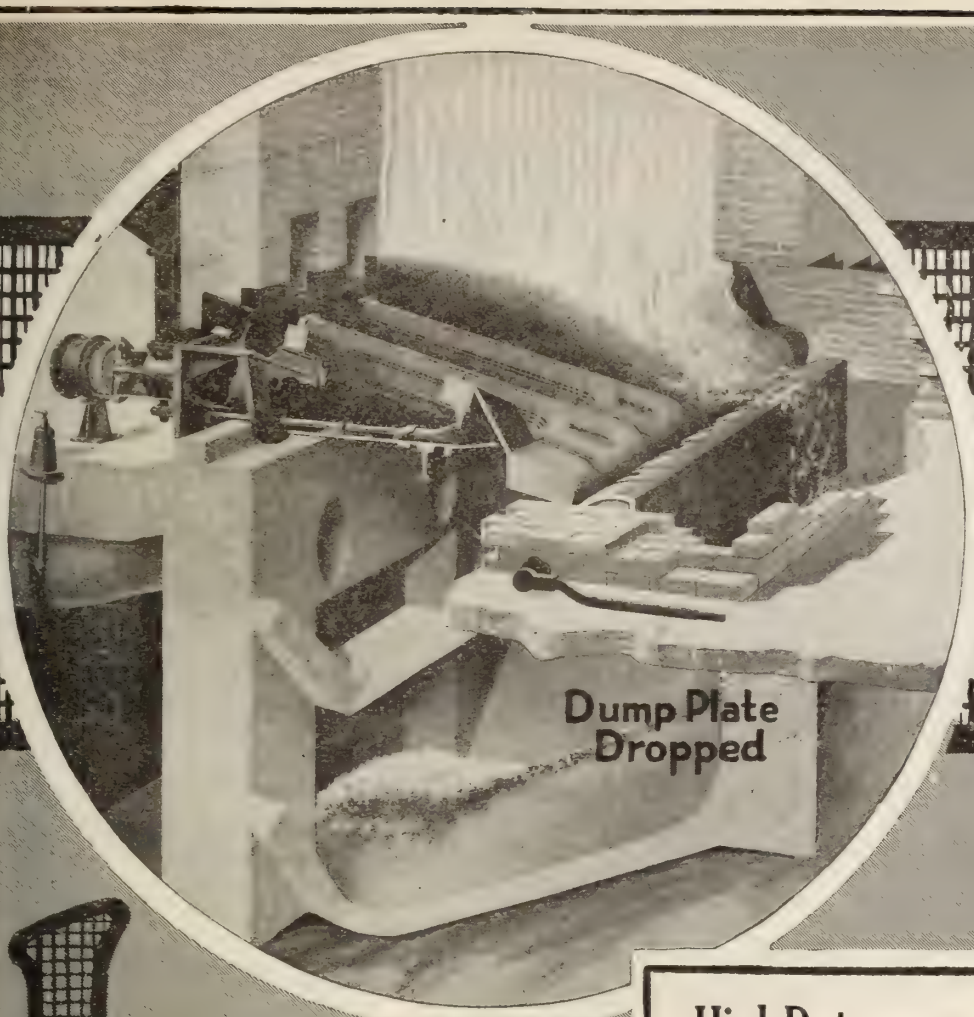
THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**



Jones "A-C"

write for the new catalog

High Duty means Low Cost

Make this simple comparison: Balance the guaranteed saving of the Jones "AC" Stoker against the interest on investment necessary for a complete installation. This is the true test of stoker worth.

The first cost of any stoker is a fixed amount, so that it is the many factors covered by the one word "saving" that determine the real cost of a stoker—saving in fuel, in labor, and as a result of reduced maintenance cost—these are the all-important items.

Hundreds of power users have found Jones Stokers a highly profitable investment as a result of unequaled ability to—

Save coal—by correct application of the Jones Under-Feed principle, which insures greater boiler capacity, ability to meet violent load fluctuations, and effective operation with every grade of coal. Save labor—by automatically controlling the supply of fuel and air, and by practically eliminating clinker trouble.

Reduce maintenance cost—as a result of extreme simplicity, rugged construction, and general accessibility.

The Jones "A-C" Stoker is manufactured by an old-established Canadian Stoker Manufacturer, newly reorganized to render a greater engineering service to Canadian power users. Write for extensive catalogs.

The Under-Feed Stoker Company of Canada, Ltd.
81 VICTORIA ST., TORONTO

Pays for Itself-then Pays Dividends

THE STOWE STOKER

EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

The Incline Results in Strong Ignition Temperatures

The Stowe Stoker is the *only* conveyor feed built on a decided incline. Every engineer can readily understand the underlying principles of such an incline, and appreciate its great value in producing strong ignition temperatures.

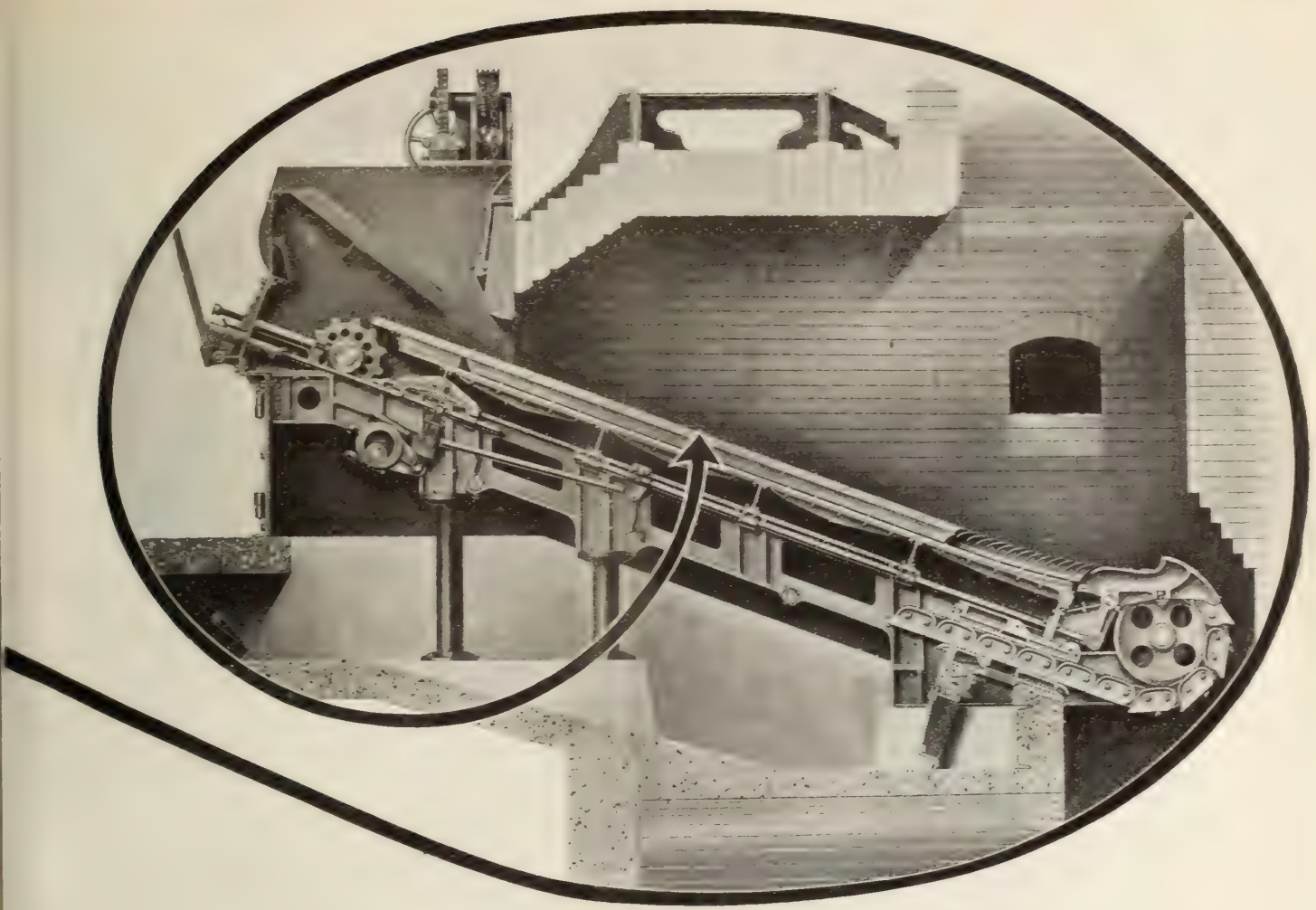
This advantage is particularly apparent in the burning of coals that are hard to light up, because of high moisture or low volatile, such as lignite, coke breeze, river anthracite, and the semi-bituminous coals.

The incline of the Stowe Stoker, because of the (resulting) high bridge wall, vertical flame travel and good furnace arrangement generally, produces very high temperatures at the front of the furnace, causing the incoming coal to ignite with great rapidity and intensity.

Coal will burn only as fast as it can be made to ignite, and *all* stokers have at times their limitations in this one particular. The rate of ignition in the Stowe Stoker, however, *exceeds that of all others,* with the added advantage of a positive, uninterrupted action from coal-hopper to ash-pit.

LACLEDE

A BUSINESS INSTITUTION



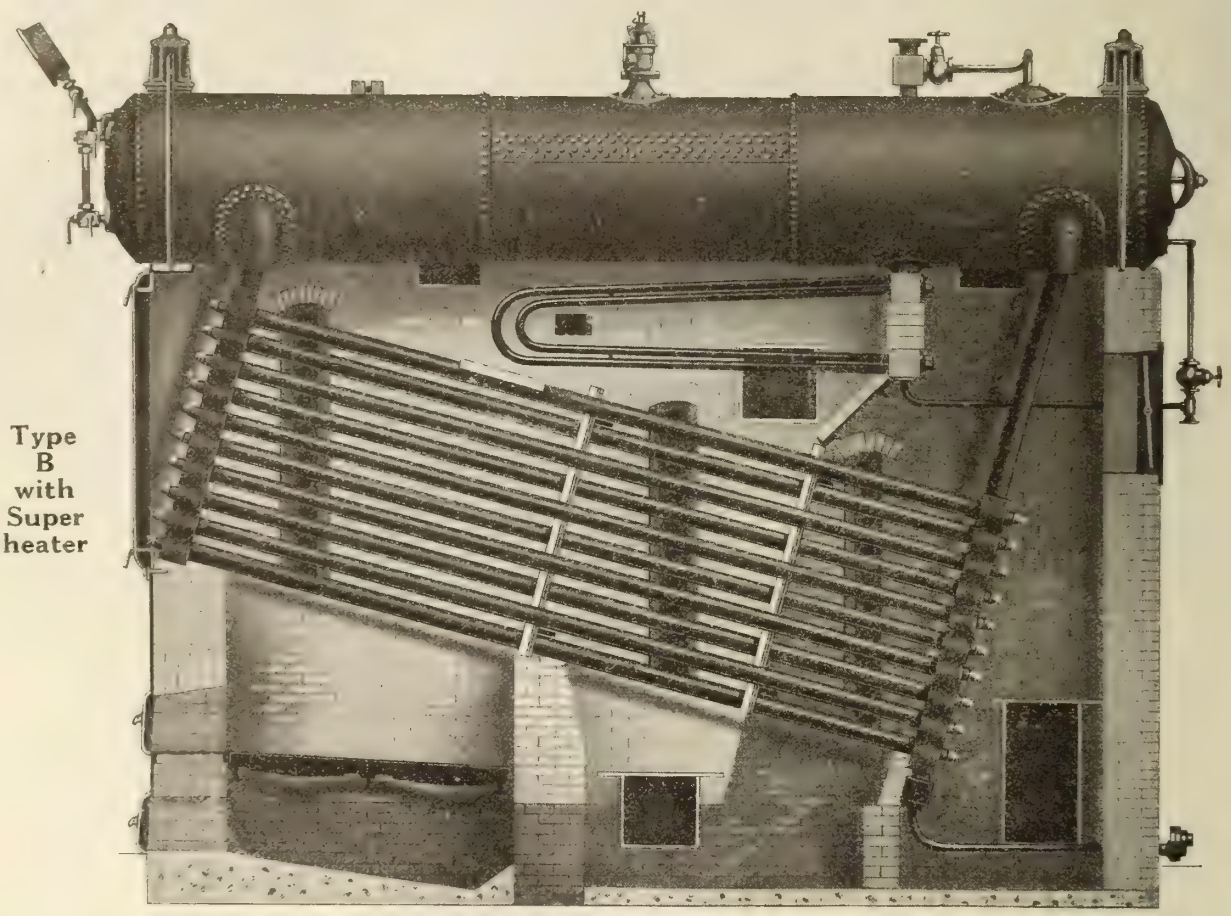
We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices: CHICAGO, 1366 Peoples Gas Bldg. PITTSBURGH, 901 Oliver Bldg. NEW YORK, 504, Fifty E. 42nd St.

CHRISTY

FOUNDED 1844 ST. LOUIS

DEPENDABLE POWER EQUIPMENT



Type B with Superheater

G. & McC. Co.

SECTIONAL WATER TUBE BOILERS

Superior in Design and Construction

Greater combustion area and increased steaming capacity are two important features of Goldie & McCulloch Water Tube Boilers that distinguish them from ordinary boilers—they can be forced without danger. They are equipped with large steam and water drums and connecting nipples of increased sizes, and every part subjected to steam pressure is made of FORGED STEEL. Send for full description.

The Goldie & McCulloch Co., Limited

Head Office and Works, GALT, Ontario, Canada

Toronto Office: Suite 1101-2, Bank of Hamilton Bldg.

Quebec Agents: Ross & Greig, 400 St. James St., Montreal, Que.

Western Branch: 248 McDermott Ave., Winnipeg, Man.

British Columbia Agents: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Power Plant of a Flour and Salt Mill

The Western Canada Flour Mill Co. at Goderich Operates a Combined Salt and Flour Mill—The Steam After Driving the Mill, Goes to the Salt Plant to Evaporate the Brine.

By T. H. FENNER

WHILE everyone is aware that flour and salt are two very necessary ingredients in making bread, it is not generally known that they can be manufactured together in the same mill. Of course it would not always be feasible, as it is in the case we are about to describe. Here the flour mill happens to be located over a bed of brine, and the same steam power is used to drive the elevator, run the flour mill, pump the brine, and make the salt. In fact the use of the steam in this plant recalls the use of the pig in the packing plant. Nothing is lost but the squeal, in the case of the pig. The steam, possessing no squeal, cannot lose it, and everything else is fully utilized.

The mill in question is that of the Western Canada Flour Mills Co., situated at Goderich, Ont., and it is an interesting plant from the point of view of the power plant engineer. We do not mean by this that it is a plant replete with all the most modern devices and instruments to make for efficiency, because it is not that. We do mean to say, however, that for a plant that suffers from perhaps a little more than the usual drawbacks it is a model of good management and efficiency. The good results obtained from the plant are due of course to the utilization of the steam in the salt manufacture, but it is due to the care bestowed on the upkeep that all the steam that passes through the engines is delivered to the salt plant. In other words, there are no leaks.

Description of Plant

The boiler room contains six boilers, five of which are Heine water tubes and one Babcock & Wilcox water-tube. These boilers are of various ages, the last to be installed being the B. & W. unit, which is about eleven years old. Two of the Heine boilers are fifteen years old, and the other three are twenty years old. The three latter have a combined heating surface of 3,051 square feet, the other two having 2,758 square feet, the B. & W. unit being of 3,140 square feet. This gives a total heating surface of 8,949 square feet, or 895 rated horsepower. The working pressure is of course governed by that allowed the oldest boilers, and the safety valves are set at 130 pounds. Hand firing is in use, and the coal has to be wheeled into the boiler room by a horse and cart, ashes being removed in the same way. The coal is brought into the yard from the steamers by the belt conveyor shown in the illustration and dumped on the pile. Formerly the coal was shoveled onto the carts to be taken to the boiler room, but a better method is now in vogue. A small donkey engine has been rigged close to the pile, and from this drags or scoops are operated, which pull the coal from the pile on to the cart in cartload lots. The horse that runs the coal cart has had the lesson of efficiency instilled in him as he absolutely refuses to do any other job than this one. He can reach the boiler room from the coal pile, back in, unload, and come out with the minimum number of steps, and so much is he engrossed in the power plant that he will allow no one but a power plant man to come near him. Mr. Taylor, the chief engineer, claims that a card taken from him would show very high power development on a small consumption (oats we presume).

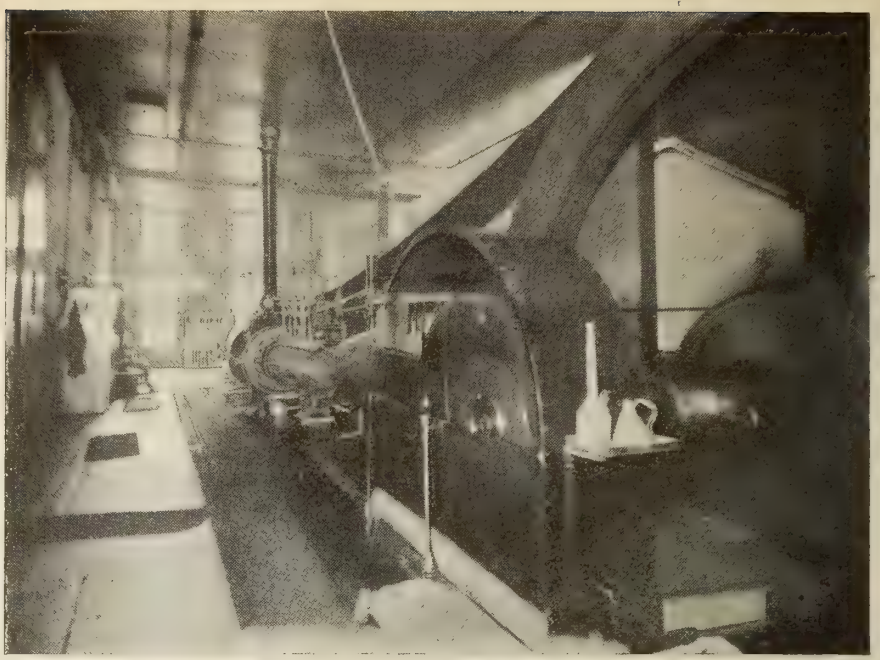
The only automatic appliances in the boiler room consist of Gelison draught gauges and a McDonough feed regulator on one boiler. There is a McDonough damper regulator fitted controlling the stack damper, and this has proved a very useful auxiliary. These boilers are always being worked up to and above rating, and under the hand-

THE GRAIN ELEVATOR COAL CONVEYOR AND COAL PILE.

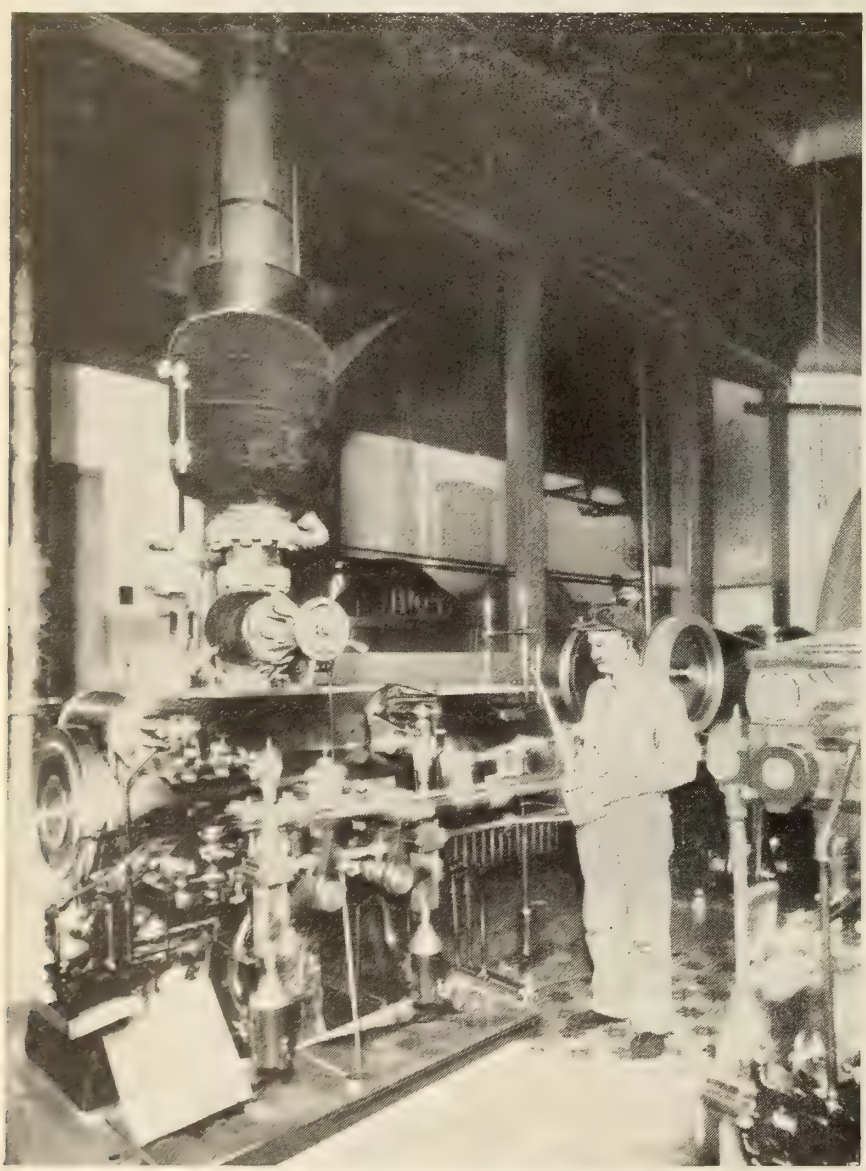
firing conditions considerable lifting of safety valves took place, with the usual amount of loss attendant on safety-valve blowing. The installation of the damper regulator has done away with this, and the only occasions on which the valves lift now are at the daily inspection.

The Engines

The mill power plant proper contains two engines, one of the Corliss type and one cross compound with Brown valve gear. The Corliss engine is interesting in that it has a history and is of ancient lineage. It was installed in the mill about the year 1874 by the same man who installed the famous Corliss engine at the Centennial Exposition in the United States. It ran without a hitch until the year 1913, when the strap on the connecting rod end broke. This resulted in a smashed-up cylinder, and led to the replacement of this part of the engine. A new cylinder 26 inches diameter was fitted, together with new valve gear, and the opportunity was taken to replace the old single eccentric arrangement for all valves with the more modern double eccentric, one for the steam and one for the exhaust valves. The engine as it stands to-day is 26 inches by 60 inches stroke, with a speed of 65 revolutions per minute. The original guide frame, connecting rod, flywheel and journal are still in commission. The flywheel is 22 feet 4 inches in diameter, with a 36-inch face. No doubt, due to this heavy wheel and efficient governor regulation, the speed of this engine is remarkably regular, a highly important feature of a flour mill engine.



THE OLD CORLISS ENGINE.



THE BROWN ENGINE. NOTE EXTRA LARGE PIPE ABOVE SEPARATOR.

In the same engine room there is a cross compound engine 15 inches by 24 inches by 36-inch stroke, fitted with Brown valve gear and built by the now defunct Polson Iron Works in 1910. This engine as originally built was designed for 88 revolutions per minute. In the year 1913 the demand for power rose from 750 to 950 horsepower, and to get the increase this compound engine was increased from 88 to 98 r.p.m. In this connection a difficulty arose, which was overcome in an ingenious manner by Mr. Taylor, the chief engineer. This gentleman has the very good habit of putting an indicator on all his engines at very frequent intervals, a habit which has much to do with his success. Any change in valve operation due to ordinary wear and tear which develops in working is thus speedily discovered and corrected. After increasing the speed of the engine the steam line of the indicator diagram showed a drop from the point of stroke commencement, such as would be shown by insufficient port opening. Increasing the lead did not overcome the trouble, and it was necessary to go further afield. Mr. Taylor then applied his indicator to the steam chest itself and speedily discovered his trouble. The increase of speed had caused a greater demand than the steam pipe had capacity for, or in other words the greater velocity of the steam led to a decrease in pressure. In order to correct this the larger diameter pipe which is seen in the photograph on the steam

THE BRINE PUMP SHOWING THE OVERHEAD GEAR USED BY WELL SINKERS.

pipe of the engine was added, with very good results. The cards are reproduced here showing the alteration from conditions before fitting the large pipe, or receiver, and after. The improvement is very noticeable.

There is a small electric lighting unit also in this engine room, an Ideal type 9 by 12 inch, running at 300 r.p.m., developing 50 horsepower.

The exhaust steam from all these engines is run to the salt plants, which will be described later.

The Grain Elevator Engine

The huge grain elevator is run by a cross compound Goldie & McCulloch engine 15 inches by 28 inches by 30 inches, running at 120 revolutions per minute, and developing 350 h.p. This engine is condensing, and drives through a belt a 220 kw. 60-cycle generator, running at 600 r.p.m., which supplies current to the motors in the elevator. The grain is taken from the ship's hold and elevated into a marine leg, the engine operating the grain shovels being a 10-inch by 10 inch at 300 revolutions per minute. From the marine leg the grain is conveyed through a tunnel and into the elevator bins by belt conveyors, and stored there until required in the mill.

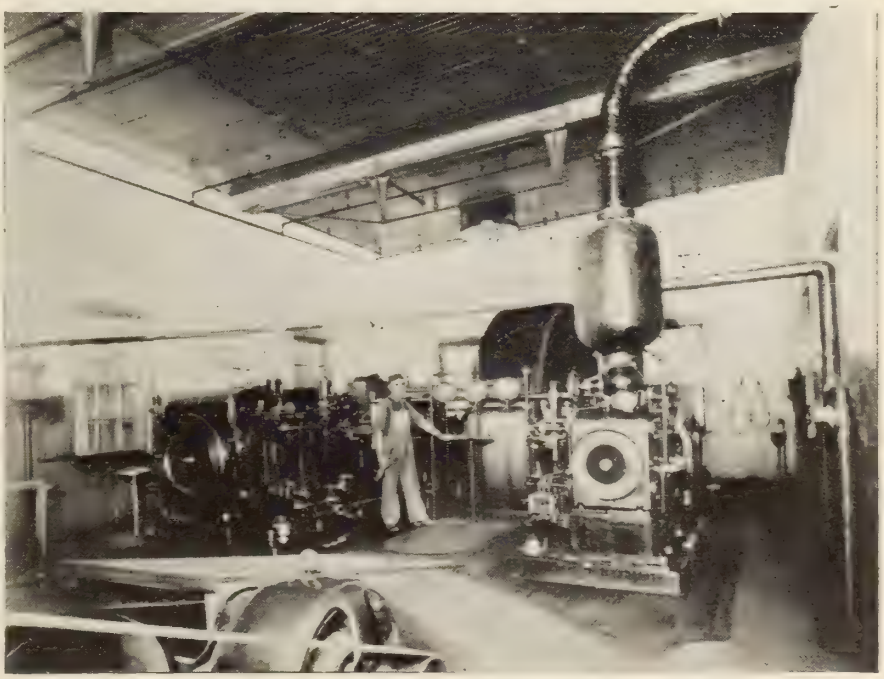
In addition to these units there is a high-speed engine 11 by 12 inches, running at 300 revolutions per minute, for operating the coal conveyor, and the small engines operating the brine pumps. There is also a 2-cylinder fire pump and a Westinghouse air compressor which supplies compressed air for the dry sprinkler system. This list covers all the units, which total 2,015 horsepower. Of course they do not all run at once.

The Operating Features

The principal units are those operating the mill proper, that is the 26 by 60 inch Corliss, and the 15 by 24 by 36 cross compound. These engines run continuously from early Monday morning till late Saturday night, and the only chance for repairs is on Sunday. The boiler plant is running continuously, and it is only about once a year that any opportunity arises for a shut-down, and this does not occur at regular intervals. One boiler is washed out as well as can be managed every Sunday, the turbine being passed through the tubes when necessary. The boilers are blown down regularly and a boiler composition is used. The feed water is taken from a 750 h.p. Cochrane heater, and in order to help this out the water is first passed through the tanks which contain coils. These coils are used to pass the exhaust steam from the feed pumps themselves, thus preheating the water before it goes into the heater. In this way the lack of adequate space in the heater itself is made up and the feed pump exhaust fully utilized. It was particularly noticed by the writer while passing through the plant that in no place was there any sign of a steam leak, and when the continuous operation is considered this speaks very highly for the care bestowed on the plant.

Owing to the two engines here mentioned carrying the brunt of the load, all the fuel burnt is charged against them. Previous to 1913 the plant had not been in particularly good condition and the consumption of fuel for the years 1911 and 1912 worked out at 4.1 and 4.07 pounds per i.h.p. per hour.

In 1913 Mr. Taylor, the present chief engineer, took charge, and immediately went to work to pull things up. In this he was materially assisted by what have been thought an unmitigated calamity, to wit, the breakdown of the Corliss engine. This gave an opportunity for a



THE ELEVATOR POWER PLANT.

thorough overhaul, with the result that the consumption per i.h.p. per hour came down from 4.07 to 2.44 pounds. This was a noteworthy saving and it may be said here was not on paper only but showed very materially on the fuel bills of the mill. The average consumption for the years 1913 to 1919 conclusive, which covers the period of the war, with its attendant fuel troubles, worked out to 2.85 pounds coal per i.h.p. per hour. This result, with the type of engines used and a comparatively low boiler efficiency due to low setting of boilers and hand firing conditions, is highly commendable, even if the exhaust steam was lost. However, in this plant the exhaust steam has a very important part to play in the making of a by-product—salt.

The boilers are fitted with rocking grates, which were adopted after evaporation tests had been run to determine the performance with straight grates and rocking grates. This was occasioned by the difference in the grade of coal being received. We reproduce here the evaporation tests and their results. They showed enough advantage with rocking grate equipment to warrant the adoption of this apparatus. These bars were supplied by the Galt Foundry Company. The original bars were of the herringbone type.

It will be seen that the efficiency reached, 66 per cent., is very satisfactory under the conditions of operation. It is higher than the average hand-fired power plant, which does not often reach 60 per cent. With stoker installations, of course, a much higher efficiency can be maintained, around 75 per cent. being not unusual.

The Salt Plant

We have spoken about the salt plant and now will describe it in detail. First of all it may be said that there are considerable brine deposits around all that portion of the country, from Windsor to Goderich. The brine in the case of the Goderich mill is encountered at a depth of 1,200 feet, and is obtained by sinking a well and installing a deep well pump. In the plant at Goderich there are two wells, and the pumps used are of the ordinary clock valve type, operated by a walking beam, which is driven from a pulley by a crank and connecting rod. The pulley is belt-driven from a small horizontal engine.

The exhaust steam from the engine is utilized in part to pre-heat the brine before it goes to the grainer or evaporators. It will be of interest to readers to know the composition of the brine, and we herewith give the chemical analysis. The chief constituents are of course water and sodium chloride, the latter of course being common salt. The percentage of water is 73.054, and common salt 25.054. The remaining constituents are slight traces of calcium sulphate, calcium chloride, and magnesium chloride. The density of this brine may be better appreciated perhaps by comparing it to sea water. This contains only 5 ounces of solid matter to one gallon, or in other words about 3 per cent.

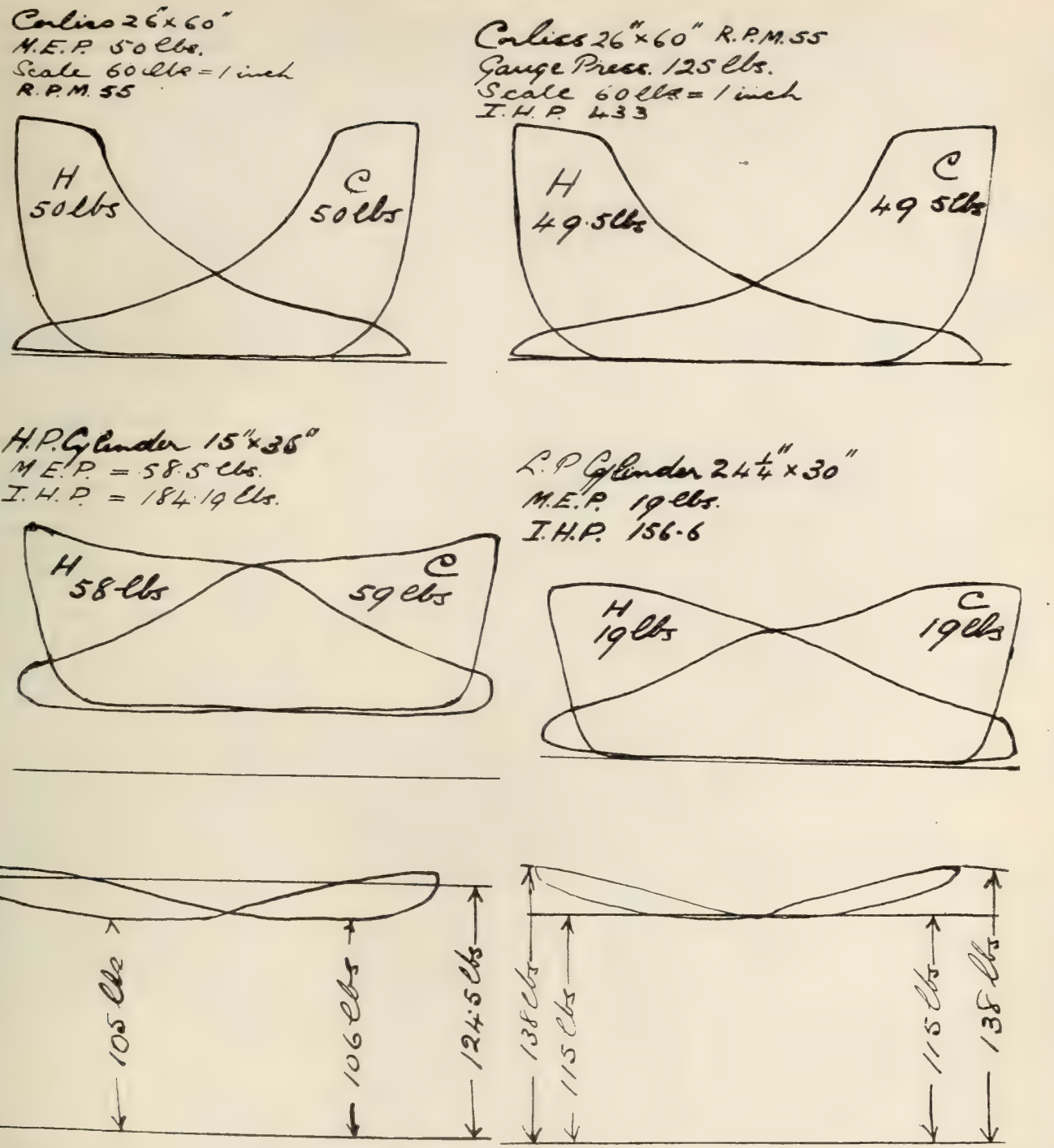
The salt is recovered from the brine by a simple process of evaporation, and there are four of these evaporators or grainers as they are called. Three of them are of the same type, and one of more modern construction. The three are simply double-bottomed steel pans, one about 126 feet long by 20 feet wide, the other two being the same length but narrower. The exhaust steam is passed through coils in the lower pan, being admitted at about ½ pound pressure above atmosphere. The action is of course to evaporate the water and leave the solid residue behind. This process can be clearly seen, the crystals gradually forming on the surface of the water, and after attaining a certain density sinking to the bottom of the tank. A peculiar feature of this evaporating process is that the process goes much better if the water is kept slightly agitated. If the water is perfectly still a slight scum forms over the surface, and this has the effect of retarding the separating of the steam from the water. It is analogous to what takes place in a dirty boiler. The vibration required is in the case of the three large steel pan grainers provided by the natural vibration of the building which contains them. The salt is recovered from these grainers by hand, the men using rakes with a hinged blade. This blade doubles back on the hinge as the rake is pushed forward, and straightens out when pulled back, bringing the salt with it.

The smallest grainer is of 840 square feet area and is different in construction and operation to the other three. It is built of concrete, and the steam coils are laid directly in the brine. A peculiarity of steel pipe was discovered in this connection, in that it was found to be porous, while iron pipe is not. With steel pipe the brine found its way into the pipe

Comparative efficiency tests made on 5 water tube boilers at the plant of the Western Canada Flour Mills, Goderich. Object of tests: To determine what advantage could be obtained by the use of the McNaughton rocking grates. The results herewith given are self-explanatory.

Test No. 1, with herringbone grates. Test No. 2, with rocking grates:

		Test No. 1	Test No. 2
Total Quantities	Date of test	5-3-15	18-5-15
	Duration of test	8 hours	8 hours
	Kind of coal used, oil test	Slack	Slack
	Weight of coal used, oil test	24.800 lbs.	22.800 lbs.
	Weight of dry coal used, oil test	23.312 lbs.	21.432 lbs.
	Calorific value of coal used, oil test (given as 13.800 B.t.u.)	13.800 B.t.u.	13.800 B.t.u.
	Moisture in coal used, oil test	6%	6%
	Total ash	1937 lbs.	1500 lbs.
	Percentage of ash in dry coal consumed	9%	7.5%
	Total combustible	21.375 lbs.	19.932 lbs.
	Total water fed to boilers (actual conditions)	151.372 lbs.	167.218 lbs.
	Equivalent evaporation from and at 212°	184.825 lbs.	202.000 lbs.
Hourly Quantities	Weight of coal as fired per hour	3100 lbs.	2850 lbs.
	Weight of dry coal as fired per hour	2914 lbs.	2679 lbs.
	Weight of water evaporated per hour (actual conditions)	18.921 lbs.	20.902 lbs.
	Equivalent evaporation from and at 212°	23.103 lbs.	25.250 lbs.
	Coal burned per sq. foot of grate per hour	22.3 lbs.	22 lbs.
Boilers and Furnaces	Type of boilers used on test	Heine	Heine
	Number of boilers used on test	5	5
	Heating surface of boilers	6000 sq. ft.	6000 s. ft.
	Horse power of boilers	600 h.p.	600 h.p.
	Horse power developed on test	670 h.p.	732 h.p.
	Type of grates	Herringbone	McNaughton
	Area	138 sq. ft.	130 sq. ft.
Average Pressures and Temperatures	Steam pressure by gauge	125 lbs.	125 lbs.
	Draft at furnace	.28	.28
	Draft at stack	.75	.75
	Temperature of water fed to boilers	42°	55°
	Temperature of flue gas	540°	550°
Economic Results	Water evaporated per lb. of coal (actual conditions)	6.1 lbs.	7.3 lbs.
	Equivalent evaporation per lb. of coal from and at 212°	7.45 lbs.	8.86 lbs.
	Equivalent evaporation per lb. of dry coal from and at 212°	7.92 lbs.	9.42 lbs.
	Equivalent evaporation per lb. of combustible from and at 212°	8.6 lbs.	10.13 lbs.
	Factor of evaporation	1.221	1.208
Efficiency	Efficiency of boilers and grates (based on dry coal)	55.4%	66%



SOME EXAMPLES OF INDICATOR DIAGRAMS. THE TWO LOWER CARDS ARE THOSE TAKEN FROM THE STEAM CHEST AS DESCRIBED IN THE TEXT.

and was detected by depositing on the interior surface. With iron pipe this does not occur. The operation of this grainer is automatic. Two angle irons laid back to back with a slot between them are arranged at each side of the tank extending the greater part of their length. A T-bar is laid on these each side with its web running between the slots left between the angle irons. Across the tank bars are riveted to these T-irons, and these bars carry a hinged blade or rake. A crosshead is also secured to these T-bars, and a connecting rod drives the crosshead from a pulley and crank. The speed is reduced from the countershaft drive by means of a double reduction gear consisting of worm and wheel and spur and pinion gearing. The action is of course a reciprocating motion of the rakes up and down the tank, and they travel at one end up an inclined wooden apron. When travelling away from this apron the rakes swing back flush with the surface of the salt, but when going to the apron they fall vertical and push the salt ahead of them. They go far enough to push the salt over the edge of the wooden apron, and it falls on to a belt conveyor which carries it away to storage. The movement of the rakes supplies the necessary disturbance of the brine, which is conducive to good evaporation. Small scrapers are suspended from the cross bars which scrape the surface of the coils, much in the manner of the scrapers used in the Grun's economizer. This grainer is entirely automatic and requires no attention beyond occasional maintenance repairs.

The exhaust steam after condensation is of course returned to the feed water and thence to the boilers. In winter of course some of the exhaust steam is required for heating the mill but when any of the isolated engines are running their exhaust can be utilized for this purpose.

With the salt grainers in full evaporation it is possible to evaporate 200 tons of water per twenty-four hours, which corresponds to a production of about 50 tons of salt. The heat available in the

steam is 1147.9 B.t.u. per pound at the salt plant, while the heat of the steam entering the engine is 1189.5 B.t.u. per pound. This shows what a wasteful thing a steam engine is at best.

We have spoken of the continuous operation of this plant. The following are the only accidental stops which have taken place from 1914 to date:

1914.—Short stop due to engineer caught in regulator belt.

1915.—Stop on account of hot rocker arm.

1916.—Part of valve gear breaking.

1919.—Stop due to hot bearing.

1919.—Stop for loose follower bolt.

Two of these stops were unavoidable and the others were caused by negligence on the part of a shift engineer.

There is a regular system of inspection carried out every Sunday, every part of the plant being carefully examined and precautions taken to prevent any breakdown. The results speak for themselves. As we said before, the chief engineer, Mr. Taylor, is a great believer in the use of the indicator, and he keeps after the valve gear of all the engines persistently. Mr. Taylor spent twenty-six seasons as engineer on the Great Lakes, and has many interesting experiences to tell of. He is an engineer from the toes up, and loves his profession. Like most successful engineers he is keen on technical knowledge and encourages his men to obtain it. We are reproducing some of these cards taken during our visit to the plant.

JOINS CONVEYORS CORPORATION

An interesting detail of the change in name of the American Steam Conveyor Corporation to that of "Conveyors Corporation of America," is an addition to the personnel of the Eastern Sales Organization.

Mr. Clarence C. Brinley has been retained as Eastern manager of the trolley carrier department, and will be attached to the New York office, 110 West 40th Street. Mr. Brinley is an engineer of broad experience in elevating and conveying machinery and has a wide acquaintance in engineering and business circles in the East. He has drawn his experience from some of the leading manufacturers and users of handling equipment, having first been connected with C. W. Hunt Co., and coming to the Conveyors Corporation from Gifford-Wood Company. During the war he was conveyor engineer for the Air Nitrates Corporation.

A student and a writer of some ability, Mr. Brinley has made several very valuable contributions to the rather sparse amount of worth-while information about the mechanical handling of bulk materials. He wrote a series of articles on "Handling Machinery in the Power Plant," published in "The Engineering Magazine" (now Industrial Management) in the fall of 1915; two articles on "Bucket Elevators," and several on the "Design and Construction of Retail Coal Pockets," contributed to the "Coal Trade Journal" during the spring and early summer of this year.

Entering the field as a draftsman with C. W. Hunt Co., at the age of eighteen, Mr. Brinley, through persistent application and diligent night study both at home and at Columbia University, rose rapidly to a position of prominence in the world of conveyor engineers. Evidence of his skill may be seen in the form of unloading towers, power plant installations, and coal pockets along the railroad lines and the water front of many sections of this country and abroad.

His wide experience in the design and application of conveying machinery has been rounded out by the supervision of the construction of several important handling machinery installations in various parts of this country and in Latin America, and by three years of successful salesmanship in the Eastern territory.

Mr. Brinley has a wide acquaintance among prominent engineers and successful business men in the East, and has made fast friends of many of his business associates.

ARMSTRONGS AND TURBINES

It will not come as a surprise that such important suppliers of war material and battleships and smaller ships of war as Messrs. W. G. Armstrong, Witworth & Co., should be very seriously taking up the manufacture of water turbines, and indeed laying themselves out to execute contracts for complete hydro-electric plants.

The peace-time requirements of munitions, if indeed we can call the present a time of peace, will naturally not furnish a market for the products of works of the size of Armstrongs. Soon after the armistice a large part of the gun shops at Scotswood, Newcastle-on-Tyne, was converted for the building of locomotives, and a $15,000,000 contract for the Belgian Government is now in course of execution. Again, the armor plate shops at Openshaw, Manchester, have been largely turned to locomotive repair work.

Water turbines will be built in the works of the group in Glasgow, which, with large extensions built about two years ago, are being worked under the title of Armstrongs and Main. The Openshaw works, too, will be called in.

Time will show whether Messrs. Armstrong will manufacture at least a part of their requirements for Canada in Canada itself. Such a step may naturally be expected, and it would undoubtedly be welcomed amongst those who still appreciate high-class workmanship, but at the same time must be on the look out for plant to suit local conditions and requirements.

It is interesting to note that Messrs. Armstrong have gone to Norway for their designs, and have secured them from a firm who have delivered, amongst many others, the following units:

	H.P. of each unit	R.P.M.
A/S Tyssefaldene	5,000	375
Rjukan No. 1 Plant	15,000	250
Do., No. 2 plant	16,400	250
A S Bjolvefossen	.....	375
Vamma Power Co.	12,000	214
Vamma Power Co.	13,000	214
Vamma Power Co.	15,000	214
Herlandsfossen Power Co.	3,500	600
Aarlifos Power Co.	6,000	187.5
A/S Saudefaldene	7,500	375
A/S Saudefaldene	6,700	750
A/S Traelandsfos	8,000	214
A/S Shallenborg	2,750	250

It will, therefore, be seen that the British firm should be fully capable of handling the largest units which may be entrusted to them to manufacture, whether of the "Francis" or "Pelton" type.

BOOK REVIEW

We are in receipt of an interesting book by Mr. E. B. Biggar, former editor of "Canadian Engineer." The volume is entitled "Hydro Electric Development" in Ontario. The subject is dealt with by the author from the point of view of a strong protagonist of public ownership, and in the first chapter he goes back to Biblical times to prove that public ownership is directly commanded by the Creator. In the second chapter he compares the power resources of Canada and the United States. Subsequent chapters deal with the original development of Niagara, and the struggle for control between public and private interests. The account of the early attempts at utilising the power is very interesting. A chapter at the end of the book contains a glowing eulogy of Sir Adam Beck, and gently chides the citizens of London for having turned their backs on the peerless knight at the late elections. Apart from the predilection the author shows against private owners and for public ownership the book is interesting, and the facts contained therein useful even if one has different opinions on the subject. The book is published by the Ryerson Press.

The Packard Electric Company, of Warren, Ohio, have issued a Bulletin on "Metering Transformers" in which are described the weatherproof and switchboard types of single, two and three phase potential and current transformers. The weatherproof, or out-door type of oil-insulated transformer has been developed in compliance with the insistent demand from the central manager who is anxious to avoid the building of a housing to protect the transformers from the weather.

A new warehouse is planned by MacDonald-Crawford, Ltd., at Regina, Sask.

Work has started on the new Garrick Theatre, Winnipeg, by Alexander M. Simpson, contractor. This theatre will be situated at the southwest corner of Garry Street and Ellice Avenue and will cost about $150,000.

Saving Fuel by Controlling Chimney Losses

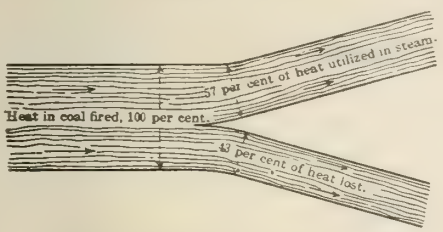
Paper Delivered Before the Fuel Section of the Sixth National Exposition of Chemical Industries, New York—The Author is an Authority on This Subject, and Commands Attention

By F. F. UEHLING.

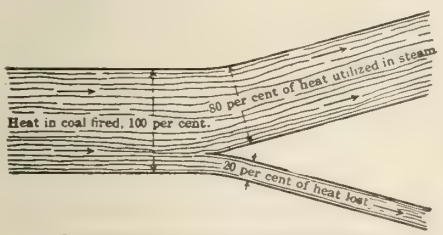
THE subject of fuel economy is today of greater interest to the fuel consumer than ever before. There are two reasons, first, fuel costs two or three times as much as it did a few years ago, and second, it has often been very difficult to get at any price during the past few years. The first reason is one that will remain. Prices of fuel, no matter what kind, will undoubtedly stay high, and in all probability will go still higher. The second reason, however, should vanish entirely when once labor and transportation facilities are properly controlled.

There is plenty of fuel for all who need it. The fuel given us by nature ready for use, will last for generations, but even when all our mines are exhausted and our oil fields pumped dry, there will be enough fuel in one form or another. Mother Nature will at that time again come to our protection with that greatest of her laws, the conservation of matter and energy. Carbon and hydrocarbons are really conserved by her unseen hand, but it remains for man to turn the key which will unlock her great storeroom.

The high cost of fuel therefore provides the principal incentive to save it



A. The average boiler plant does like this.



B. The best plants are doing like this.

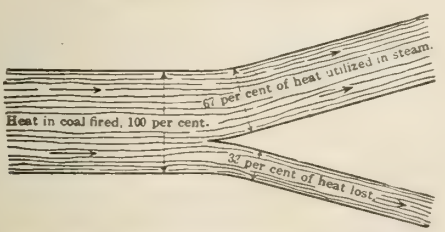


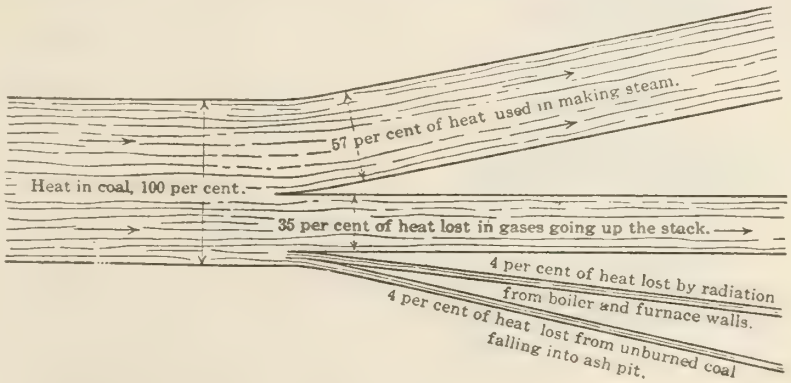
FIG. 1—DIAGRAMS SHOWING POSSIBLE IMPROVEMENT IN AVERAGE PLANT.

and the greater the cost the greater will be that incentive. The principal factors which enter into the cost of fuel are labor and transportation. Its price to the consumer will be governed by these two charges, plus whatever additional charge competition will permit the mining interests to add. As our resources are depleted, mining will become more difficult, and as production moves farther away from consumption, transportation charges are bound to increase. The price of fuel will, therefore, advance from year to year, until finally it will be cheaper to make artificial fuel, such as alcohol. In all probability, however, the cheapest fuel for our principal needs will be that which can be gotten out of the ground, as long as it lasts, in its ready-to-use form. That is why it should be made to last as long as possible through the practice of economy. However, since the price of fuel in the future does not seem to interest the present generation, the elimination of unnecessary waste should perhaps even be enforced by law for the benefit of posterity.

Over One-Third of the Fuel is Lost Up the Chimney

No matter how the fuel we use is consumed and no matter what kind of fuel is burned, whether solid, powdered, liquid or gaseous, the biggest loss is always due to the heat energy wasted up the chimney. In this connection it might be well to quote the following very conservative statement from Technical Paper No. 205, issued by the Bureau of Mines:

"In the average boiler plant, 35 per cent. of the heat in the coal burned under the boilers is lost with the stack gases. That is, out of every 100 tons of coal burned under the boilers, the heat of 35 tons literally goes up the stack. It is this loss that can be greatly reduced and every effort should be made to do so."


57 per cent of heat used in making steam.
Heat in coal, 100 per cent.
35 per cent of heat lost in gases going up the stack.
4 per cent of heat lost by radiation from boiler and furnace walls.
4 per cent of heat lost from unburned coal falling into ash pit.

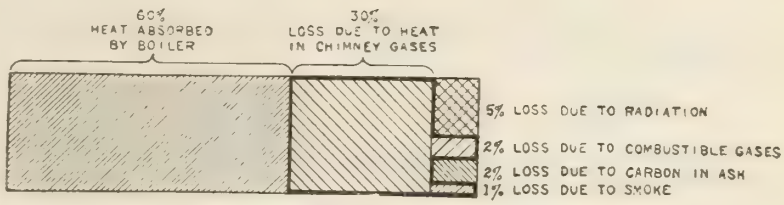

60% HEAT ABSORBED BY BOILER
30% LOSS DUE TO HEAT IN CHIMNEY GASES
5% LOSS DUE TO RADIATION
2% LOSS DUE TO COMBUSTIBLE GASES
2% LOSS DUE TO CARBON IN ASH
1% LOSS DUE TO SMOKE

FIG. 2—WHERE THE HEAT GOES IN AVERAGE PLANT.
FIG. 3—CHART SHOWING HEAT DISTRIBUTION FROM COAL.

Figures 1 and 2, which are reproduced from the same Government bulletin, illustrate graphically the magnitude of fuel waste in steam boiler practice and show that the most important part of it is due to the loss up the chimney. According to the speaker's experience, however, this loss in the average plant is not less than 40 per cent., and in very many cases approaches 50 per cent. of the total heat energy in the fuel used.

The loss up the chimney, which is always the largest individual loss in any plant, depends for its magnitude on three factors. They are, in order of importance, first, excess air in the products of combustion; second, temperature of the products of combustion; third, amount of unconsumed fuel in the products of combustion.

Greatest Loss Due to Using Too Much Air

The excess air in the products of combustion results in a loss greater than

that from any other source. Each kind of fuel requires a definite amount of air to burn it, the exact quantity depending principally upon the ratio of its carbon and hydrogen. When considering coal, for example, the principal constituent is carbon, every pound of which requires 12 pounds of air to completely consume or oxidize it. All air that is used above this amount is with one square foot cross sectional area, it would have to be long enough to extend nearly from New York to Baltimore. Stated in another way, if the floor of a room were covered with coal to a depth of one foot, the ceiling would have to be over three miles high in order for the room to contain as much air as is generally used to burn that quantity of fuel. The fact that so much contains the major portion of the heat that is unnecessarily wasted. The exact amount of heat wasted in this way can be determined by the weight of the products of combustion per pound of fuel burned, and the temperature at which they leave the furnace or enter the stack. Thus, in the average plant, from one-third to one-half of the heat contained in the fuel is stolen by the

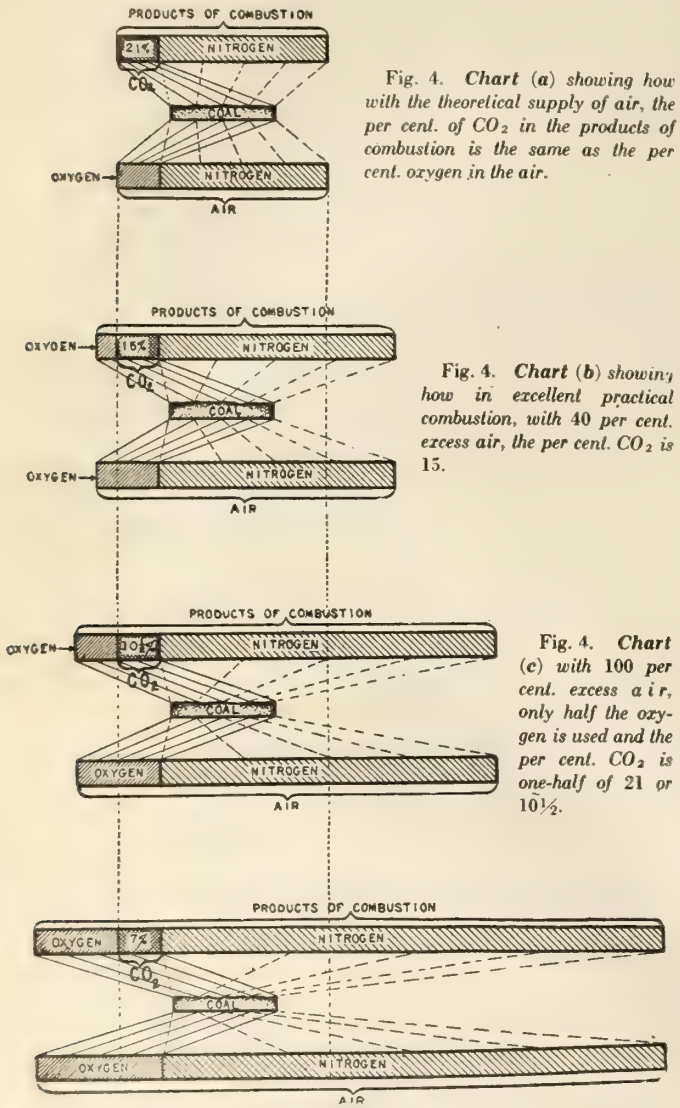
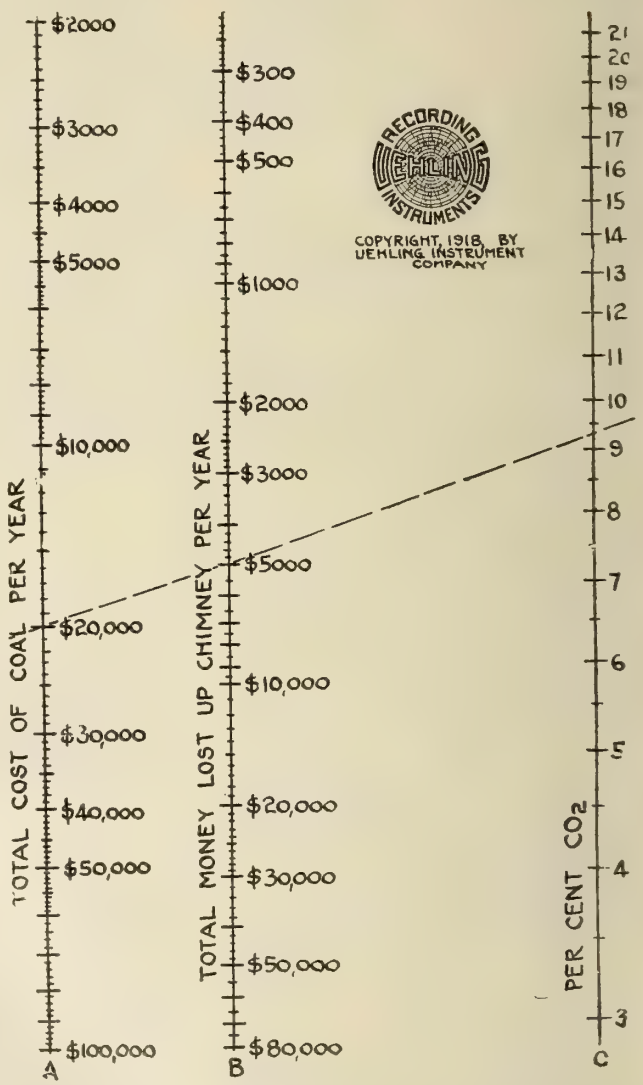


Fig. 4. *Chart (a) showing how with the theoretical supply of air, the per cent. of CO_2 in the products of combustion is the same as the per cent. oxygen in the air.*

Fig. 4. *Chart (b) showing how in excellent practical combustion, with 40 per cent. excess air, the per cent. CO_2 is* 15.

Fig. 4. *Chart (c) with 100 per cent. excess air, only half the oxygen is used and the per cent. CO_2 is one-half of 21 or* 10½.

FIG. 4—SHOWING EFFECT OF EXCESS AIR.



SCALE SHOWING $ AND CO(2).

known as excess air, and when supplied in greater quantities than is necessary to meet the particular conditions of the furnace in which the fuel is burned, an unnecessary burden is immediately placed on the temperature possibilities of the furnace and the amount of fuel consumed to accomplish a desired result increases in proportion.

Even in fairly good practice, about 25 tons of air is used to burn one ton of coal, and in the more poorly operated plants this amount is often doubled. Twenty-five tons represents a lot of air. Under normal conditions it occupies a space nearly 16,000 times as large as the coal which it consumes. If the amount of air generaly used to burn one ton of coal were contained in a pipe air is consumed in burning coal is not realized by the fireman and the important relation which this huge mass bears to fuel economy is generally not given sufficient thought by his superiors. Although air costs nothing, and is available in unlimited quantities, when used to burn fuel in excess of what is required, as is the case in the average plant, it becomes one of the most expensive raw materials.

All the air that is used in burning fuel, whether under steam boilers or for any other process, appears in the products of combustion. If three times as much air is used as is necessary there will be just about three times as much products of combustion as necessary. This gas as it passes up the chimney products of combustion and dissipated into the atmosphere.

Smoke Not Necessarily a Sign of Waste

The other loss up the chimney, namely that due to unconsumed fuel in the products of combustion, is usually not so serious. The old idea that a smoky stack is a sign of tremendous waste is not always true, in fact, whether the gases leaving a chimney are smoky or smokeless is no indication at all as to the efficiency with which the fuel is consumed. Steam boilers, for example, connected with a stack that does not show the slightest trace of smoke may burn twice as much coal per pound of steam generated as when smoke is in great prominence. Black smoke is, of

course, unburned carbon, but the amount of carbon in this light and finely divided form that is necessary to give the products of combustion a dark or even a black appearance is generally only a small fraction of one per cent. of the actual fuel burned. The additional unconsumed fuel that is apt to be present in the products of combustion is carbon monoxide and hydrocarbons, both of which are caused by an insufficient air supply or the improper mixture of the air with the fuel before it is ignited. Although it is possible for the loss due to this cause to be serious, it is a fact that the average loss from this source can safely be estimated at less than two per cent. Figure 3, based on a representative test, gives a good idea of what becomes of the total heat in the coal and particularly how large a proportion of it is dissipated as sensible heat in the products of combustion.

Instruments Detect Chimney Losses

It is not the object of this paper to discuss any particular method of burning fuel. To minimize chimney losses, no matter what means are used, we must know whether or not the proper amount of air is being supplied, whether or not air is mixed with the fuel before it is ignited, and whether or not too much heat is left in the products of combustion as they pass up the chimney. Under all conditions these important facts can be determined by consistent flue gas analyses and temperature measurements. In so far as stack losses are concerned, the effect of any change in fuel or method of firing, the results of any additions or changes, or the value of any new appliance, can in this way be determined at once, and the best efficiency under the working conditions of any plant can generally be obtained and maintained without the necessity of lengthy and elaborate tests.

In 99 cases out of a 100, excessive loss of heat up the chimney is simply due to lack of facilities for determining whether the proper amount of air is supplied. When carbon, the principal constituent of any fuel, is completely burned, the result is carbon dioxide (CO_2). Complete combustion occurs when air is supplied in excess of what is needed. When, however, the air supply is reduced too much so that it is little more than that which is theoretically required, there is also a possibility of incomplete combustion due to an insufficient amount of air reaching part of the combustible. When this is the case some of the carbon in the fuel will become only half oxidized, that is, it will burn to carbon monoxide (CO) instead of to CO_2.

Heat Carried Away by the Dry Chimney Gases Per Pound of Combustible

POUNDS OF AIR PER POUND OF COMBUSTIBLE AND CORRESPONDING PERCENTS CO_2	TEMPERATURE OF CHIMNEY GASES, DEG. FAHR.							
LBS.	300°	350°	400°	450°	500°	550°	600°	650°
12	750†	905	1060	1216	1370	1528	1683	1840
21%	5.2‡	6.2	7.3	8.7	9.5	10.5	11.6	12.7
15	865	1112	1305	1498	1679	1880	2072	2262
16.8%	6	7 6	9.1	10.3	11.6	13.0	14.3	15.6
18	1004	1321	1550	1778	2010	2235	2460	2692
14.0%	7.2	9.1	10.7	12.2	13.9	15.4	17	17.9
21	1266	1530	1785	2060	2320	2582	2846	3118
12.0%	8.7	10.5	12.3	14.2	16	17.8	19.5	21
24	1440	1740	2040	2340	2640	2940	3240	3540
10.0%	9.9	12	14	16.1	18.2	20.3	22.4	24.4
27	1611	1950	2281	2620	2958	3291	3628	3962
9.3%	11.1	13.5	15.7	18.1	20.4	22.7	25	27.4
30	1785	2160	2530	2900	3270	3641	4016	4396
8.4%	12.4	14.9	17.4	20	22.6	25	27.8	30.4
33	1957	2362	2779	3180	3589	4000	4405	4820
7.6%	13.5	16.3	19.2	22	24.7	27.6	30.5	33.2
36	2130	2579	3020	3461	3910	4350	4798	5290
7.0%	14.7	17.8	20.8	23.9	27	30	33	36.6
39	2300	2781	3261	3743	4220	4700	5180	5670
6.5%	15.9	19.2	22.5	25.8	29.2	32.4	35.7	39
42	2479	2999	3508	4023	4540	5052	5570	6100
6.0%	17.1	20.6	24.7	27.7	31.3	34.8	39.4	42

* Gebhardt Steam Power Plant Engineering.
† Heat wasted in B. t. u.
‡ Heat wasted in per cent. of total heat in coal.

FIG. 5

Carbon Dioxide in Flue Gases the Key to Wasteful Air Supply

It must be remembered, however, that the big loss in practice is due to excess air and not to an insufficient supply. In order to clearly illustrate the importance of this fact, let us consider carbon as the fuel we are burning. Since carbon is the principal constituent of all fuels, the same reasoning will also apply to any other fuel, the principal difference being that the maximum obtainable percentage of CO_2 is less when fuels higher in hydrogen are used, due to the fact that hydrogen consumes oxygen to form water vapor (H_2O) instead of CO_2. Thus if one pound of carbon were consumed with the exact amount of air required to completely burn it, the 21 per cent. of oxygen in the air used would combine with it and appear as 21 per cent. CO_2 in the products of combustion for the reason that oxygen combines with carbon to form an equal volume of CO_2. On the other hand, if the same weight of carbon were consumed with twice the amount of air theoretically required to burn it, only one-half of the 21 per cent. of oxygen in the air used would combine with the carbon, the volume of the products of combustion would be twice as much, and the CO_2 content only 10½ per cent. Again, if the same weight of carbon were consumed with three times the theoretically required air, only one-third of the 21 per cent. of oxygen in that air would combine with the carbon, the volume of the products of combustion would then be three times as great as theoretically necessary and the CO_2 content only seven per cent. It therefore follows that the lower the percentage of CO_2 in the products of combustion the greater will be the volume of weight of the flue gases per pound of fuel burned, and the greater the temperature of this gas as it leaves its zone of usefulness the greater will be the loss per unit of its weight. This is clearly illustrated by Figure 4. In average steam boiler practice, for example, every pound of flue gas as it passes up the chimney is laden with sensible heat energy to the extent of from 100 to 200 heat units, and since there are from 25 to 30 or more tons of flue gas for every ton of fuel consumed, the magnitude of this tremendous loss can be readily appreciated. What it amounts to in actual heat units or in percentage of fuel used depends upon the percentage of CO_2 and the stack temperature. A table based on carbon as the fuel burned is shown in Figure 5. Such a table can be prepared for any kind of fuel. With fuels such as oil, which are high in hydrocarbons, the maximum percentage of CO_2 obtainable would be less, but every one per cent. drop in CO_2 would mean a greater increase in fuel wasted than a corresponding drop in CO_2 where a fuel richer

in carbon is used. The percentage of CO_2 in the products of combustion is therefore an index to the amount of air used per pound of fuel burned, no matter what commercial fuel is utilized. Several illustrations of this fact are shown in Figure 6. Chimney losses can thus be controlled, at least to the extent which the particular design of furnace will permit, by the simple regulation of the air supplied, so that the weight of the products of combustion per pound of fuel burned will be reduced to a minimum. The two most important constituents of the products of combustion, for determination by flue gas analyses, are, therefore, the percentage of CO_2 and the percentage of CO. The former should be made continuously by means of a CO_2 recorder, while the latter determination is only necessary when the percentage of CO_2 is so high that an insufficient supply of air to all or part of the fuel is suspected.

Chimney losses, as previously stated, depend upon three factors, the amount of excess air in the products of combustion, which is determined by the percentage of CO_2; the amount of unburned fuel in the products of combustion, the magnitude of which is indicated by the percentage of CO; and the temperature of the products of combustion, which can be determined with an ordinary flue gas thermometer inserted in the last pass of the boiler furnace, just before the gas enters the stack.

Of these three determinations the percentage of CO_2 is by far the most important. The percentage of CO_2 is something the fireman can easily regulate. If the brick setting of a furnace or of a boiler is made tight to prevent air in filtration it is an easy matter for him to decrease the excess air supply to 50 per cent. or less by simple cut and dry methods in the regulation of draft, thickness of firebed, etc., even though the excess air supply may have been 200 or 300 per cent. before he attempted to so regulate combustion.

The determination of the percentage of CO, being generally of much less importance, need be made only when there is reason to believe that incomplete combustion exists. In fact the majority of plants where CO_2 recorders are used, get remarkably good results, in so far as economy is concerned, without making CO determinations at all. In other plants, a series of tests are run for determining the maximum safe percentage of CO_2 without the formation of CO and the firemen are instructed to keep the CO_2 as near this point as possible without exceeding it. In many plants, however, the practice of merely instructing the firemen to keep the percentage of CO_2 as high as they can has led to surprisingly good results.

The third variable, namely the temperature of the products of combustion as they enter the stack, is one over which the firemen have no control at all.

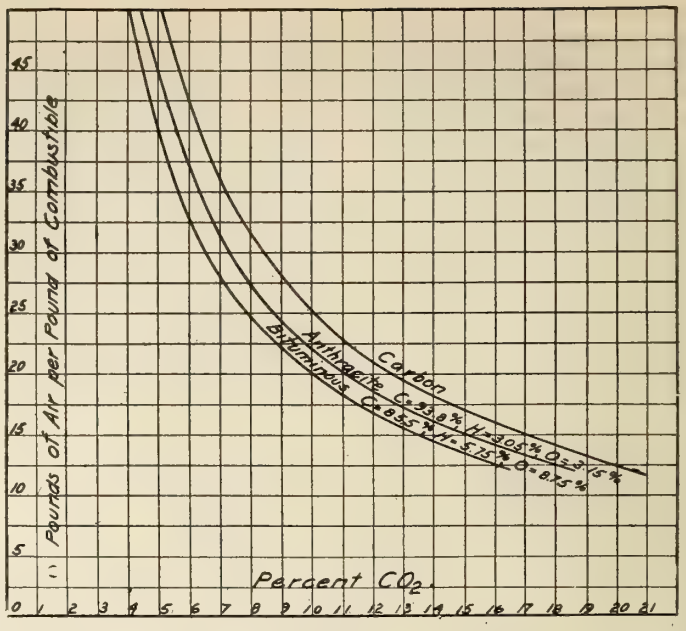


FIG. 6—CHART SHOWING RELATION OF CO_2 AND POUNDS OF AIR PER POUND OF COAL.

This temperature should, of course, be kept as low as possible, but it depends entirely upon how much of the heat in the furnace is absorbed or utilized before the products of combustion make their final exit. In boiler practice, for example, stack temperature depends upon the area of the heating surface over which the hot gases pass and the cleanliness of the heating surfaces. The lower the stack temperature, the less will be the heat wasted; on the other hand the higher the percentage of CO_2 the less will be the volume of flue gas to carry away valuable heat energy as it passes up the chimney. Since the temperature of the products of combustion does not vary materially during short intervals of time, the percentage of CO_2 by itself becomes a most reliable index to the greatest loss of all — the sensible heat energy wasted up the chimney.

Savings by Controlling Chimney Losses in a Small Plant

As a typical example of what can be done to save fuel by the simple regulations of the percentage of CO_2 it will undoubtedly prove of interest to compare the two CO_2 records as shown in Figure 7. They were made at a small New England plant. A CO_2 recorder was connected with the boilers and placed in the office of the chief engineer without the knowledge of the firemen. They knew, however, that a 24 hour evaporation test was to be conducted and were instructed to utilize every effort to maintain the load during that period with the least possible amount of fuel. Although they worked hard to make a showing for themselves the chart on the left illustrates that great variations occurred in the percentage of CO_2 and that the average was quite low. After the test had been completed, an auxiliary CO_2 indicator was placed at the boiler front for the firemen's particular benefit. They were advised that another test of the same duration would be run, but that this time only two things would be expected of them, viz., they were to maintain the steam at the required pressure and keep the CO_2 as high as possible. Not having heard of CO_2 before, the chief engineer simply pointed out the indicating column with

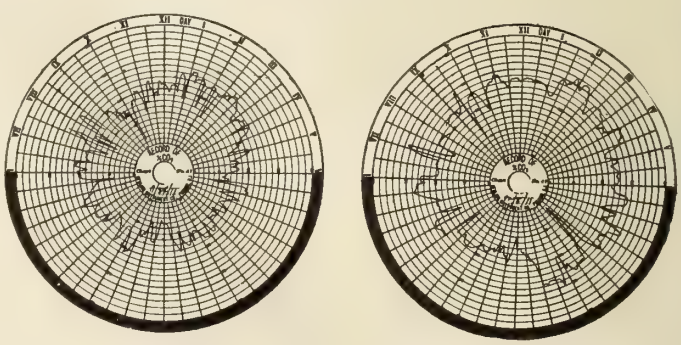
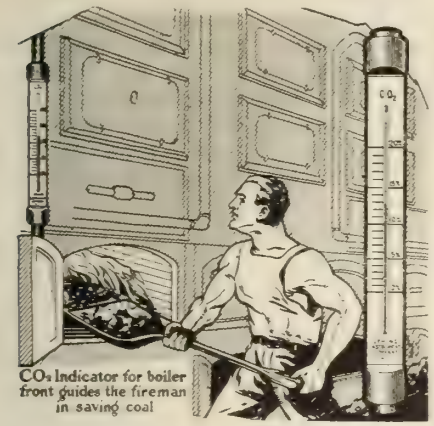


FIG. 7—COMPARATIVE CO_2 CHARTS AFTER INSTALLATION OF INSTRUMENT. THE CHART AT RIGHT WAS TAKEN SEVERAL WEEKS LATER THAN THE LEFT.

a statement that it must be kept high and that the way to keep it high was to make the necessary adjustments of draft, thickness of firebed, etc. They were particularly instructed, however, to make only one change at a time in any adjustment, and then note the result; if the indicator went up they would know that the change was made in the right direction and if it went down they would know the change was made in the wrong direction. They were allowed to use their own ingenuity and to



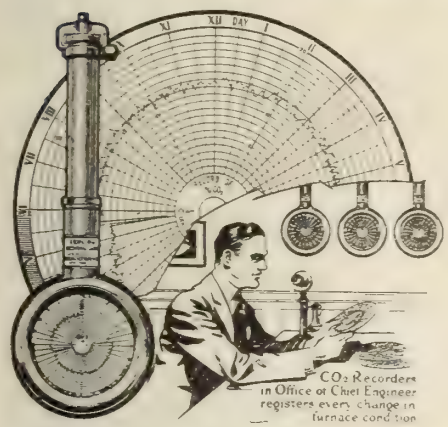


FIG. 8 AND 9—INSTRUMENTS FOR RECORDING AND INDICATING CO_2.

manipulate all furnace adjustments as they saw fit. They soon gained confidence and in a few days expressed their belief that the proper ratio of air to fuel burned could be maintained by watching the CO_2 indicator and making adjustments accordingly. The second evaporative test was thereupon started. The chart on the right hand side shows the results. This record is consistently higher than the first and the percentage of CO_2 is comparatively free from irregularities. The actual test showed a saving of 9.9 per cent. made solely by the efforts of the firemen who had never heard of CO_2 before. Showings of this kind are being made repeatedly at hundreds of prominent and smaller plants throughout the country.

Figure 8 shows the instruments used for determining the percentage of CO_2. The one on the left serves as a constant working guide for the firemen, while the one on the right simultaneously traces a record of CO_2 on a chart in the engineer's office, thus enabling him to keep tab on the work of the fireman.

The scale, Figure 9, will be found useful for estimating the value of the fuel lost up the chimney due to low CO_2. It is based on 600 degrees chimney temperature and high carbon fuel.

Toronto No. 2 Lodge Has Festive Evening

A HIGHLY successful and enjoyable meeting, followed by an informal supper was held by the Toronto No. 1 Lodge on Wednesday, October 27th. The guests of the evening were the members of the Hamilton Lodge, a number of whom motored over from the "city by the hill" to attend the event. The Hamiltonians present were Brothers A. Heath, A. Leckie, W. Tabor, W. Webb, W. Daly and L. J. Ellis, the latter gentleman being the Grand Secretary of the organization.

The Hamilton deputation were somewhat late in arriving, being delayed by reason of the highway being under repair. Indeed, from what some of them said later, it appears that the journey had been fraught with many perils, and there had been times when they had expected the two gallant "Lizzie's" that carried them, to founder with all hands. However, it would take more than bad roads and stormy weather to deter an engineer, so the party arrived in safety.

The chair was taken by "Dad" Wickens, the Hamilton guests being arranged to the right and left of the chairman. Other invited guests present were Messrs. Gordon Keith, of "Canadian Manufacturer," Grant Cole, Chas. Mosely, of the examining board, Howard Fletcher, and T. H. Fenner, editor of "Power House."

After an excellent supper had been disposed of and cigars passed round, the toast of the King was loyally honored, and following this, "Dad" Wickens spoke briefly on the subject he knows so well, the C.A.S.E. He passed briefly over its early development and the varying success that had attended their efforts, and then of the brighter prospects that opened before the organization to-day under the Dominion Charter.

L. J. Ellis, Grand Secretary, speaking in reply to the toast of the Grand Lodge, spoke of the efforts that were being made by the Grand Lodge officers to weld the organization into a cohesive whole. He exhorted the members to pull together and do each one his little best to help the other. Mr. Ellis spoke appreciatively of the opportunity given the lodges by "Power House" to publish their meetings and any events of interest. This, he said, would materially assist the work of the Grand Lodge in keeping the different lodges in touch with each other.

Mr. R. C. Leach, Grand President, spoke along the same lines, and said that by next convention there would be a bigger and better organization. They expected shortly to have affiliation with the North-Western Electrical and Mechanical Engineers of Edmonton, which was practically an offshoot of the C.A.S.E.

Mr. Keith, speaking as the secretary of the Exhibitors' Association, promised the members a good exhibition at the next convention. He also took the opportunity of adding a word of commendation for "Power House," of which he was editor at its inception.

The members of the Hamilton Lodge all spoke briefly in testimony of the pleasure it gave them to be at the meeting. They too breathed the spirit of progress and loyalty to the C.A.S.E. and its members, and also voiced a spirit of friendly rivalry with their Toronto brethren.

Mr. Harding, secretary of the Toronto Lodge, proposed the toast of the "Technical Press," and Mr. Fenner was called upon to respond. In doing so, Mr. Fenner took the opportunity to thank the members for their appreciative comments on Power House, and assured them that its pages were always open for the expression of their views and for comparing their experiences. He hoped the lodges would avail themselves of the invitation extended to them, and thus gain some much needed publicity.

The meeting concluded with "God Save the King," and the Hamilton deputation embarked once more on their faithful "Lizzies" for the run home. At the time of writing this we have not heard of their arrival. On the other hand, not having heard to the contrary, we will trust that they are safe in the shelter of their beloved mountain.

BUSINESS PAPER EDITORS' MEETING

Clay C. Cooper, Mill Supplies, Chicago, was elected president of the National Conference of Business Paper Editors for the ensuing year at a meeting held in connection with the annual deliberations of the Associated Business Papers, Inc., at the Hotel Astor, New York City, Oct. 20 and 21. The other officers chosen were: Vice-president, C. J. Stark, The Iron Trade Review, Cleveland; secretary-treasurer, R. Dawson Hall, Coal Age, New York. The executive committee is composed of A. I. Findley, Iron Age, New York; C. T. Hawson, Railway Maintenance Engineer, Chicago; A. R. Kennedy, Canadian Machinery, Toronto; James H. Stone, Shoe Retailer, Boston; H. L. Parmalee, Metallurgical and Chemical Engineering, New York; and Arthur L. Rice, Power Plant Engineering, Chicago.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE have covered a good portion of the horizontal boiler and will go into the question of reinforcing openings for mountings, etc., to some extent. A few lines on practical problems dealing with setting, etc., and one or two points dealing with calculations on furnaces of internally-fired boilers, and we can leave this subject. The reader who has followed this course should have gained enough knowledge to enable him to apply any of the rules relating to boiler construction that he may come across, and be ready to take up some further branches of engineering study.

Other Types of Boilers

Although our calculations have been confined to the H. R. T. boiler, most of the problems connected with other types are covered by the same work.

In the water-tube boiler with cylindrical steam and water drums, the strength of the drum is calculated by the same method as the shell of the H. R. T. boiler. The drum of the water-tube boiler is of small diameter, and on this account it is usual to use a double riveted lap joint on the longitudinal seam. The ends of drums or heads on the B. & W. type of boiler are usually of the convex type. Another place where this type of head is used is on steam domes. The advantage of using this form of construction for a dome head or drum end is that it requires little staying if a portion of a sphere, or none at all if it is hemispherical in form. The working pressure allowed on a hemispherical end is double that allowed on a cylinder of same size and thickness.

It is not unusual to find steam domes on boilers with heads unstayed, and the radius to which the heads are bumped may easily be determined by a simple measurement and calculation. Measure across the dome at the point where the flange commences, or where the plate is bent round to form the flange. From this line, which can be formed by placing a straightedge across, measure the height to the centre of the dome. Then the radius can be found by the following:

$$2r = h + \frac{C^2}{4h}$$

$$r = \frac{h + \frac{C^2}{4h}}{2}$$

If in the illustration the dome is 24 inches diameter and the length of the cord C is 23 inches, and height h is 4 inches, then the radius of the head will be

$$r = 4 + \frac{\frac{23 \times 23}{4 \times 4}}{2}$$

$$= 18\tfrac{1}{2}$$

This means that the head may be considered as a portion of a sphere of 37 inches diameter. The British B.O.T. rule for a bumped head, which is a portion of a sphere, requires staying but allows 18,000 pounds per square inch on steel stays.

When a dome is fitted to a boiler it should be stayed to the shell, whether the head is strong enough or not. The staying relieves the shell of a very severe stress and the portion of the shell under the dome should not be cut away entirely. It should be merely cut out sufficiently to allow steam to fill the dome. The form of staying shown in the illustration, where the stays are secured to the side of the dome, is a very poor method. While staying the head it leaves all the stress on the rivets holding the dome to the shell. The direct stay is good, and the third form of dome requires no staying at all. That is as far as the dome itself is concerned, it is the strongest possible construction. Generally speaking, domes are gradually dying out, and the modern dry pipe practice is much to be preferred.

Reinforcing Openings

Wherever an opening is made in a boiler shell and is over 2 inches in diameter, the shell should be reinforced to make up for the metal lost. The sectional area of the reinforcing ring should be at least equal to the metal cut out, and in many cases is required to exceed that amount. Supposing we have to reinforce a manhole opening on a shell 16 by 12 inches.

The long axis of the opening is always placed at right angles to the axis of the boiler when the manhole is in the shell. The amount of metal cut out will be

$$\frac{\pi}{4} \text{ — } Dd$$

where D= long axis and d=short axis. This is the formula for the area of an ellipse, and substituting figures we will have

$.7854 \times 16 \times 12 = 150.8$ square inches.

Now to reinforce this opening we will have to place a ring round its edges wide enough for riveting with a double row of rivets and at least of equal area. We have to allow for two rows of rivets, and if the plate is ⅜ in., that will be ¾ in. rivets. The distance from the edge of rivet hole to edge of plate wil be at least ¾ inches, and adding the rivet hole will be 1½ inches. Allowing a diameter between rows of rivets gives 2¼ inches and for the second rivet hole and lap to edge of plate is another 1½ inches, which makes 3¾ inches. We would then have for our ring a long diameter of $16 + 3.75 \times 2 = 23.5$, and for the short diameter $12 + 3.75 \times 2 = 19.5$.

The area of this is

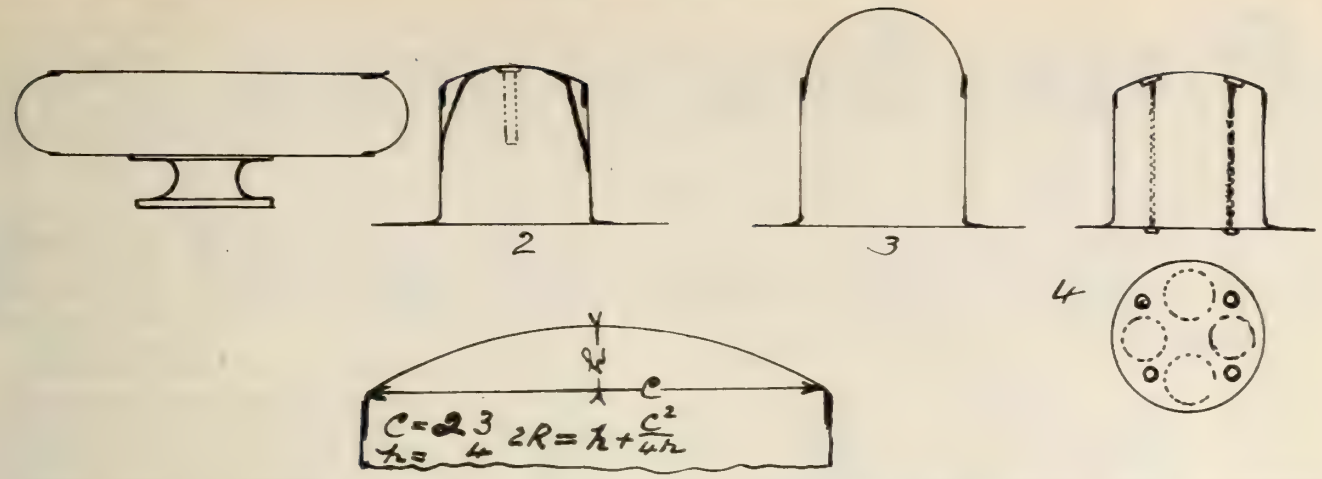
$$\frac{\pi}{4} \text{ — } 23.5 \times 19.5 = 360.$$

From this subtract the area of the hole 150.8 and we have 209.2 square inches, which is more than required. However, as the fault is on the right side it does not matter. It could be reduced by making the width 4 rivet diameters instead of 5, which would give 160 square inches.

It is usual to reinforce the opening in the bottom of the shell where the blow-off pipe is fitted, this usually being done by fitting a pad. In well-finished boilers, pads are fitted to the openings for water column fittings. The openings for steam pipes and safety valves are generally fitted with presesd steel nozzles riveted to the shell, which perform the function of attachment and reinforcement at the same time. This is usual in modern practice. Steam is collected in a perforated pipe inside the shell of the boiler, known as a dry pipe. Any moisture in suspension is usually separated form the steam in entering this pipe and falls back to the steam space. This dry pipe arrangement has practically superseded the dome.

Vertical Fire Box Boilers

The joint on the shell plates of a vertical boiler is calculated in exactly the same manner as the longitudinal joint in the horizontal boiler. It is of course exactly the same thing. The furnace is usually made of one plate, riveted either single or double lap. However, the stress on the furnace is a collapsing one as against the bursting stress on the shell. It is usual to consider the furnace of a vertical boiler as a flat plate, neglecting the strength due to its form. The strength then is considered as being due to the thickness of plate and the pitch of stays, and is covered by the formula



FIRST DOME THAT REQUIRES NO STAYING. 2. WRONG METHOD OF STAYING. 3. HEMISPHERICAL HEAD. 4. CORRECT METHOD OF STAYING. METHOD OF FINDING RADIUS OF HEAD.

$$\frac{C(T+1)^2}{S-6} = \text{W. P.}$$

where C=a constant varying with conditions from 120 to 200
T=thickness of plate in one-sixteenths.
S=Surface supported.

The surface supported will of course depend upon the pitch of the stays, and the stress allowed on stays. For screwed stays such as are used in firebox staying, the stress allowed is usually 8,000 pounds per square inch. The effective area of staybolts is of course taken at the bottom of the thread.

Plain and Corrugated Furnaces

The formulae for the collapsing pressure on plain and corrugated furnace tubes have been determined empirically and the candidate for examination will have no trouble in following them out. They are simple arithmetical problems. The strength of a plain tube varies according to its length and diameter, the longer and larger it is the weaker it is; of course the thickness has the effect of bringing up the strength, but a furnace wall must be kept as light as possible. With a corrugated furnace the length does not affect the strength, this thickness and diameter being the main considerations. The formulae are as follows:

$\frac{806300 \times t^2}{L \times d}$ = Collapsing pressure on a plain tube.

$\frac{90000 \times t^2}{(L+1) \times d}$ = Limiting working pressure on plain tube.

$\frac{14000 \times t}{d}$ = W. P. on corrugated tube.

where L=length in feet
t=thickness in inches
d=outside diameter in inches (measured at bottom of corrugations).

We think that enough has been said on the subject of strength of boilers for the purpose of these articles, and will take up new ground in our next articles.

The writer will gladly make clearer any points on which a reader requires further information.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question:—We have a return tubular boiler 60 inches diameter by 12 feet long. What height should the chimney be to obtain a draught of say .25 inches water?

Answer:—There are various rules for chimney height. The intensity of the draft of course depends on the height of the unbalanced column of hot gases, or in other words, the height of the chimney. The diameter will, of course, depend on the grate area, and in the case of a single boiler, the chimney area should be from 1-7 to 1-6 the grate area. It does not matter if the chimney area is a bit large, as it can always be reduced by dampering. There is always a portion of the chimney near the wall ineffective. A fairly simple rule given by Kempe is:

$$h = \left(\frac{W}{14a}\right)^2$$

Where h = height;
W = lbs. coal per hour;
a = area.

The coal burnt per hour with natural draught would be approximately 300 lbs. per hour on a boiler this size, and the area of chimney would be

$$\frac{25}{8} = 3.125 \text{ sq. ft.}$$

$$\text{Then } h = \left(\frac{300}{14 \times 3.125}\right)^2 = 47 \text{ feet.}$$

This formula does not give the draft which can be found from the following

$$d = h\left(\frac{7.6}{t \times 460} - \frac{7.9}{T \times 460}\right)$$

Where d = draft in inches of water.
h = height.
t = temperature of atmosphere say 60 degs.
T = temperature of gases say 600 degs.

$$\text{Then } d = 47\left(\frac{7.6}{60 \times 460} - \frac{7.9}{600 \times 460}\right)$$

d = .33 inches.

To find any specified draft reverse the formula. Say you want ¼-inch or .25 draft:

$$h = \frac{.25}{\left(\frac{7.6}{60 \times 460} - \frac{7.9}{600 \times 460}\right)} = 34 \text{ feet.}$$

Question. — Would it be asking too much of you to tell me briefly, "What are the advantages of a shaft governor

(Continnued on page 498.)

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)
A. R. KENNEDY, Managing Editor.
B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.
UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.
GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, NOVEMBER 5, 1920 No. 21

PRINCIPAL CONTENTS

The Power Plant of a Salt and Flour Mill	483
Saving Fuel by Controlling Chimney Losses	489
Toronto No. 1 Lodge Has Festive Evening	493
A Course of Instruction	494
Editorial	496
Progress in New Equipment	497

Another Harmless Boiler Explodes

ONCE again has a boiler, used on a farm for the purely agricultural purpose of threshing, proved that it is not exempt from the physical laws that govern other steam-containing, or pressure-containing vessels, though it is free from legislation. It proved this elemental fact by the very impressive means of blowing up, fortunately without hurting anybody. The men in the immediate vicinity had a very lucky escape, and those who were further away from the firing line were also fortunate, as some pieces weighing several hundred pounds were reported to have landed several fields away.

It shows surely a lack of consideration, or a sense of the fitness of things, on the part of these boilers to blow up when several successive governments have decided in their wisdom that these boilers cannot blow up, and are perfectly harmless domestic pets. The process of reasoning which decided that because a boiler is on a farm it is going to act differently under given circumstances than a boiler in an industrial establishment is not very clear to the ordinary mortal. Furthermore, the boiler on the farm is supposed to be possessed of sufficient intelligence to enable it to perform its functions without the aid of any skilled help. It is very likely that the real reason of the exemption of boilers on the farm from the Steam Boiler Act was on account of the farmers all possessing votes, and the fact that a farmer suddenly called upon to pay inspection fees, and probably higher wages to skilled help, would have emitted a howl that would have been heard uncomfortably in Queen's Park.

Our own opinion is that if there is any place on earth where a steam boiler should be subject to rigid inspection, it is on a farm, because anyone who has noticed the way many a farmer treats his farming implements can form a fair estimate of the way he will look after such a thing as a steam boiler.

We have pointed out from time to time in these columns the potentiality of danger that lies in any vessel containing a quantity of water under high steam pressure, and the fact that it was of relatively small size did not eliminate the danger. If one were to take the kitchen kettle and carefully seal the spout and tie the lid on after filling it with water, and then place it over the flame of the gas heater or the coal fire, it would probably blow the kitchen to pieces. The smallest boiler is much larger than the biggest kettle. Why should it be exempt?

The Cost of Strikes

THE Bureau of Labor Statistics at Washington has concluded that it is no use trying to compute reliable figures on the cost of strikes. All data pertaining to the matter, where an attempt has been made to reduce it to money, are of no value.

The bureau refers to the steel strike as showing the difficulties of gaining accurate information as to costs. Because of the difficulty of ascertaining the number of persons actually on strike and the different statements made by the two sides, it is held to be impossible to get figures of any value.

The innocent third party, the public, the bureau says, seldom suffers a money loss, its losses being mostly in the matter of inconvenience.

In Britain, right now, there is a concrete case of what it means to the third party. If the miners persist in their strike it will mean in a short time that hundreds of thousands of workers, who have no quarrel with their employers, and who cannot afford to do so, will be thrown out of work by reason of the absence of coal to keep their places of employment in operation.

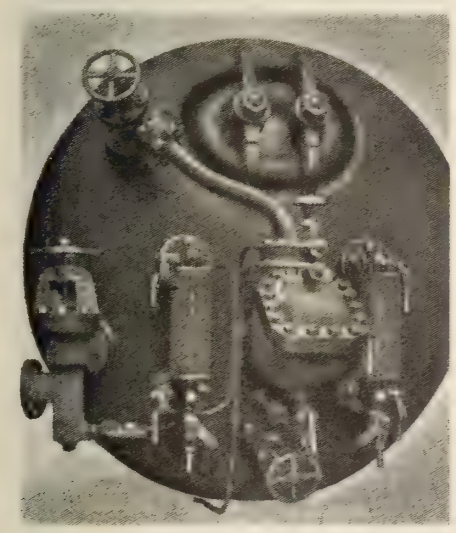
—Knott in the Dallas "News."
The Optimist.

Progress in New Equipment

AN AUTOMATIC FEED REGULATOR

An automatic regulator for boiler feed water, made by A. G. Mumford, Ltd., of Colchester, in which only very simple mechanism is employed, is shown in the engravings and drawings on this page.

The regulator acts directly on the feed check valve and relies for its effect on the control of the leakage past a piston connected with the valve. The check valve is shown at A in the drawing, and it will be seen that the body is extended downwards to form a small cylinder, in which there works a piston attached to the check valve. The piston is quite an easy fit in the cylinder. A hand wheel and screw are provided so that the valve may be closed if necessary, but normally the valve is only controlled by the piston. At the bottom of the cylinder there is a drain pipe which is of such a capacity that it will carry away the water leaking past the piston through its clearance in the cylinder. As the areas of the piston and valve are equal and the feed water acts on both at the same time, the pressure of the feed cannot open the check valve against the boiler pressure until the pressures



ARRANGEMENT OF REGULATOR

on both sides of the piston are balanced. Such a balance can be effected by closing the drain-away from the bottom of the cylinder and allowing the leakage to accumulate beneath the piston. Thus, by regulating the drain the check valve can be controlled.

The valve E for regulating the drain is operated by a float in a chamber connected with the water space of the boiler. The plug cock on the drain at the check valve is merely for shutting off the regulator. The float chamber B

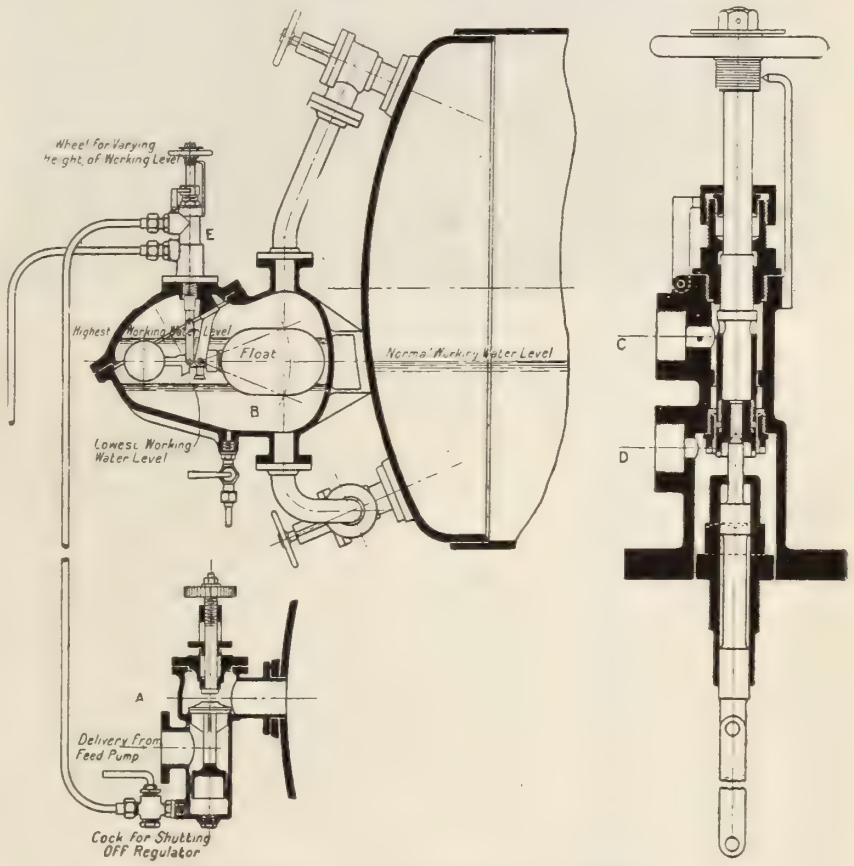


DIAGRAM OF FEED WATER REGULATOR.

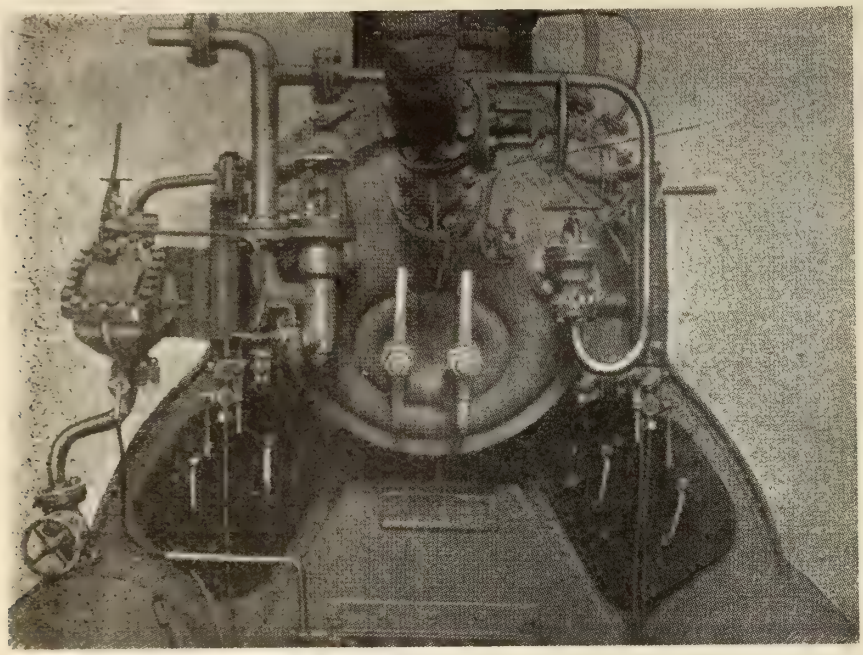
communicates with the boiler, both above and below the water line, and is so placed as to have its centre at about the normal working level. In it there is a substantial float, which is counterbalanced and pivoted on a bracket fixed to the chamber cover. A pair of links connects the float lever with the valve for controlling the leakage drain, of which a detail is given. The arrangement of the float lever and valve, it will be seen, is such that the valve closes when the float drops. Thus when the water level is lowered in the boiler the float closes the control valve, water accumulates under the piston and the check valve opens to admit water to the boiler. On the level in the boiler, rising above the normal the reverse action naturally takes place.

The leakage drain is connected with the valve at C, while a final drain leads from D to the feed pump suction. The seating of the control valve is fixed on the end of a long hollow spindle, which is screwed and furnished with a hand wheel at the top. It is thus possible to vary the position of the seating, and consequently the water level at which the float will close the valve.

It will be noticed that all the working parts of the mechanism are entirely within the casings, with the result that there are no stuffing boxes with their friction to check the free action of the gear. There is a spindle which comes through the wall of the float chamber in a stuffing-box; but it is quite separate from the rest of the mechanism, and is only used to test the freedom of the float. The spindle has a handle on the outside and terminates within the float chamber in an arm which can be engaged with the float lever. This arm

can be seen hanging just below the bracket carrying the float.

One of the great merits of the apparatus is the ease with which it can be overhauled while the boiler is under steam. If the valves in the pipes connecting the float chamber with the boiler and the plug cock on the check valve are closed, the whole mechanism can be opened up and hand regulation reverted to for the time, during which the automatic gear is out of commission.



ANOTHER ARRANGEMENT

FILTRATION AND STERILIZATION

To the man who is not vitally concerned the matter of machine tool lubrication may not appear of much importance. On the contrary, it is of proven importance, otherwise there would not be the demand for such a large number of different cutting oil liquids and compounds.

It was not so long ago when the ability to increase production by liquids applied to cutting tools was recognized and the initial steps taken along that line. Water was the first liquid tried, used as a stream feed, or provision made so it would be allowed to trickle upon the tool and work. A little experience in this way proved that a mixture of soda and water was more satisfactory all around, as the tendency to rust and corrode was largely overcome.

The evolution of machine shop practice, requiring high speed tools, carried with it efforts for extreme accuracy in machining and the element of increased production. With the speeding up of tools it was readily recognized that in order to keep down operating costs and produce a product of the highest quality, it would be necessary to use a cutting fluid which had not only the cooling properties necessary to absorb excess heat, but lubricating qualities as well, to increase accuracy, decrease the power consumed, and at the same time speed up production.

With the production of a cutting oil which would serve the double purpose came the increased cost and this item must, of necessity, be kept at the lowest possible figure, otherwise the product could not be marketed. It was, therefore, apparent that an equipment which would filter and sterilize the liquid would eliminate the necessity of throwing the used oil away. This method would reduce cutting oil expense and still promote high speed operation.

The S. F. Bowser Company, Limited, oil storage and filtration engineers, Toronto, are out to meet this need and have designed a filtering and sterilizing system which will soon be placed on the market. The illustration gives a good idea of its appearance and construction. These embody the tried and true principles of screening, precipitation, filtration and sterilization, all combined in a commercial and practical manner. This class of filtration is not a venture or experiment, and the company have had systems, essentially the same, in service for several years, which are giving the very best results.

An installation of this nature will naturally increase the life of the cutting tools, decrease power consumption, permit higher operating speed, increase accuracy, give better lubrication and save throwing away oil which has been used. By this conservation a better grade of oil can be used—one which will not foam, rust or corrode the work or tools. While the filtering process, which is automatic, is under way, the oil is also sterilized, thus eliminating obnoxious odors and preventing infection, thereby preserving the health of the employees.

The systems are so designed that they can be adapted to conditions prevailing and arranged to accomplish the work required. From the machines and chip separators the oil, either by gravity or special provision, can be delivered to the filter and sterilizer which automatically removes foreign matter and sterilizes the fluid. After going through a series of compartments, screens, filtering devices, etc., the liquid is delivered to the filter tank, which acts as a temporary storage. From this tank the oil can be returned to the different machines the same as new oil and used again.

POWER CAUSES MORE TROUBLE

Industrial Centres Have Hard Time in Keeping Their Plants in Operation

BRANTFORD.—The Hydro Commission here has been unofficially notified that a 20% reduction in Brantford's Hydro allotment will be made shortly. A conference of manufacturers and the local Hydro Commission will be arranged to take steps to prepare for the cut. The situation here is already serious and the city council committee in charge of street lighting is prepared to curtail this to provide more power for domestic users.

Windsor's Shortage

WINDSOR.—Deeming it necessary to bar use of Niagara power for signs and window lighting, the Windsor Hydro-Electric Commission will ask the city council to pass a by-law giving effect to a resolution passed at a meeting of the commission. O. M. Perry, manager of the local commission, said every effort will be made to discourage the use of electric heaters. Co-operation is necessary also on the part of business men, Manager Perry said, in order that street lighting may be provided in new residential sections.

OUR QUESTION BOX

(Continued from page 495.)

over a fly ball governor?" I have this question to answer at our next regular meeting night, October 26th. Not having much experience with a shaft governor, am kind of "up against it." After looking over some dozens of the Power House could not seem to find the point. As you have helped me out of difficulties before, I thought I would try you again.

Answer:—The advantage of a shaft governor lies in the fact that it acts directly on the steam distributing valve, and alters the cut off, thus getting a longer expansion curve, or in other words, more heat from the steam. The fly ball governor acting on the throttle valve curtails the opening through which the steam passes, causing loss of heat by wire drawing, and the cut off remaining the same, the steam leaves the engine at a higher terminal pressure.

FAIRBANKS-MORSE

Building a Bigger Canada

THESE are days of progress—days when industry is leaping ahead and Canada is assuming her place in the world of commerce. Giant structures are being reared to house the machinery, men and equipment necessary to a bigger business.

Great highways are being constructed to provide for the easier transportation of Canada's products; elevators, wharves, factories, mills, mines—everywhere the hand of the contractor is set to some big task.

And wherever this construction work is going on, Fairbanks-Morse contractors' equipment is playing an important part—rendering its services as a factor in this work of progress. From the shovel to the steam and electric hoists, from the concrete mixer to the heavy road machinery, drill and jack, to truck and railway car, Fairbanks-Morse equipment is the choice of the contractor, because he knows that behind the smallest tool is the same quality guarantee and service that supports the largest unit of Fairbanks-Morse equipment.

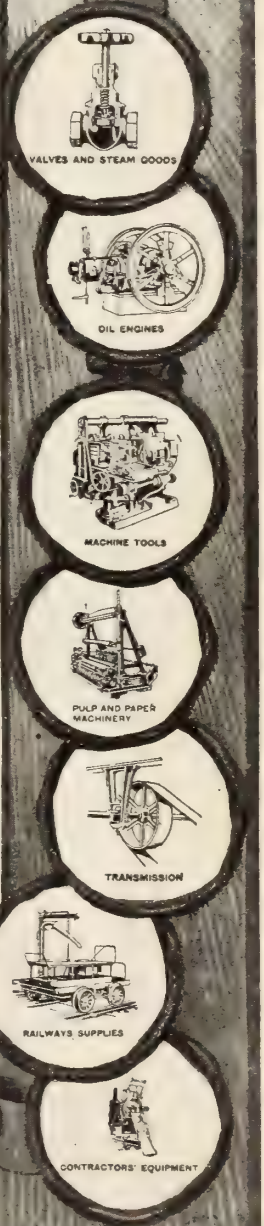
He knows that the Fairbanks-Morse 100% quality seal is the ideal of the Fairbanks-Morse institution—a standard and a guide in building a bigger Canada.

The Canadian Fairbanks-Morse Co. Limited

Canada's Departmental House for Mechanical Goods

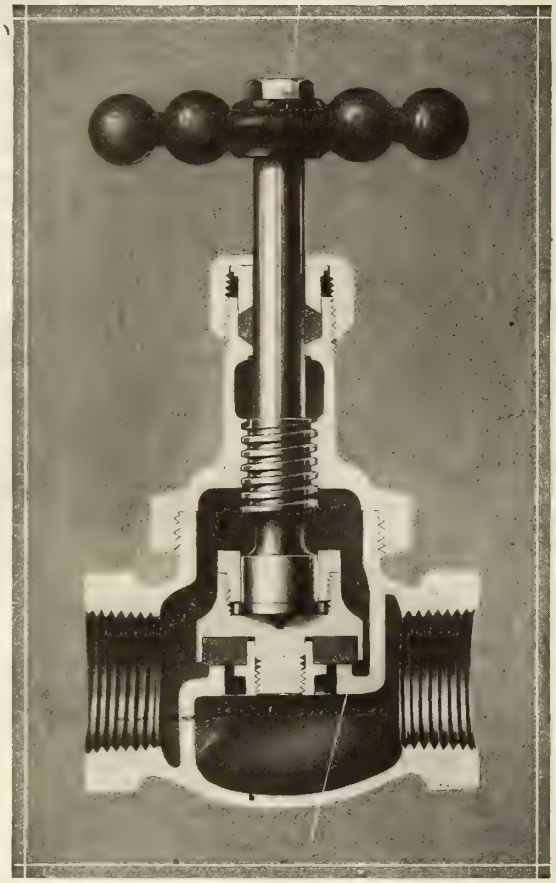
Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Saskatoon Regina
Calgary Vancouver Victoria

11



TRADE PENBERTHY MARK.

BE SURE THIS NAME is on the Valve you buy



SECTIONAL VIEW OF PENBERTHY COMPODISK VALVE
Registered and Approved for 175 lbs. Steam Pressure

Then you get "The valve with the outside bonnet construction."

The first progressive improvement made in brass valve construction in generations.

Think of the advantages! Valve always accessible.

No straining or stripping of threads when assembling or taking apart.

Impossible to spread or enlarge body of valve when screwing down bonnet to place.

No corrosion of threads, for they are on the outside, away from the action of steam and water.

Penberthy Valves Are High Grade Valves

The fine quality of metal—the excellent workmanship and finish—the up-to-date design with the outside Bonnet Construction—the long wearing, serviceable Composition Discs —the Government approval of 175 lbs. steam pressure—all these advantages are yours when you buy the genuine Penberthy Valves. We also make the Regrinding Type approved for 200 lbs. steam pressure, as well as Brass Gates, Swing, Horizontal, Vertical, and Angle Check Valves.

STOCKED BY LEADING JOBBERS AND MILL SUPPLY HOUSES IN CANADA

PENBERTHY INJECTOR CO. LIMITED
WINDSOR CANADA

Tragedy in an Unusual Form

THE generation of high potential electric current and the transmission of it over many miles of country is attended by comparatively few accidents in proportion to the amount of electrical power development. The chief cause of fatalities through high voltage electric lines is by the coming into contact with them of linemen engaged in their usual work of running new lines, and repairing and locating faults in existing ones. Accidents in the generating stations themselves are happily few in number, and fatalities even less, and with the constantly better efforts towards safety that are being put forth, the number should steadily decrease. It is therefore with something of a sensation of horror that we read of the destruction of no less than eleven men, almost instantly, through an accident which, although it may have happened before, does not recur to our memory. The accident in question was the explosion by some fault in the insulation, presumably, of the oil used for the cooling of a transformer in the Tonowanda power house, Buffalo. The change of electric current, which is generated at high pressure, to current at a much lower pressure is accomplished by means of transformers which consist of two separate coils of wire wound on iron cores. The high potential coil will consist of a large number of turns of small wire, and the low potential side of a less number of turns of a larger wire. The effect of the high potential current being passed through the high potential coil is to induce a current in the low potential coil of the same periodicity, and the relation between them is such that if the high side A consists of 50 turns, and the voltage is, say 100 volts, then if the low side consists of 25 turns the voltage in that coil would be reduced to 50. This, of course, applies to any voltage, and any relation of the number of turns. There is little loss between the two sides, by which we mean that the product of volts and amperes in the low side will be almost the same as that of the volts and amperes in the high side. What loss there is, however, appears in the form of heat, and in order to carry off this heat, it is usual to immerse the whole apparatus in a bath of oil. This oil in turn has very often coils running through it which carry a circulating stream of cooling water, and thus the heat is effectually dissipated. It was this bath of oil that exploded and thrust forth a sheet of flame which licked out the lives of eleven men in an instant. The cause of the accident is stated to have been a short circuit. The apparatus was under test at the time, and it is probable that oil bath had been raised to a dangerously high temperature without it being noticed. A piece of defective insulation and a high tension spark would easily supply the little extra heat necessary to cause the flash. No doubt the enquiry that will follow will throw light on the exact cause of this sad accident, and make the recurrence of it extremely unlikely in the future.

TRADE GOSSIP

Equipment Wanted.—T. McAvity & Sons, Ltd., St. John, N.B., are in the market for a few No. 6 turret screw machines.

George A. Marshall, of Messrs. Marshall, Son & Bunney, 39 Richmond St. E., Toronto, has gone to England on the SS. Metagama, where he will spend a month or more on business matters.

At a recent meeting of the Montreal Branch of the Engineering Institute of Canada the entire evening was devoted to moving pictures, both of an instructive and entertaining character. One of the reels shown was in connection with the work of McGill University. Every branch of the work was covered by the film, including educational, athletic and military features. Between the showing of the pictures brief addresses were given by J. L. Busfield and the secretary F. S. Keith.

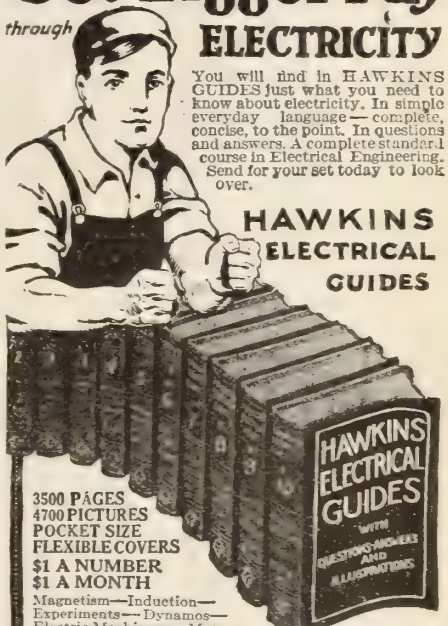
Locating in St. Thomas. — The Canadian Edison Phonographs, Ltd., have taken over the buildings in St. Thomas, formerly occupied by St. Thomas Cabinet, Ltd., and before that by Thomas Bros. The Edison Company took over the buildings, much of the equipment in the woodworking shops, and get six acres of land along with it. They have also placed orders for considerable new equipment in the line of woodworking machinery. The deal for the sale of the plant to the Edison Company was put through by Mr. William Garlock, of the Garlock-Walker Co., Toronto.

Will Finish Ships.—Arrangements are being made by the Department of Marine with the liquidator of the Dominion Shipbuilding Co., of Toronto, for the completion of the two steamships which that corporation had under construction for the Government of Canada. The vessels, which were being built for the fleet being operated by the Canadian Government Mercantile Marine, are to be of 3,500 tons each, and about 75 per cent. of the work upon them had been done when the company went into liquidation. The Department of Marine will either undertake to do the remainder of the work or have it done through the liquidator.

Following a conference held between the Administrative Commission and an influential delegation of business men and citizens of Montreal, headed by Lord Shaughnessy, a deputation will go to Ottawa to confer with the Government on the question of constructing a second bridge across the St. Lawrence in the vicinity of the harbor of Montreal, to connect the Island with the south shore. It is felt by a large number that this additional means of communication between the two points is an urgent necessity and that the next few years will demand some relief from the present conditions.

May Earn Less.—In commenting on the business prospects, President T. J. Dillon, of Canada Foundries & Forgings, Welland, Ont., says: "In order to realize on the full possibilities of the plants this company found on its hands at the end of the war, it was considered advisable to appropriate a fairly large amount for additional equipment for rounding out their different units to lower the cost of manufacture of regular lines and add a few new ones. Indications point strongly to gradually lowering on steel commodities, and lessened dividends, which will result in declining earnings. Although the common dividend declared was somewhat less than those previous, it makes 10 per cent. for the year 1920."

Get Bigger Pay through **ELECTRICITY**



You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language — complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied.

Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination **Hawkins Electrical Guides** (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____

Occupation_____

Employed by_____

Residence_____

Reference_____ **Power House**

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 35
Plates, ¼-in. up	6 50	6 60

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.00	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
4½-in. and larger, 10%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	27½
Palacine	30½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82½
Cylinder Oil, Acme	70
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	10
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, squpare blank	add $ 2 00
Nuts, square, tapped	add 2 25
Nuts, square blank	add $ 2 00
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ove	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 35
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	16 00
Glue, ..nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 38
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl	4 50
Sandpaper, B. & A....list, plus	43%
Emery cloth.....list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	49 00	48 00
Copper sheet, tinned, 14 x 60, 14-oz.	52 00	48 00
Copper sheet, planished, 16-oz. base	56 00	55 00
Braziers', in sheets, 6 x 4 base	48 00	46 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$54 00	$55 00
Spelter	9 00	10 50
Lead	9 50	9 50
Antimony	9 50	12 00
Aluminum	36 00	37 00

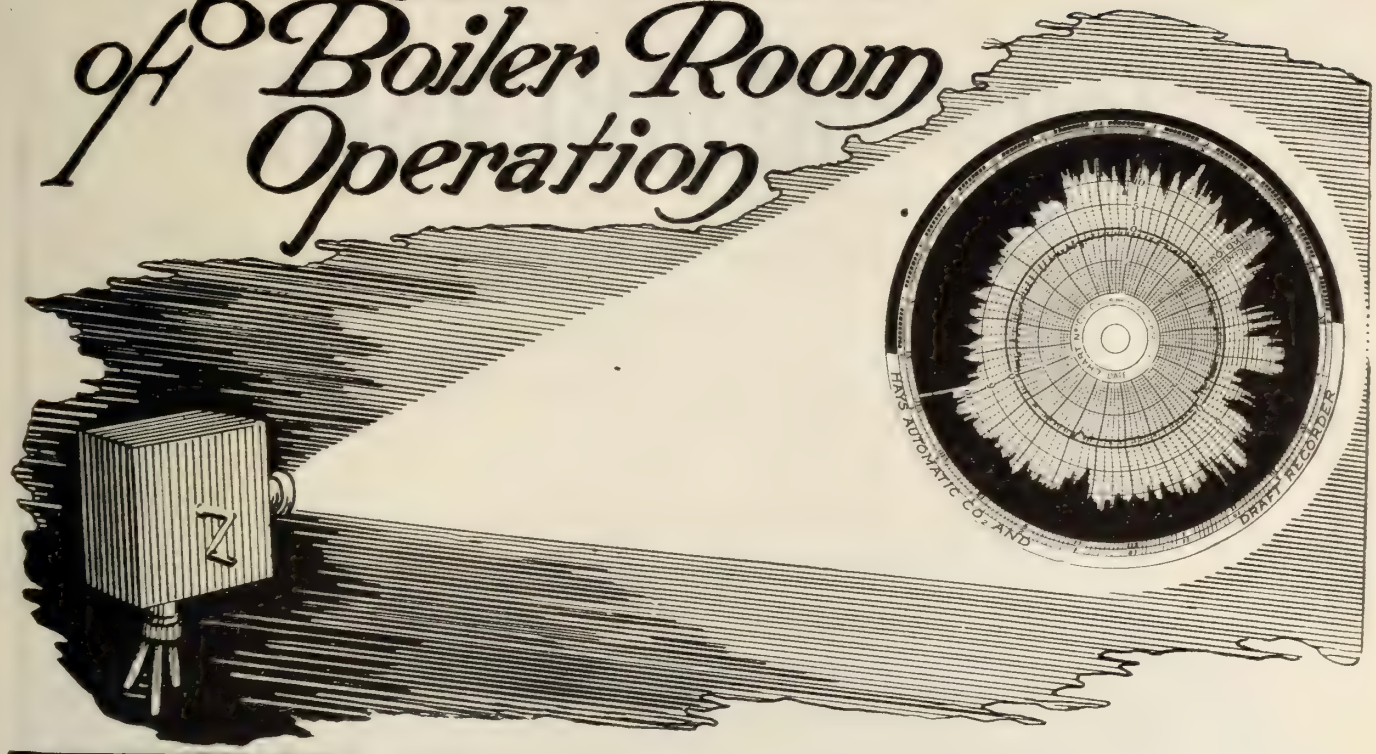
Prices per 100 lbs.

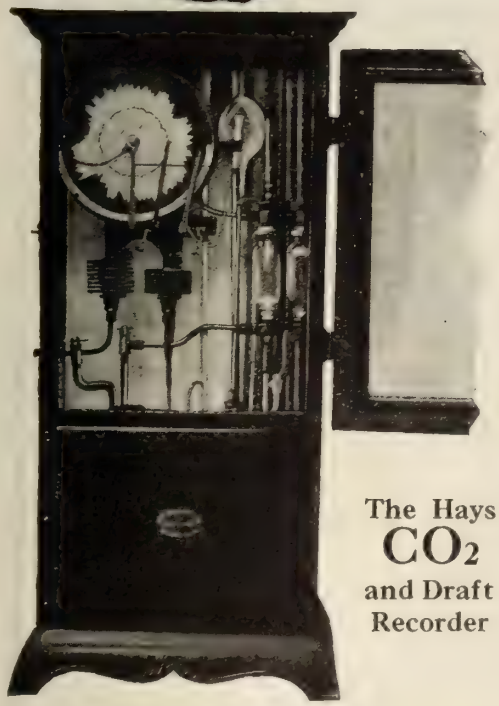
LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$11 50	$14 50
Sheets, 3½ lbs. sq. ft.	11 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	11 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Moving Pictures of Boiler Room Operation





The Hays CO_2 and Draft Recorder

Awarded certificate of merit by Franklin Institute

The Industries have come to appreciate the value of pictures which show every important detail of an operation and enable careful analysis to be made. Waste motion is eliminated; higher efficiency and better products at a lower cost are the results when a scientific study is possible thru such a record.

The daily picture made by the **Hays Automatic Co_2 and Draft Recorder** shows cause and effect of Boiler Furnace Conditions. The fireman makes his own record. He sees trouble coming and takes measures to avoid it. He knows what to do and why to do it because he has analyzed by "reduced motion" the Hays Record of the performance of his equipment. He knows the draft and the fuel thickness which gives highest percentage of CO_2 under different loads, and firing to him means imposing these *best* conditions.

Department "S" will gladly send you complete data about Hays Appliances with a copy of the interesting Booklet "Fuel."

The Jos. W. Hays Corporation

Combustion Efficiency Appliances

Michigan City, Indiana

100% MEMBERSHIP

On Wednesday, Oct. 20, the Association of Canadian Advertisers endorsed the statement of W. G. Stewart of Goodyear Tire and Rubber Company that all trade newspapers should be required to furnish audited statement of circulation.

We're with you, Mr. Stewart. Every publication issued by MacLean Publishing Company is a member of Audit Bureau of Circulations.

Advertisers who are members of A.C.A. and those who are not would be acting in their own interests and in the interests of Canadian publishers by insisting that every publication in which their advertisements appear should come out into the open and furnish a statement of circulation certified by some independent organization such as A.B.C.

The following MacLean publications will gladly send A.B.C. statement of circulation on request:

TRADE NEWSPAPERS

Hardware and Metal
Druggists' Weekly
Canadian Grocer
Sanitary Engineer
Dry Goods Review
Men's Wear Review
Bookseller and Stationer
Canadian Motor, Tractor and Implement Trade Journal

MAGAZINES

MacLean's Magazine
Farmers' Magazine

TECHNICAL NEWSPAPERS

Power House
Canadian Machinery
Canadian Foundryman
Marine Engineering
Printer and Publisher

COMMERCIAL NEWSPAPER

The Financial Post

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK

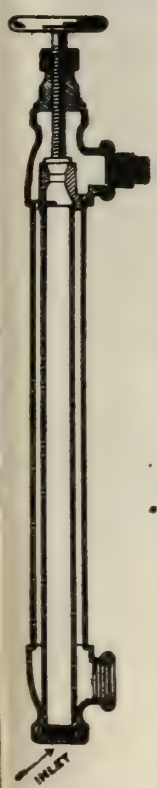
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

The LONG

PATENT

STEAM TRAP



Saves Coal

The Long (Patented) Steam Trap conserves fuel by stopping steam wastage.

Most simple and effective Steam Trap you can install in your plant. **Has only one Movable part.**

The Long Trap is open at the start and cannot become air bound. Never freezes. Works against 1 and 200 pounds pressure. Can be installed in any position.

Write us and we will send you the full story of its efficiency. 'Twill save you worry, time and money.

J. T. LONG
84 Adam St.
MONTREAL CANADA
If your dealer does not sell it, write direct

Classified Advertisements

TWO CENTS A WORD, Box Number as five words; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

MALE HELP WANTED

MECHANICAL ENGINEER, PREFERABLY technical graduate, having steam-power-plant experience to assist in the preparation of technical-book manuscripts and in other steam engineering work largely of desk and detail character. Ability to write pure, simple, expressive English is essential. Teaching experience desirable. Must be accurate and thorough. We desire to locate a steady, well-balanced, painstaking engineer who does not ordinarily answer advertisements. To one who can satisfy our requirements we can offer a good future. Apply by letter only, in your own handwriting, giving age, education, experience (when and where you worked and what you did) and salary expected. Terrell Croft Engineering Company, 6600 Delmar Ave., University City, St. Louis, Mo. (p10h)

WANTED

WANTED AT ONCE — POSITION AS ENgineer. Hold second-class certificate. Steady, reliable man. Will go to any place. Box 101220, Power House. (f)

WANTED—EXPERIENCED BOILER DESIGNer by large manufacturing plant in Ontario. Apply Box 92120, Power House. (f)

GOOD INVENTIONS

ENCLOSED LIQUID FUEL COMBUSTION APparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented October 8th, 1918. Can be inspected at and for sale by H. W. Petrie, Limited, 131 Front St. W., Toronto.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

Do you realize the Grea Expense of Packing Stuffing Boxes to-day?

Everything is costly

The heaviest item of expense is the labor of applying the packing and not the packing itself.

It is therefore necessary that the heavy labor expense be minimized by using only the packing that gives the longest service.

Ask the Engineer who uses

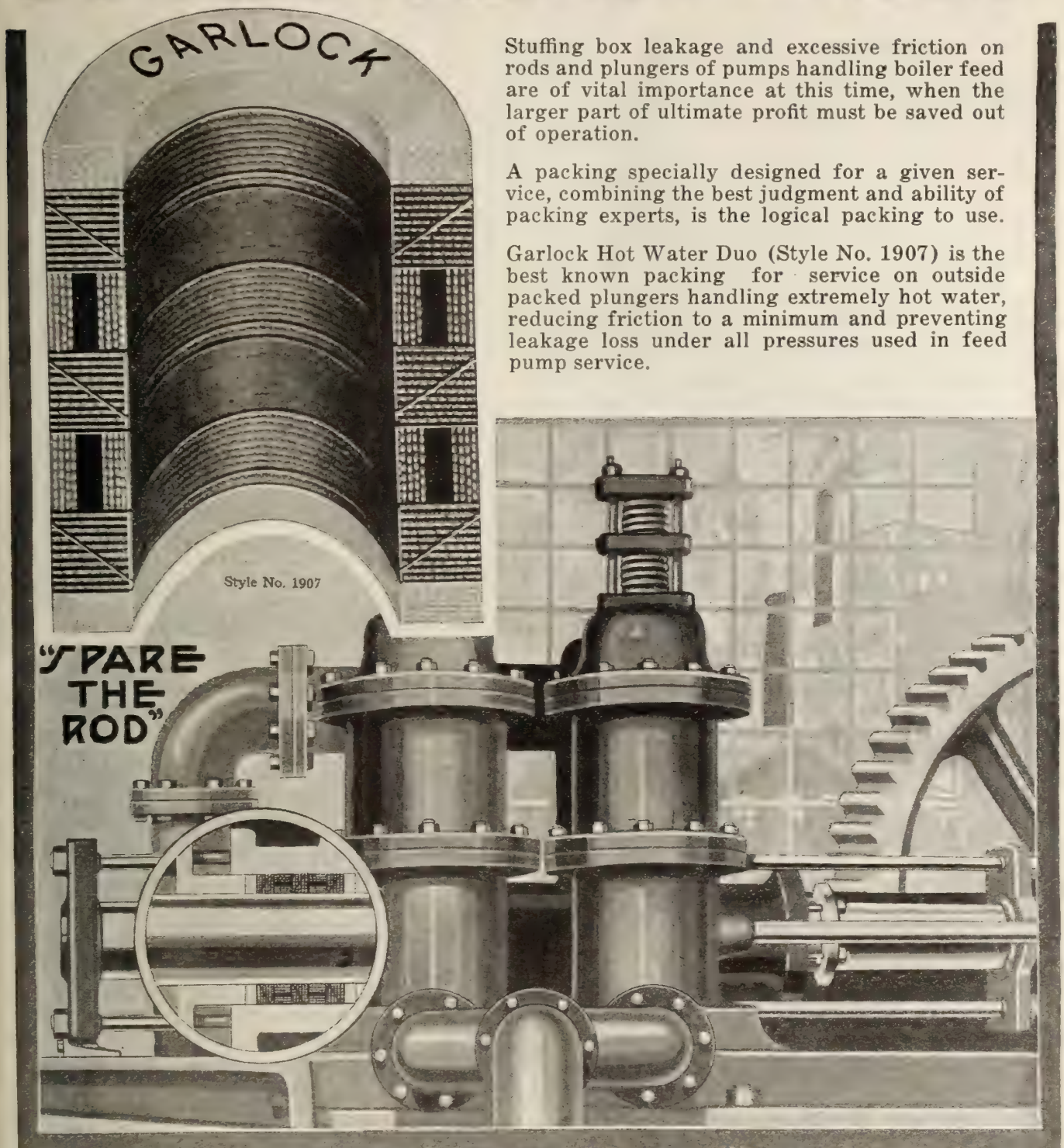
TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

and he will tell you how long it outlasts other packings.

If you don't know what "PALMETTO" packing will do for you in the way of saving needless trouble, and useless expense, ask us to send you working samples to test under your own conditions. It will cost you nothing for the samples and it will prove our claim.

GREENE, TWEED & CO.
SOLE MANUFACTURERS
109 DUANE ST., NEW YORK

OUTSIDE PACKED PLUNGERS



Stuffing box leakage and excessive friction on rods and plungers of pumps handling boiler feed are of vital importance at this time, when the larger part of ultimate profit must be saved out of operation.

A packing specially designed for a given service, combining the best judgment and ability of packing experts, is the logical packing to use.

Garlock Hot Water Duo (Style No. 1907) is the best known packing for service on outside packed plungers handling extremely hot water, reducing friction to a minimum and preventing leakage loss under all pressures used in feed pump service.

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONT.

BRANCHES

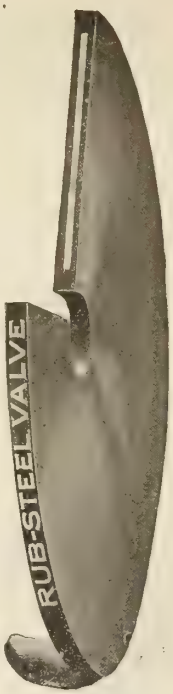
Montreal, Que.	Toronto, Ont.	Winnipeg, Man.
Calgary, Alb.	St. John, N.B.	Vancouver, B.C.

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

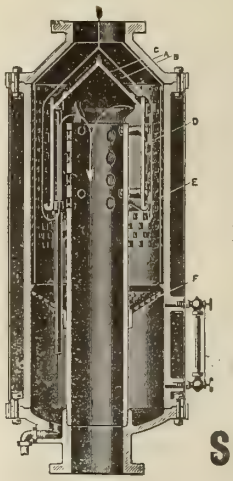
One installation will convince YOU.



Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Williams' Improved "Vulcan" Chain Pipe Wrench

Where strength and positive grip are requisite, specify Williams' "Vulcan" Chain Pipe Wrench. At your Dealers'.

Ask for Booklet

J. H. WILLIAMS & CO., LTD.
"The Wrench People"
Formerly Canadian Branch of the Whitman & Barnes Mfg. Co.
ST. CATHARINES ONTARIO

Coppus in the Confectionery Industry

Wherever candy is sold Huyler's trade-mark means quality supreme. Wherever candy is made—there is an opportunity for COPPUS Turbo Blowers to save money in power plant operation.

These two 18" Blowers have been economizing time, fuel, and labor in the boiler room of the Huyler's Chocolate Company, 136 East 18th Street, New York City, since July, 1917. They burn inexpensive fuel—keep up full steam pressure—and meet peak loads without extra exertion by the engineer, **quickly, easily, cheaply.**

They can do this better than any other type of blower because of their

Standardized Construction
Rugged Reliability
Economy of Operation

What COPPUS Turbo Blowers are doing in other plants they can do in yours. If you will ask us we will be glad to send you complete information showing just how COPPUS Turbo Blowers can help you secure more power from your present equipment and greatly increase the efficiency of your power plant.

Write for Blower Catalog.

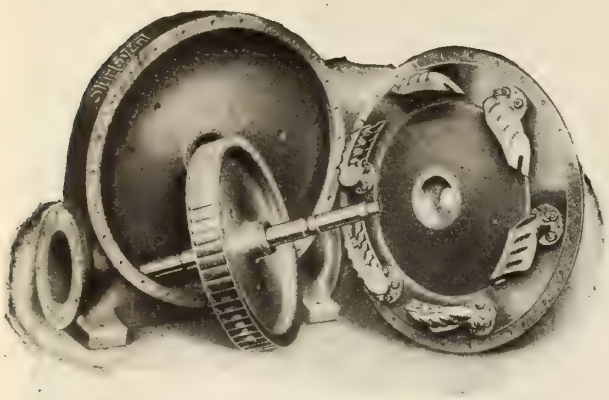
"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine
341 Park Ave., Worcester, Mass

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.

COPPUS TURBO BLOWER

For Low Cost



Contrary to popular belief, a careful comparison of the steam consumption of an engine and of a turbine of equal capacity will show that they run closely together when both are new.

At the end of a short period of operation the wear on the engine valves will have materially decreased the initial economy while that of the turbine remains practically unimpaired.

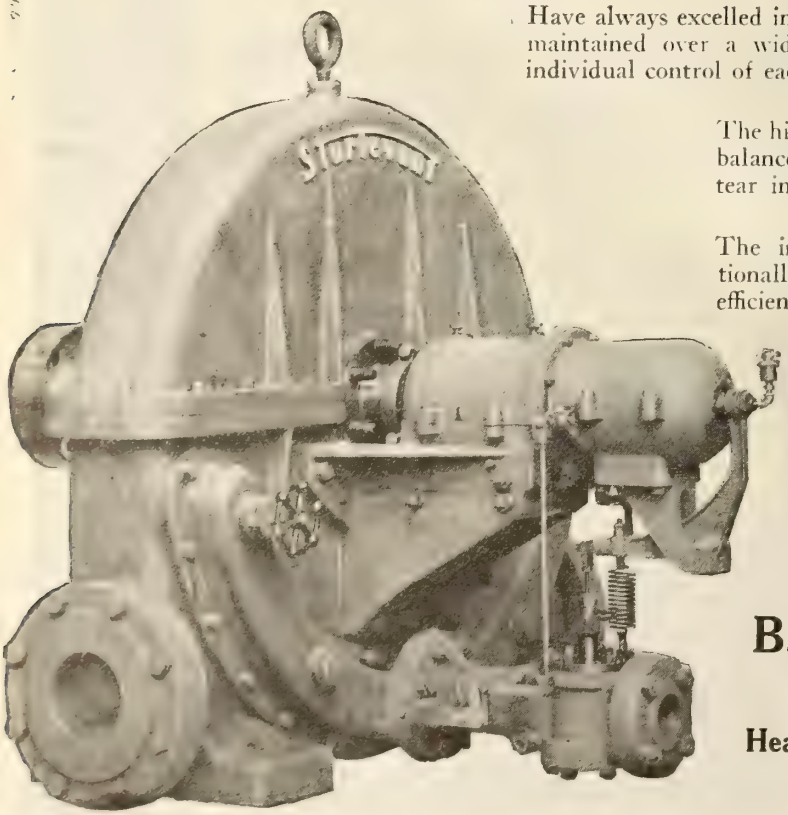
When the lesser attention and the large saving in oil are furthermore given due consideration it will be found that the turbine is actually the *more economical* of the two.

Sturtevant

(TRADE MARK)

Steam Turbines

Have always excelled in two points—supreme reliability and good economy maintained over a wide range in load due to superior design and the individual control of each nozzle by convenient hand valves.



The high grade of materials and workmanship plus careful balance insure smooth operation with minimum wear and tear in service.

The improverd governing mechanism maintains exceptionally close regulation, which particularly adapts these efficient turbines to direct connected generator drives.

Before deciding on your small turbine drives be sure to consult our engineers. They have valuable information to give upon request. Write for Catalog "V" today.

B. F. Sturtevant Company of Canada, Limited

Head Office and Works - Galt, Ontario

Sales Offices: Toronto and Montreal

in Operation

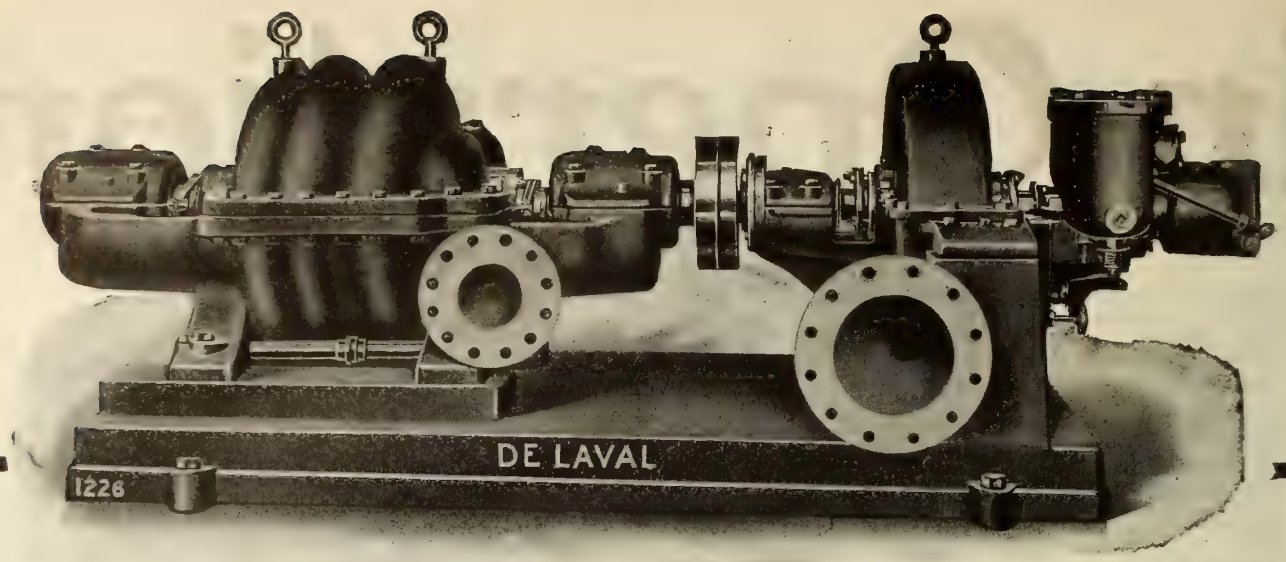
Sturtevant Turbines are particularly desirable for driving Boiler Feed and Condenser Pumps due to their dependability and smooth operation with practically no attention.

Sturtevant Turbines are protected from grit and dirt. This makes them ideal for direct connections to fans and blowers, where the latter are located in places where the dust would make it unsafe to operate an electric motor.

Sturtevant Turbo Generator Sets are very economical for small plants or for auxilliary equipment in the larger plants and central stations. The excellence of regulation is particularly commendable.

Sturtevant Gear Transmission can be supplied where the most efficient speed of the driver member is below the turbine speed.

In every case our engineers should be consulted before any Sturtevant Turbine Drive is specified.



A 13,000 H.P. Boiler Feeder

The De Laval Steam-Turbine-driven Three-stage Centrifugal Pump shown above has a capacity of 800 gals. per min. against 520 ft. head. This particular unit is used as a boiler feeder, and will supply 13,000 boiler h.p. normally.

De Laval Turbine-driven Centrifugal Boiler Feeders effect a great saving in space and in cost of supplies and attendance. There are no packings except the simple ones about the shaft, and no rubbing surfaces except the bearings, which are ring-oiled. There is no vibration and no pulsation in pipe lines, and automatic boiler feed regulators and feed water meters can give good results.

In smaller sizes De Laval Turbine-driven Boiler Feeders are combined in a single casing, with only two bearings, and one shaft.

Ask for our new Centrifugal Boiler Feed Bulletin N. 62.

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LTD., 73 King St. W., Toronto
THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING CO., LIMITED, Vancouver, B.C.

MACGOVERN & COMPANY INCORPORATED

POWER MACHINERY

114 Liberty Street - - - New York, N. Y.

WATER TUBE BOILERS

Eight 250 h.p. Stirling Boiler, 160 lb. Pressure

FOR PROMPT SHIPMENT

Complete with Automatic Stokers and all necessary fittings

These boilers have new tubes throughout, making them as good as new.

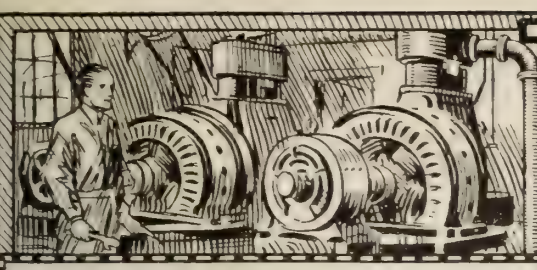
The above are only a few items from our large stock of Steam and Electrical Equipment, consisting of TURBO UNITS, RECIPROCATING UNITS, ROTARY CONVERTERS, MOTOR-GENERATOR SETS, BOILERS, CONDENSERS, PUMPS, ETC. Complete list will be gladly mailed upon request.

Send for our special lists of INDUCTION MOTORS, new and used, as we have too many to list here.

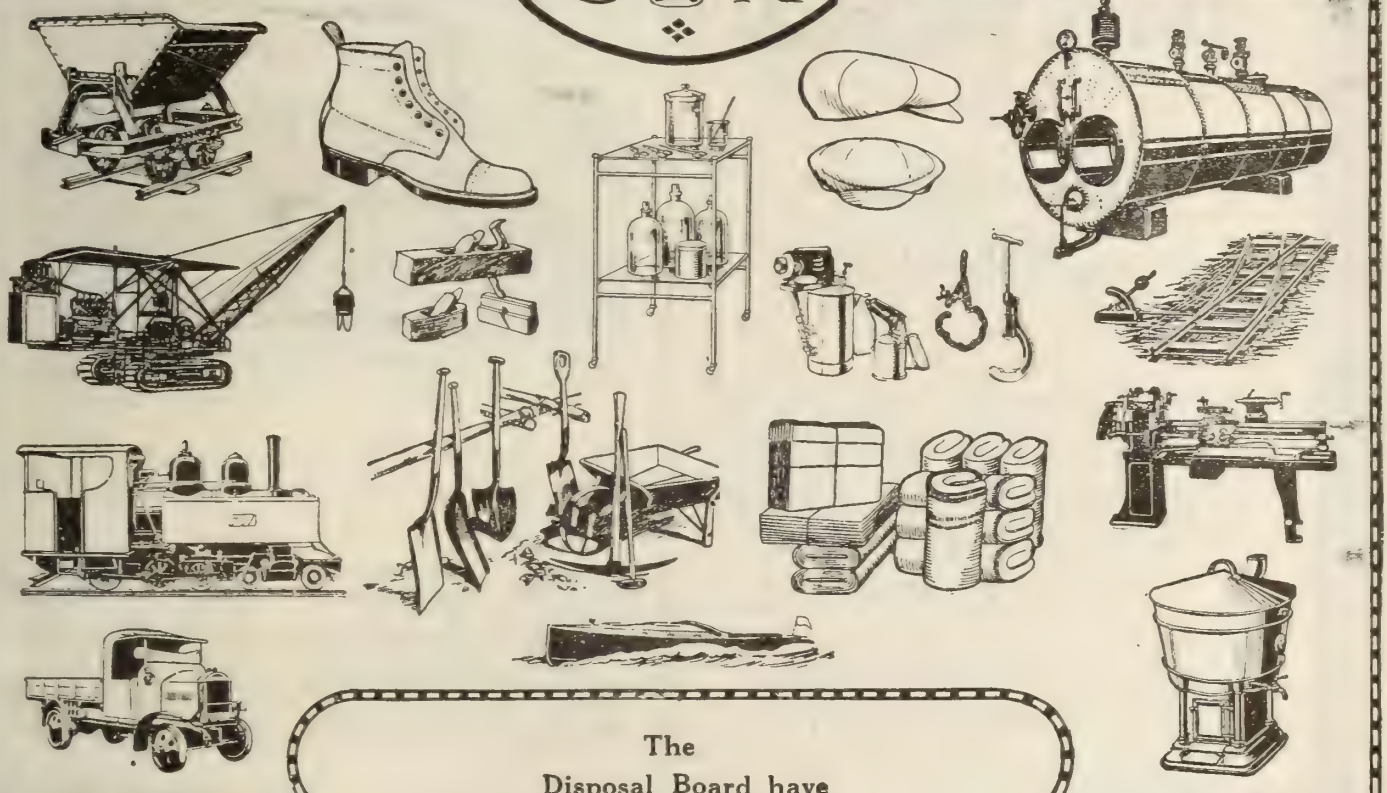
PITTSBURGH, PA.
498 Union Arcade Building

BRANCH OFFICES:
SEATTLE, WASH.
L. C. Smith Building

MONTREAL, QUE.
285 Beaver Hall Hill



MINISTRY of MUNITIONS
G R



The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Contractors' Stores
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

LINCOLN ARC WELDER

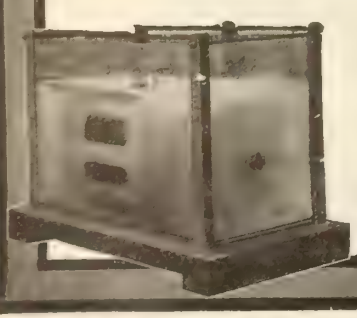
Link Up With Lincoln for Performance and Service

THE Lincoln Electric Company owns and operates the largest electric welding plant in the Dominion of Canada.

There is no electric welding undertaking too large for us to handle. Neither is there one too small.

If you do not know just what possibilities Lincoln Welding offers, one of our engineers will be glad to explain them to you. Write our nearest office.

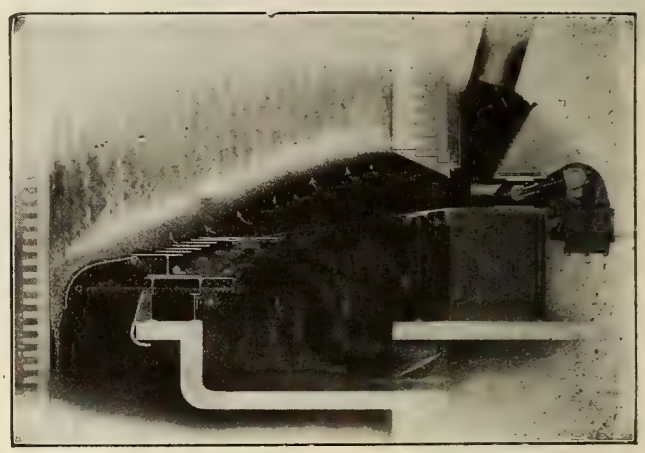
The Lincoln Electric Co.
of Canada, Limited



Head Office and Works:
John St., Toronto
Phone Adelaide 7200

Montreal Branch:
Coristine Building

BURN ALL GRADES OF COAL



Cross-section Through Stoker Showing Automatic Operation

No device has shown itself better adapted to burn any available coal than the

RILEY UNDERFEED STOKERS

Low-grade coals—those high in ash—in sulphur and clinker-forming qualities—can be handled successfully for the following reasons:

1. The moving grates keep the clinkers broken up—combustion is intensified—the fuel bed is always active, even and in a homogeneous state.

2. The rocker dump, with its combination of vertical thrust and rocking motion, grinds up—discharges the ash continuously and automatically—keeps the fire clean and the bridge wall free from accumulations.

3. The underfeed feature makes possible high capacity and instant response to overload demands.

Our engineers will be glad to acquaint you with the wide range of fuels now being handled by the RILEY UNDERFEED STOKER under many varying conditions.

Write for Catalog HM-10

Sanford Riley Stoker Co.
Worcester, Mass.

BELTING EFFICIENCY

P.M.S. BELTS

Scientifically designed to meet difficult transmission conditions such as cone drives in Paper Mills. It successfully meets all extremely hard belting tests. Wonderfully adapted to conditions of heat, exposure or dampness

P.M.S. BELTS

Gutta Percha & Rubber, Ltd.

HEAD OFFICES AND FACTORY, TORONTO

BRANCHES: HALIFAX, MONTREAL, OTTAWA, FORT WILLIAM, WINNIPEG
REGINA, SASKATOON, EDMONTON, LETHBRIDGE, VANCOUVER, VICTORIA

"MEAD-MORRISON"

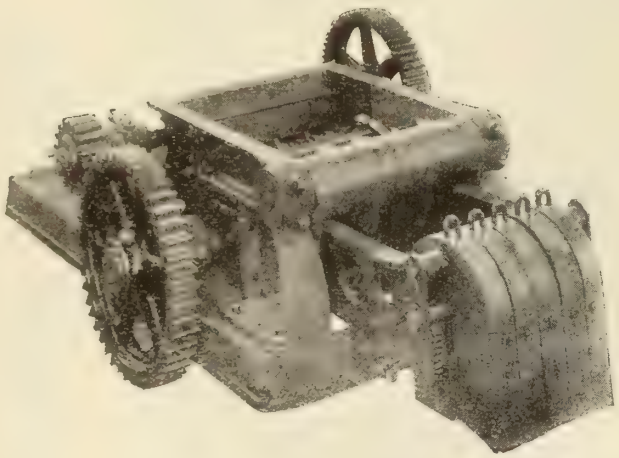
CANADIAN MM ©

CANADIAN MM ©

Single Roll

COAL CRUSHER

Made in Canada



Capacity Single Roll Crusher, 50 to 70 tons an hour.

Capacity Double Roll Crusher, 100 to 150 tons an hour.

McCASLIN CONVEYORS
GRAB BUCKETS
SKIP HOISTS
COAL HANDLING MACHINERY

Dependable Service

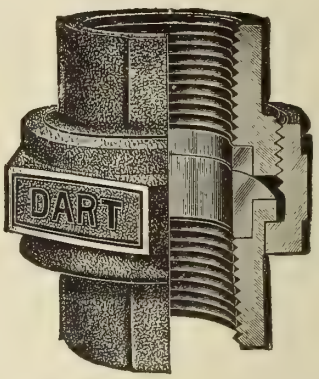
AGENTS:

Ferguson and Palmer, London, Eng.
Harvard Turnbull, Toronto.
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Dart unions

BRONZE TO BRONZE



STAY TIGHT

Permanently

Both Face and Seat being Bronze makes deterioration and loosening up at the joint **impossible.** Then, too, there is added security in the heavy iron parts—they will not stretch or pull apart. **Use again and again**—they're always efficient.

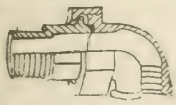
Your jobber sells them.

Manufactured by

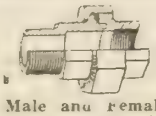
Dart Union Co., Limited, Toronto

JEFFERSON

"Look for the name on the nut"



Union Elbow, an economizer of the most pronounced type. Also made all female.



Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.

Union Tee, with union on the outlet. Made also with male end on outlet.

Say "Good-bye" to Your Pipe Line Troubles

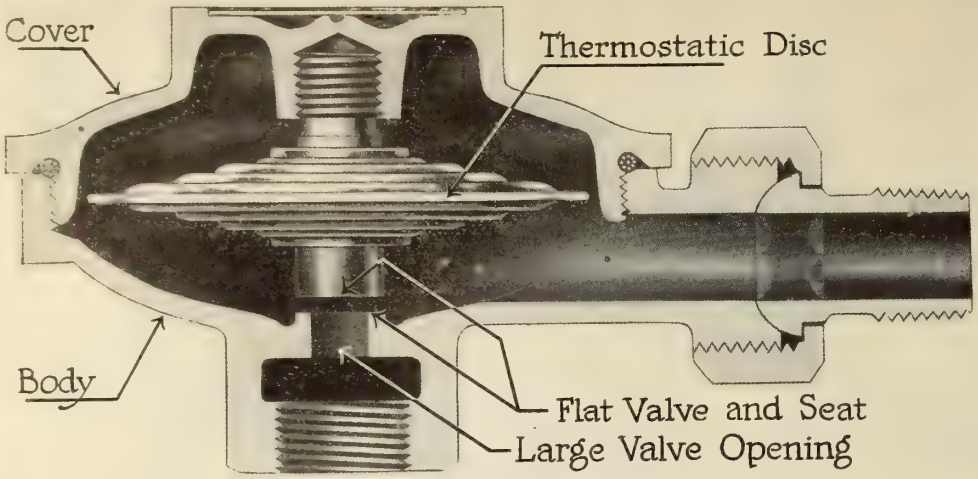
Once you put a JEFFERSON UNION on the line you can say Good-bye forever to union troubles, because a Jefferson gives perfect service as long as the line holds out.

JEFFERSON UNIONS are built by specialists and embody all qualities necessary for 100% efficiency in pipeline and power plant service.

The name "JEFFERSON" protects you from the "just as good" variety of unions which might involve a costly shutdown or loss of life at a critical moment. Try out a Jefferson on the hardest service in your plant and be convinced of their superior qualities.

Write to-day for our complete catalog, "UNIONS."

The Jefferson Union Co.
LEXINGTON, MASS.



Cross Section of No. 2 Dunham Trap

Made in Canada

SAVING B. T. U'S

Lets the air and water out; keeps the steam in. This is our claim —and the fact. With every coil hot, no air and water to stop circulation, and each radiator simmering around 100% efficiency, it is not surprising that Dunham Radiator Traps are helping make new records for fuel saving. Complete details should prove very interesting to you.

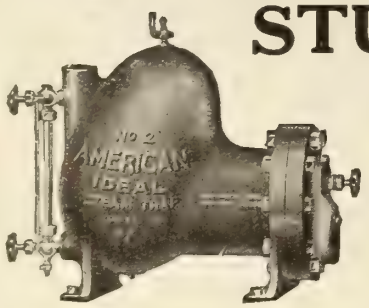
DUNHAM SPECIALTIES

Packless Radiator Valves
Drip Traps
Blast Traps
Air Line Valves
Vacuum Pump Governors
Reducing Pressure Valves
Oil Separators
Suction Strainers
Air Vents
Return Traps
Check Dampers
Damper Regulators

C. A. DUNHAM COMPANY, Limited, Toronto, Canada

Halifax Vancouver Winnipeg Ottawa Montreal Calgary
London: 233A, Regent Street, W. 1.

The DUNHAM HEATING SERVICE



STUDY TRAP CAPACITIES

Select your Traps on a Guaranteed Capacity Basis.

SAVE SPACE— SAVE MONEY

Send for our New Trap Booklet

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York Chicago BOSTON Atlanta Pittsburgh

BAILEY METERS

BAILEY FLUID METERS record and integrate the flow of low and high pressure steam; boiler feed, condensate, circulating water, brine and other liquids; also compressed air, natural gas, coke oven gas, and practically any fluid at any pressure, temperature and capacity. Pressure and temperature records may be made on the same chart with the Rate of Flow.

BAILEY BOILER METERS accomplish more real results toward obtaining maximum efficiency and capacity than all other meters or instruments combined. They record Rate of Steam Flow from the boiler and Rate of Air Flow through the furnace; and the relation between these two records shows whether an excess or a deficiency of air is being supplied for the support of combustion. They may also record Flue Gas Temperature, Wind Box Pressure, Stoker Speed, etc.

BAILEY WEIR METERS record and integrate flow of water or other liquids through V-Notch weir; used for feed water, hot well discharge, or other fluids and chemicals at or near atmospheric pressure.

Write for Literature.

2001 E. 46th Street

BAILEY METER COMPANY

Cleveland Ohio

What Would a 25% Increased Capacity Mean to You?

ELESCO Superheaters so decrease engine or turbine steam consumption as to provide a reserve boiler capacity and so make possible either the operation of your boilers at a lower rating, or the additional steam necessary to meet overloads.

In other words, ELESCO Superheaters make it possible to increase the power which a prime mover may develop over what it could produce with saturated steam.

This increased capacity may be obtained at one-fifth the cost of new boilers.

An increase in capacity as high as 25% is an opportunity worth investigating.

Send for Bulletin T-6, which tells where the ELESCO Superheater accomplishes these results.

The Superheater Company, Limited

Transportation Building, Montreal, Que. **Works at Sherbrooke, Que**

Designing Engineers and Manufacturers of Superheaters and Pipe Coils for all classes of service

MADE IN CANADA

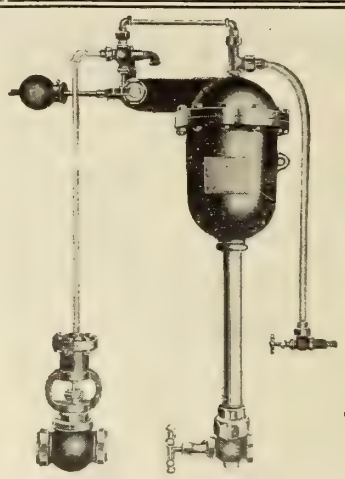
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



Insure Constant Level

The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gage, the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way.

They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers, and they feed continuously with perfect uniformity.

Write For Full Particulars

The Chaplin-Fulton Mfg. Co.

28-34 Penn Ave., Pittsburgh, Penn.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Insist Upon Having the TRADE CAOUTCHOUC TRADE MARK Packing Bearing Our MARK

TUCK & COMPANY, LIMITED

London Liverpool Cardiff, Etc.

Canadian Representative:

Wm. J. Brown, 117 Youville Square - - - Montreal, Que.

All Sizes Stocked in Montreal

POWER HOUSE Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month—Twenty-four per Year

$2.00 THAT'S THE PRICE TELL THE OTHER FELLOW

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E. S. MANNY Co

27 COTE St. MONTREAL, QUE

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freigh Elevators—Webster Vacuum Heating System.

Largest manufacturers of white metals in the world

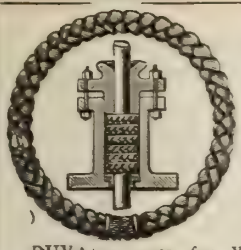
Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.

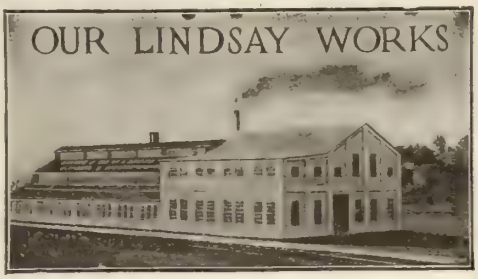
Stock carried in Montreal.

SOLE AGENTS FOR CANADA

LAURIE & LAMB

Board of Trade Building, Montreal

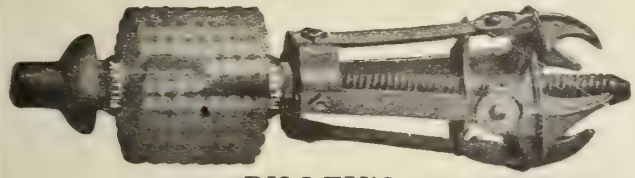
Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

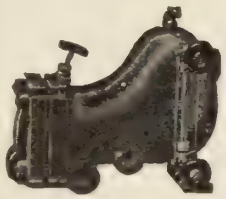
For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.



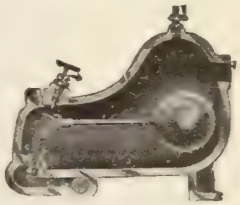
McDaniel Improved STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



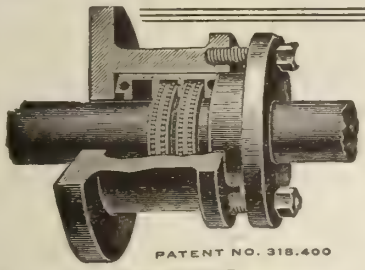
Send for Catalogue

THE GARTH COMPANY

26 Craig Street. MONTREAL, CAN

WATSON & McDANIEL, CO.

No. 146 N. 7th St., PHILADELPHIA Pa.



PATENT NO. 318,400

PAT. NO. 500,899
" " 534,104
" " 602,328
" " 654,541
" " 654,542
" " 725,388
" " 774,490
" " 775 193
" " 775,194
" " 791,300
" " 805,689

PAT. NO. 829,116
" " 856,530
" " 856,103
" " 878,238
" " 894,537
" " 895,791
" " 893,066
" " 905,102
" " 934,629
" " 979,208
" " 1000,76

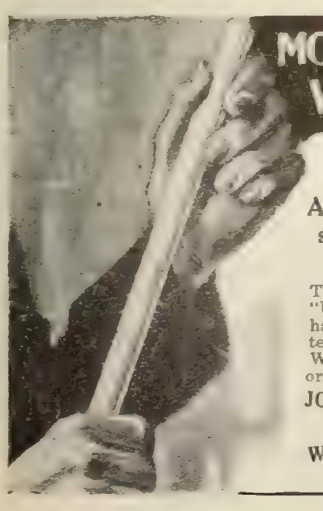
Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.

Incorporated 1897



MONCRIEFFS "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

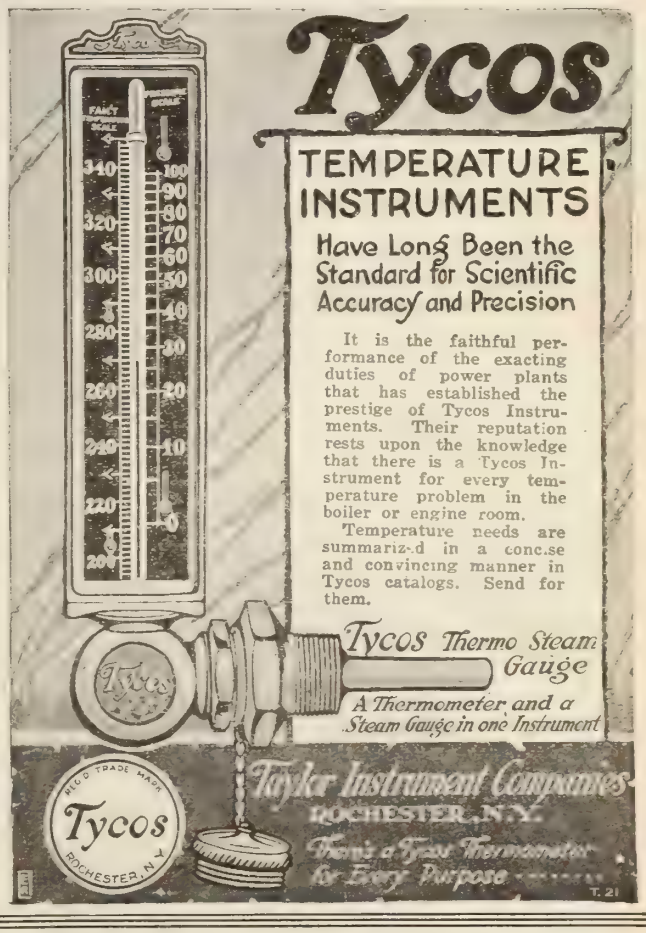
The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.

Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotland

Canadian Representative:

W. J. WALL, 134-136 Bleury St., Montreal


Tycos
TEMPERATURE INSTRUMENTS
Have Long Been the Standard for Scientific Accuracy and Precision
It is the faithful performance of the exacting duties of power plants that has established the prestige of Tycos Instruments. Their reputation rests upon the knowledge that there is a Tycos Instrument for every temperature problem in the boiler or engine room.
Temperature needs are summarized in a concise and convincing manner in Tycos catalogs. Send for them.
Tycos Thermo Steam Gauge
A Thermometer and a Steam Gauge in one Instrument
Taylor Instrument Companies
ROCHESTER, N.Y.
There's a Tycos Thermometer for Every Purpose
T. 21

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

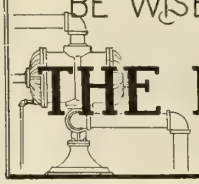
CRANE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices: Halifax, Quebec, Ottawa, Calgary.

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH



THE E.S.MANNY Co
27 COTE ST MONTREAL, CAN.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

New and Used
POWER PLANT
EQUIPMENT

Horizontal Boilers Up to 200 H. P.
Vertical Boilers from 1 to 75 H. P.

Steel Tanks
Any Capacity, Any Purpose

Automatic Engines
Up to 450 H.P.

Steam Engines
Slide Valve, High and Slow Speed Types

Vertical Engines

Partial List of Boilers and Engines in Stock

Firebox Boilers
12 h.p.

Horizontal Boilers
200 h.p., 125, 100, 80, 60, 50, 25, 18 and 15.

Marine Boilers
2 Internal Fired.

Vertical Boilers
75 h.p., 15, 16, 12, 10, 8, 6, 5 and 4.

H. W. PETRIE LIMITED
TORONTO

Automatic Engines
450 h.p., 90 and 60.

Horizontal Slide Valve Engines
40 h.p., 20, 15 and 5.

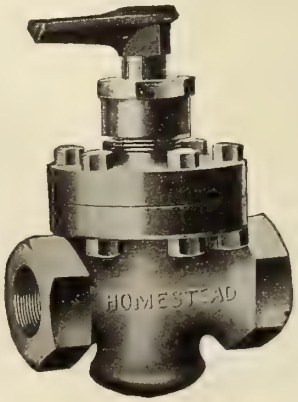
Marine Engines
1 Steeple Compound.

Vertical Engines
75 h.p., 20, 10 and 7.

H. W. PETRIE LTD., Toronto and Hamilton

Homestead Valves

Two Solutions to the Valve Problem



The Homestead Quarter-Turn Plug Valve for hydraulic service is made of Brass heavy enough for 1,500 lb. working pressure, is used exclusively on the hydraulic lines of the largest Manufacturing Plants of the country.

The Homestead Semi-Steel Straight-Way Screwed Valve is made of our special mixture of Semi-Steel and carefully machined. It produces more than expected results in all places where the ordinary valve fails to give satisfaction.

Literature giving detailed descriptions of these and other Homestead Valves will gladly be sent upon request.

Homestead Valve Mfg. Company
Homestead, Pa.

Showing ease with which Plibrico is laid in place.

PLIBRICO IS PLASTIC

and particularly adapted for Jointless, one-piece front-door arches, bridge walls, side walls, combustion chamber walls and baffles.

BETTER THAN FIRE BRICK

Can you see the advantage and economy?

Write for book on furnace building.

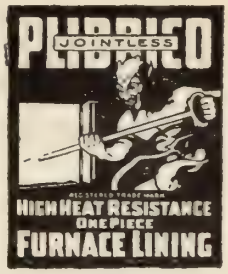
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

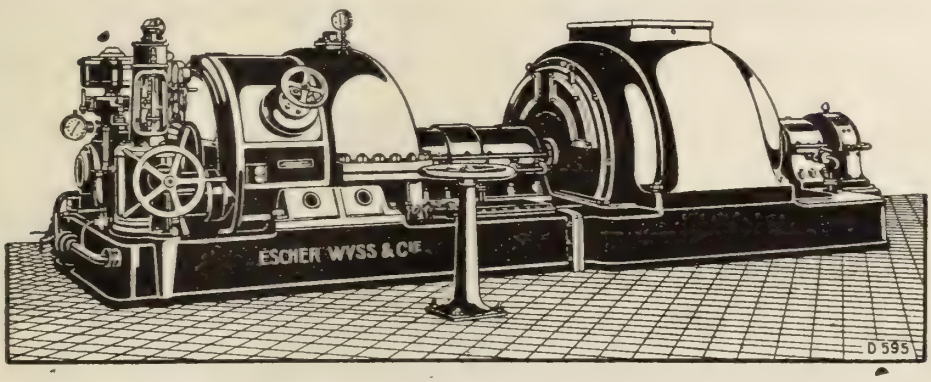


Trade Mark
Reg. U.S. Pat. Office.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

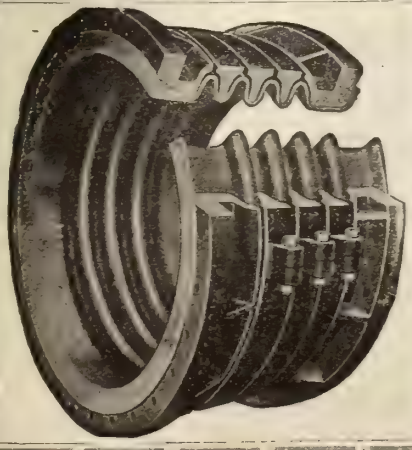
Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9/20



BADGER
SELF-EQUALIZING EXPANSION JOINTS

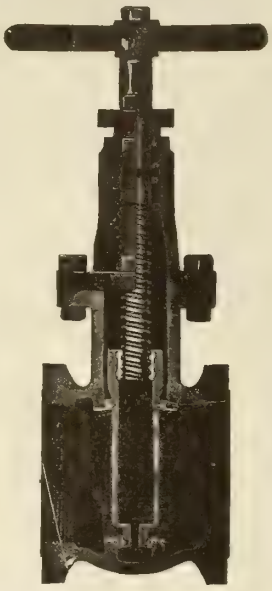
Prevent leaks in all pipe lines

E.B. Badger & Sons Co.

101 PARK AVE. NEW YORK — 75 PITTS ST. BOSTON — 616 S. MICHIGAN AVE CHICAGO

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Nonpareil Shaking and Dumping Grates
SAVE COAL

Supplied in all Sizes

Another Large Toronto Power Plant Adopts Nonpareil Grates

When more efficient Grates were needed for the power plant of Toronto's Isolation Hospital, Nonpareil Grates were chosen.

There's no better way to combat high fuel prices than by installing Nonpareil Shaking and Dumping Grates. Knowing how much better combustion these grates give, we absolutely guarantee that their installation will save you at least 10% of your present coal bill!

Write for full details of Nonpareil Grates and our 30 day free trial offer.

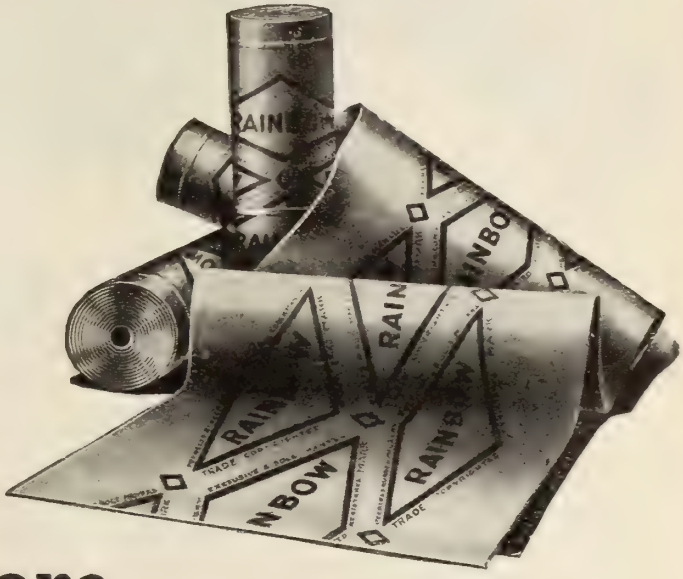
The W. R. Sexton Boiler Setting Company

127 D'Arcy St. and 114 Grenadier Rd., Toronto

Established 1900 Phone: Jct. 2259 W., Coll. 682

FIREBRICK WORK and REPAIRS

Building in boilers and general firebrick work our specialty. Repairs made to all kinds of grates and boilers. Give us a trial on your next job.



Steam Engineers Know Rainbow's Worth

Practical men best appreciate the sterling value of Rainbow Sheet Packing because they know the better service it gives. They know the saving that is effected when joints are tight and stay tight. They appreciate the absence of frequent shutdowns to re-gasket steam lines.

Rainbow Sheet Packing

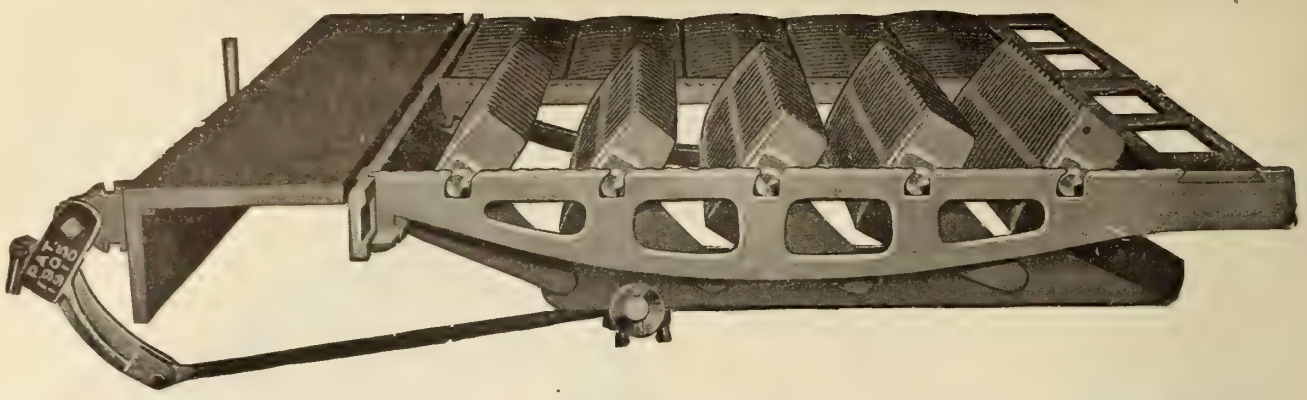
is the original red sheet. Look for the "Rainbow" trade mark—it means economy through service.

Write for a catalogue. Our technical experts are always at your service to help overcome your packing problems.

Genuine Rainbow Sheet Packing is made in Canada.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Dominion Rubber System
Rainbow Rubber Products Department
201 Inspector Street, Montreal



Coal is becoming more and more difficult to secure and its price is constantly mounting. The shortage is seriously affecting many firms, some of whom are obliged to use screenings and other low-grade fuel. These conditions will give you little cause for worry if you are a user of Cyclone Grates!

CYCLONE GRATES

Burn Screenings and Low-Grade Soft Coal

The scientific design of Cyclone Grates ensures perfect combustion even when low-grade fuels are used. Their 60% air space and 90% under-draught means **no clinkers—no waste!**

The jarring, shaking movement sifts all the ashes through—the good fuel remains. Write for particulars of our 30 days' free trial offer.

NOTE:—Ask for particulars about our new pin-hole grate bars for burning hard coal screenings

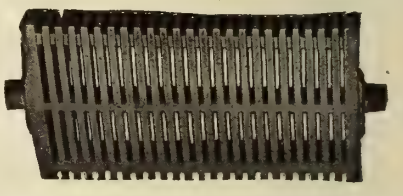
The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street **Phone G. 3660** **Toronto, Ontario**

AGENTS:

ST. JOHN, N.B.: F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator Co., Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. WINNIPEG: Vulcan Iron Works. OTTAWA: Campbell Steel & Iron Works, 855 Carling Ave.



In Many Paper Mills Thru-out the Country

THE "COLE" SYSTEM

is saving thousands of dollars in fuel!

It will cost you nothing to have one of our expert engineers visit your plant.

If we cannot improve your conditions, we will not waste your time.

GEO. W. COLE, LIMITED

2002-4 DUNDAS STREET WEST

TORONTO, CANADA

REPRESENTED IN

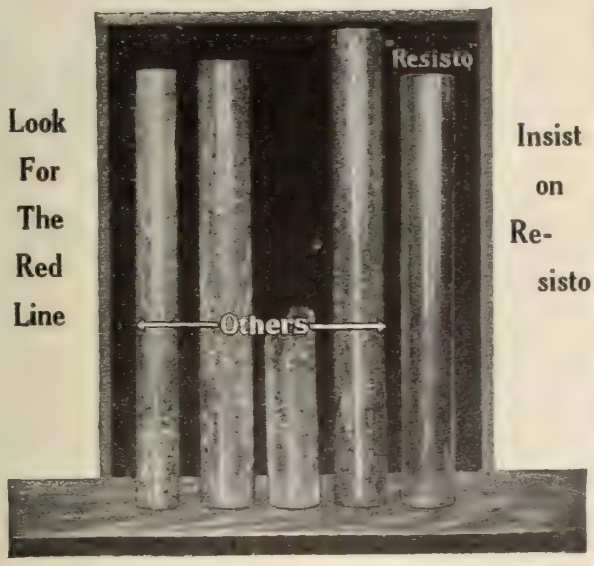
Montreal, Que.; Winnipeg, Man.; Vancouver, B.C.; New Glasgow, N.S.

You can again obtain Genuine "Resisto" Gauge Glasses with the Red Line—

You'll be glad to know this. No more dangerous experimenting with inferior glasses. You can depend upon the "Resisto"---its reputation is your assurance of perfect service.

Get your order in at once.

Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.



THE
SCHAEFFER & BUDENBERG MFG. CO.

338 Berry St.
BROOKLYN, N.Y.

Toronto—A. G. Milton, 32 Front St. West

The De Laval Oil Purifier Insures Gears and Bearings

The De Laval Oil Purifier insures the power plant against losses and delays due to excessive friction, clogged oiling systems and all other troubles that result from the use of lubricating oil that has become foul.

It also insures plants against the trouble that is frequently caused by core sand, red lead, pipe scale and pipe burrs being present in the lubricating system.

All such impurities are instantaneously removed by centrifugal force in the bowl of the De Laval Purifier. It is the modern method of purification, and is rapidly replacing older and less efficient methods in well-equipped power plants.

The old method of allowing impurities to settle out of used oil by gravity effects only a partial purification, and is slow and wasteful of oil besides. Filters remove only the larger particles of foreign matter from the dirty oil, quickly clog up and become inoperative, and cause constant expense for new filtering material.

Compared with either of these methods, The De Laval Oil Purifier saves time, space and oil, and lengthens the life of machinery by providing oil free from all impurities.

It is a simple matter to install a De Laval Purifier in either an old plant or in one now building. It occupies less than two square feet of floor space, can be placed almost anywhere and is entirely independent of the other units in the plants.

You are invited to call on De Laval engineers for additional information and advice regarding your particular problem.

Write to nearest De Laval office for Oil Purification Bulletin No. 100; also Crank Case Oil Bulletin No. 102.

The De Laval Separator Company

New York Chicago

Turbine Equipment Co.
Toronto, Ont.

The De Laval Co., Ltd.
Peterboro, Ontario

Grey Iron Castings

We are ready to give prompt service for grey iron castings, any size up to 15 tons. Anything we do is well done—35 years of experience and every modern facility to help us.

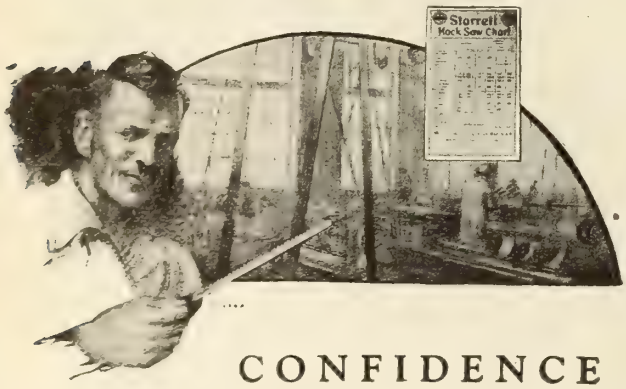
Boiler Sizes Ready

Subject to prior sale of materials, we offer prompt shipment of the following (and smaller) sizes—72″ x 18′, 72″ x 16′, 66″ x 16′, 66″ x 14′.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices:
Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal



CONFIDENCE

—in yourself and in the tools you're using means efficient work.

Mechanics who use Starrett Hack Saws according to the Starrett Hack Saw Chart, are sure of their results. Starrett Saws are sold upon the *confidence* mechanics have in them.

A saw for each kind of material to be cut—each blade made of the finest grade of hack saw steel. And behind them the Starrett Service, helping hack saw users to get every bit of value out of Starrett Blades that we put into them. That's why they "cut quicker and last longer."

Begin to-day to lower your cost per cut. Write for "Hack Saws and Their Use," the first practical book on hack saws ever published.

The book that helps you lower your cost per cut"

THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS 42-8

Use Starrett Hack Saws

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent. of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office
Fireman's CO_2 Guide on Boiler Front
Continuous records (not intermittent)

No Chemical Solutions

Send for Booklet
"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.
Combustion Engineers
2008 EMPIRE BLDG., NEW YORK

ROBB

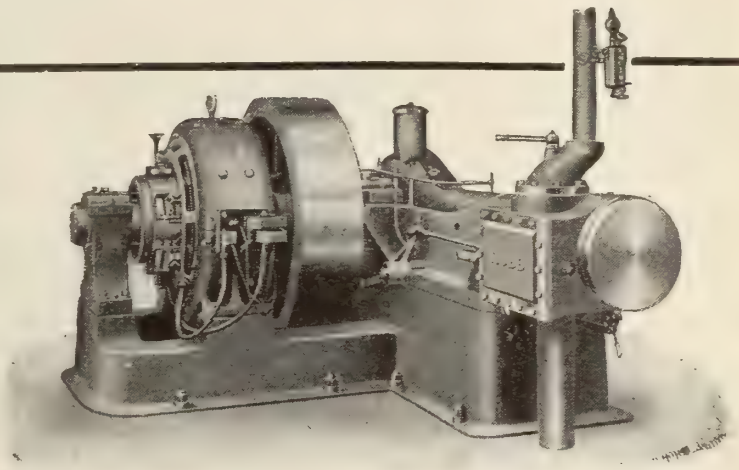
For Quality Equipment

POWER PLANTS

We specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water tube, Return tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market—remember it will pay you to purchase equipment that has won the confidence of leading engineers.



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office:
16 Cathcart Street

Toronto Office:
20 Victoria Street

FOR REFRIGERATING EQUIPMENT

USE

P⌀H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KINDS AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office:

100 Church Street, TORONTO, Ont.

The ANDERSON PRESSURE OIL FILTER

Makes Drip-pan Collected Oil as Clean and Pure as New

Though exceedingly high in price, over half the oil used is wasted—lost on wipers.

By placing drip-pans beneath the machinery and passing the oil thus collected through an Anderson Pressure Oil Filter, this waste can be practically eliminated.

The Anderson Filter cleanses and purifies the oil by a treatment identical to that of the refiners. It comes from the filter in a pure, clean state, fit for the finest bearings.

Write for fuller particulars.

The V. D. Anderson Co.

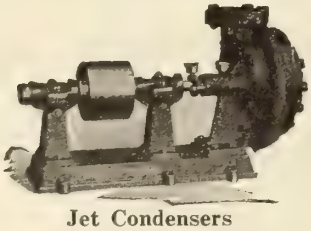
1935 West 96th St., Cleveland, Ohio

AMERICAN-MARSH PUMPS

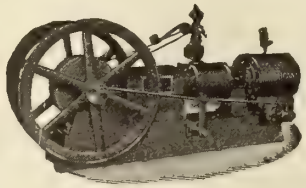
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

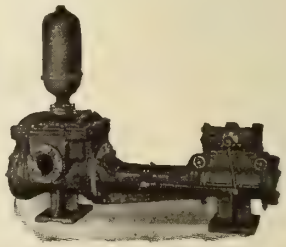


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps



Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

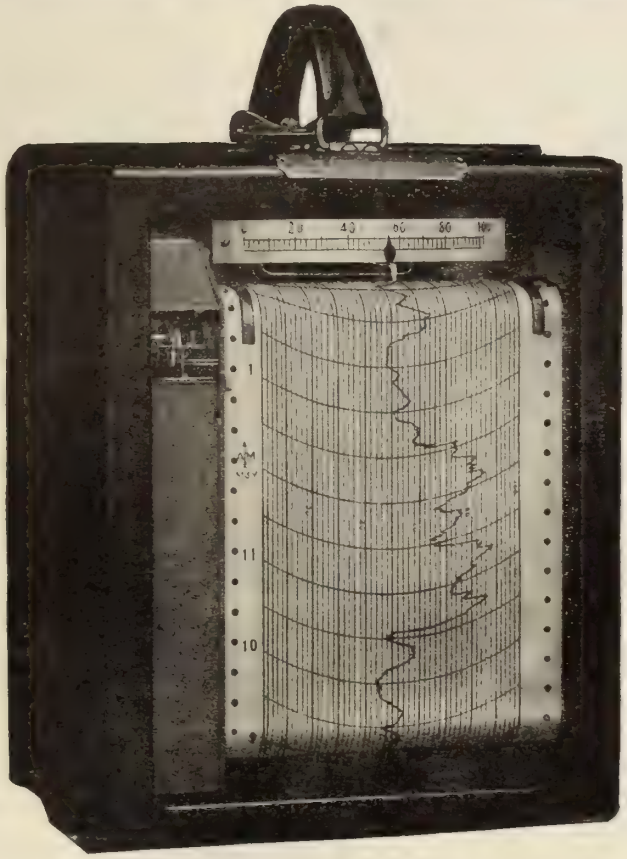
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanics' Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

ESTERLINE

TRUE RECORDING INSTRUMENTS

Portable and Switchboard Types



Graphic Wattmeters **Graphic Voltmeters** **Graphic Power-Factor Meters**

¶ Ideal for generating stations, sub-stations, industrial and isolated plants where the value of a true load curve cannot be overestimated.

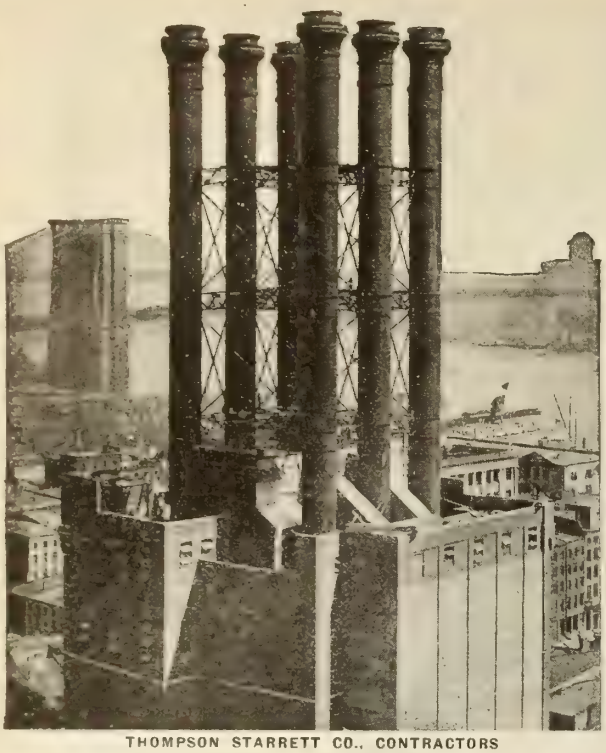
¶ The Illustration shows one of the Portable Graphic Meters, which is placed in an aluminum case with a glass face. The clock has an eight-day lever movement controlling the chart which is six inches in width and twenty-six feet long. A special inking device has been arranged for the marking of these charts. The holder will contain a supply for eight days and the ink is drawn through a tube to the pen by capillary action.

"Have you seen the new Esterline Portable Current Transformer?"

Northern Electric Company

LIMITED

MONTREAL QUEBEC TORONTO WINNIPEG CALGARY VANCOUVER HALIFAX
OTTAWA HAMILTON LONDON WINDSOR REGINA EDMONTON



THOMPSON STARRETT CO., CONTRACTORS

And in the new power plant of the New York Steam Co.

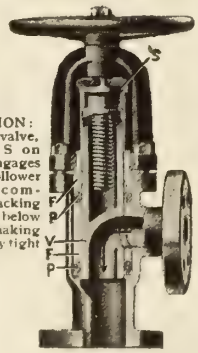
SEVENTY-ONE Yarway Seatless Blow-Off Valves are in Service in the new building of the New York Steam Company—a model of up-to-date power plant efficiency. Not all of these are original equipment; re-orders helped to make up the present total.

YARWAY

Seatless Blow-Off Valves

NOTHING but proven value could bring orders and reorders from such concerns as these:

Atlantic Refining Company
American Woolen Company
American Smelting and Refining Company
Big Four R. R.
Delaware & Hudson R. R.
Gulf Refining Company
Libby, McNeill and Libby
Pennsylvania R. R.
Philadelphia Electric Co.
Standard Oil Company
Virginia Shipbuilding Co.
Westinghouse Air Brake Co.

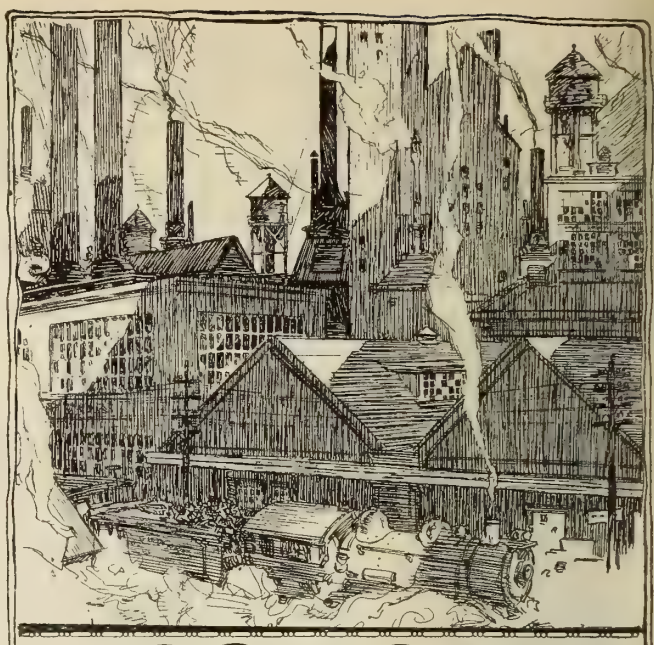


OPERATION: In closing valve, shoulder S on plunger V engages the loose follower gland F, compressing packing P above and below the port, making an absolutely tight valve.

Ask for Bulletin No. B-410

YARNALL-WARING CO.
7604-20 Queen Street
Chestnut Hill Philadelphia
Agents in All Principal Cities

"No Seat to Leak"



ECONOMY *renewable* FUSES

Knife-blade type Economy Fuse

Industries persisting in the use of "one-time" fuses pay more for electrical protection than those equipped with Economy Fuses.

The famous Economy "Drop Out" Renewal Link makes possible an annual saving of 80% in fuse maintenance costs.

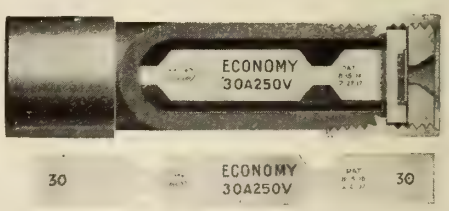
Nothing is destroyed when an Economy Fuse blows but the inexpensive strip of fusible metal.

This is quickly and easily replaced with a new "Drop Out" Renewal Link without delay to men or machinery. The heavy cartridge, end caps and the winged washers which lock the fuse are virtually indestructible and are used again and again.

Check up fuse costs in your plant. And remember that Economy Fuses give maximum protection at minimum cost.

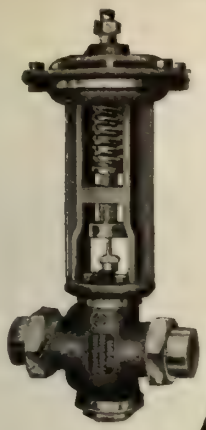
For sale by all leading electrical jobbers and dealers.

Economy Fuse & Mfg. Co. of Canada, Ltd.
UNITY BLDG., MONTREAL, CANADA



Ferrule type Fuses with Economy "Drop Out" Renewal Link

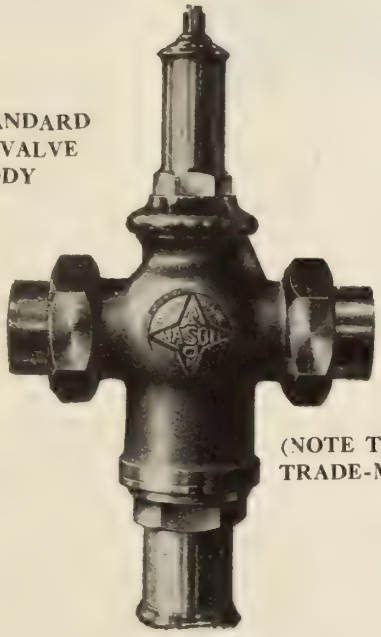
Economy Fuses were the first line using inexpensive bare links for restoring blown fuses to their original efficiency to be APPROVED IN ALL CAPACITIES by the Underwriter's Laboratories.



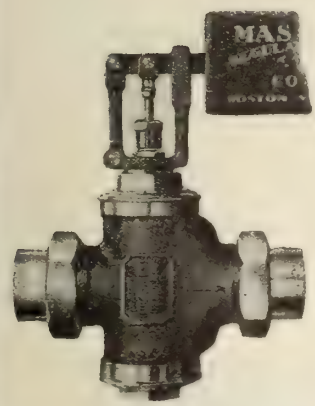
MASON No. 55 PUMP
PRESSURE REGULATOR

MASON STANDARD
REDUCING VALVE
IRON BODY

MASON STANDARD
REDUCING VALVE
BRONZE BODY



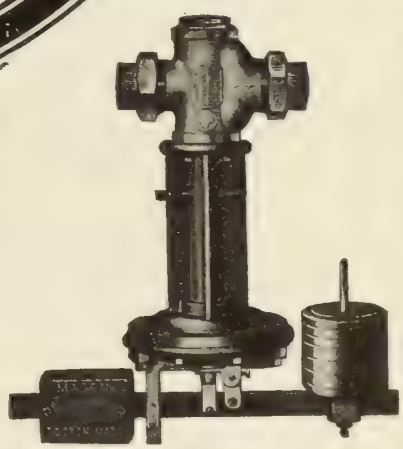
(NOTE THE
TRADE-MARK)



MASON BALANCED
VALVE WEIGHT AND
LEVER STYLE

SERVICE
RELIABILITY
POSITIVE ACTION

GET THE GENUINE
OUR TRADE-MARK IS YOUR GUARANTEE

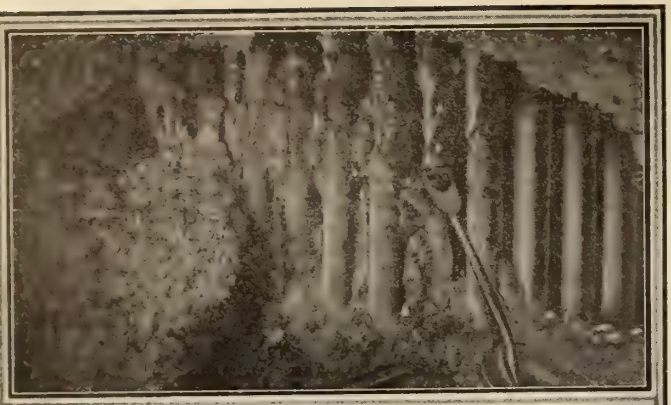


MASON LEVER STYLE
REDUCING VALVE

THE MASON REGULATOR CO.,
BOSTON, MASS.

MADE IN CANADA BY

THE MASON REGULATOR & ENGINEERING COMPANY, LIMITED
MONTREAL TORONTO



Can YOU Afford It?

Soot and ash deposits on the fire surface of boilers cause a loss of millions of dollars annually.

Your proportionate share in this loss depends upon the number of boilers you operate, the cost of coal, and the degree of cleanliness obtaining.

Suppose you have four 500 H.P. boilers. Normally these will require 4 tons of coal per hour, or 20,000 tons of coal per year on a 5,000 hr. basis. At present prices, this coal probably will cost you $100,000 per year.

If you customarily allow your boilers to get in the condition shown in the picture before cleaning them, your loss is anywhere from $10,000 to $20,000 or more per year.

If you clean your boilers regularly and conscientiously with the hand lance, your loss is from $4,000 to $8,000 per year, depending upon the skill of the fireman.

If you clean your boilers with Diamond Soot Blowers you incur no loss, but get value received in steam (within the limitations of your furnaces and boilers) for every dollar spent for coal.

Best of all, Diamond Soot Blowers cost but a fraction of the annual saving.

Ask for Bulletin 280.

DIAMOND SPECIALTY COMPANY
Windsor, Ont.

Diamond

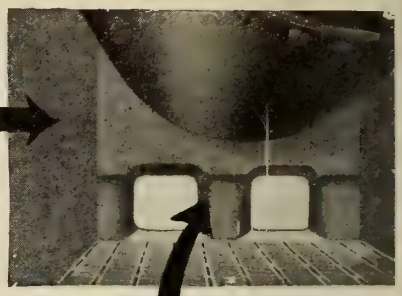
SOOT BLOWERS - SAVE 4 to 8% FUEL

BETSON'S

REG. U.S. TRADE MARK PAT. OFF.

PLASTIC FIRE BRICK

Not a Brick or Joint in this Furnace Lining



For Water Tubes and Fire Tube Boilers of any type or make.

Door Arches Properly Formed and Flared Inward for the Easy Placing of Coal on Any Part of the Grate

THERE is no mystery about Betson's. It is the pioneer and proven Plastic Fire Brick that has made practical the one-piece furnace lining without joints, and is not affected by expansion and contraction. It is gastight and has a record of 20 years' satisfactory service under all sorts of trying conditions.

It comes in yellow-top barrels ready for use. Anyone can do the job. Experts not necessary. A mallet and trowel are the only tools required.

Write for booklet that tells of its uses in the boiler room.

Canadian Distributors:

International Chemical Co.
44-46 Lombard Street
TORONTO, ONT., CANADA 9-42

Sterling

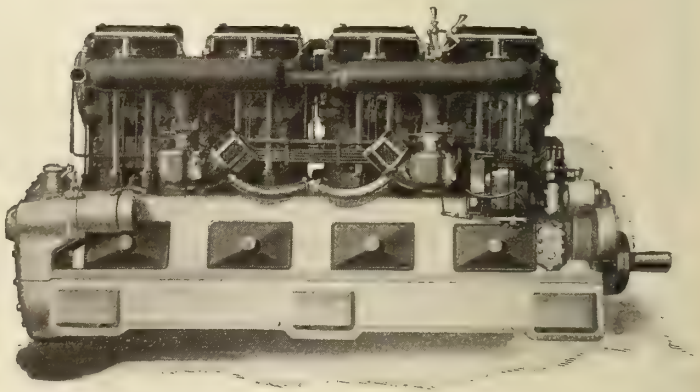
THE ENGINE of REFINEMENT
For the finest boats that float

ELECTRICAL WORLD says:

A great increase in coal costs of utility companies will result from the freight increase.

Answer:

Install a Sterling high duty gasoline engine for emergency and cut down your boiler capacity,—and your fuel consumption.



Catalog on request.

STERLING ENGINE CO. Buffalo, N.Y.
Dept. C-4

12-300 H.P. for Centrifugal Pump and Electric Generator drives, for emergency service and fire protection.

Weir Products

Single Acting Simplex Feed Pumps
Compound Feed Pumps
General Service Pumps
Multiflow Heaters
Direct Contact Heaters
Evaporators
Distillers

The confidence-inspiring service which Weir Pumps are rendering their 65,000 users all over the world is ample proof of their merit. To watch their slow, steady, powerful strokes, is to become convinced that they are accurately designed and made to give long, satisfactory, efficient service.

In addition to our standard pumps, we have a large variety of designs for special duties. For high duty installations, for water or oil, we can supply special patterns, simple, compound or triple, for pumping against pressures up to 1,000 pounds per square inch.

Weir Service

To offer to our customers the entire resources of our organization—research, designing, manufacturing and operating—this is the Weir idea of service. The experience, the data and the results of our thirty years' concentration upon specific lines, we place at their disposal.

To serve our clients efficiently, satisfactorily and to the full extent of our ability —such is our aim.

The company of G. & J. Weir (Canada), Limited, has been incorporated to take over the business of the Clyde Engineering Company, Limited, and will manufacture their complete line of power plant auxiliaries and marine auxiliary machinery.

G. & J. Weir (Canada) Limited

Sales Engineers

Peacock Brothers, Limited, Montreal

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, LINK
Waterous Engine Works Co., Brantford

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane, Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
International Chemical Co., Toronto, Ont.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal Que.
Mason Regulator & Eng. Co., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

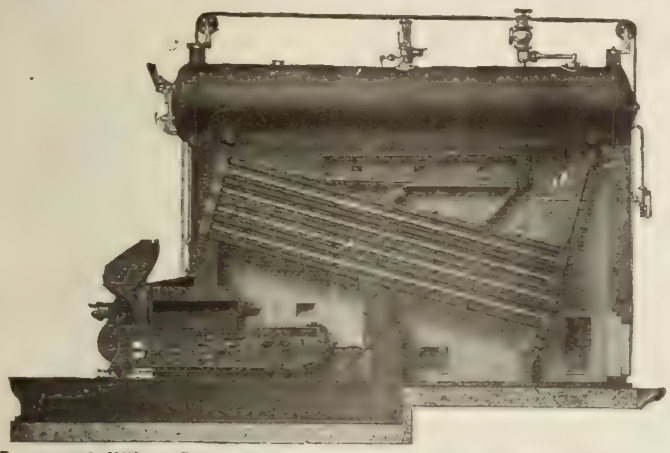
CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y

CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

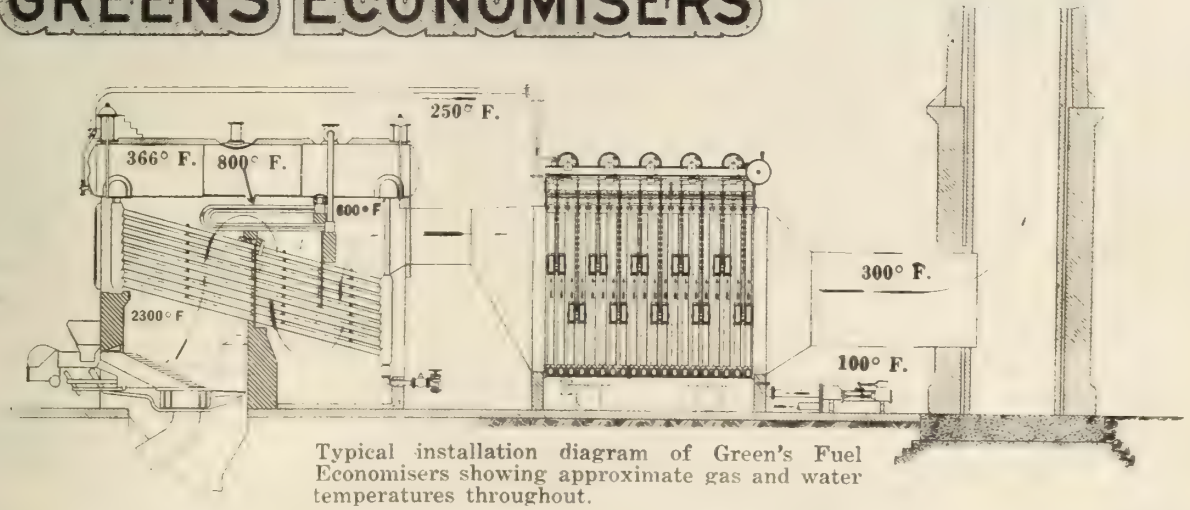
ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

GREEN'S ECONOMISERS



Typical installation diagram of Green's Fuel Economisers showing approximate gas and water temperatures throughout.

At the recent Chemical Exposition in New York, during the fuel economy conference, one of the speakers, a noted engineer, stated that by far the greatest heat loss in the boiler room was in the sensible heat of the exit gases.
The use of extra boiler surface to cool gases below 500° F. does not pay because below 500° F. the heat absorbed per square foot of heating surface does not equal the cost of maintenance. The use of Green's Economiser is the most economical method for recovering this loss—it will reduce the gas temperature to a low figure at minimum cost by transferring the heat of the gases to the feed water, under boiler pressure, thus allowing the boiler to be supplied with water at a temperature slightly lower than the steam itself.

Write for our bulletin No. 151, or call for one of our engineers to inspect and make recommendations for your conditions.

GREEN'S ECONOMISER, LIMITED
TORONTO

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS

Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES

Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL

Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS

Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lynah Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS

Can. Mead-Morrison Co., Ltd., Montreal.

COILS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR

American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS

Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS

Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY

Bacher, Wyss Co., Montreal.

CONDENSERS

American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS

Laurie & Lamb, Montreal.
E. J. Phillip & Sons, Toronto.

CONDUITS

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER

The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)

C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED

Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS

J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES

Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL

Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS

Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS

Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION

Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE

Garlock Packing Co., Hamilton. Ont.

COUNTERS

American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION

Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE

Jefferson Union Co., Lexington. Mass.

COUPLINGS, SHAFT

Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS

Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC

Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY

Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE

Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING

Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto., Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE

Can. Link-Belt Co., Toronto., Ont.

CRANES, SWING JIB

Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL

Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT

J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY

Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP

Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN

Gutta Percha & Rubber Co., Limited.

DIESEL OIL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE

Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER

Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL

Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN

Can. Link-Belt Co., Toronto., Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC

Holden Co., Limited, The, Montreal.

DRILL RODS

Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS

J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS

Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS

Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal. Que.

EFFICIENCY ENGINEERING

MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS

Babcock & Wilcox, Ltd., Montreal.

EJECTORS

Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY

Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS

Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRIC GRINDERS

Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES

Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS

Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS

Holden Co., Ltd., The, Montreal.

ELEVATORS

Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS

Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY

Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE

J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES

Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd. Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE

Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE

Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL

Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL

Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE

Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London. Ont.

ENGINES, GASOLINE, STATIONARY

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES

Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM

Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY

Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE

Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION

Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS

Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS

American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS

Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING

Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS

Mason Regulator & Eng. Co., Ltd., The Montreal.
Babock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS

Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS

Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS

Ministry of Munitions, London, England.

FILTERS

S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER

Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT

Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS

S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS

Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK

Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC

Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR

Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT

Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

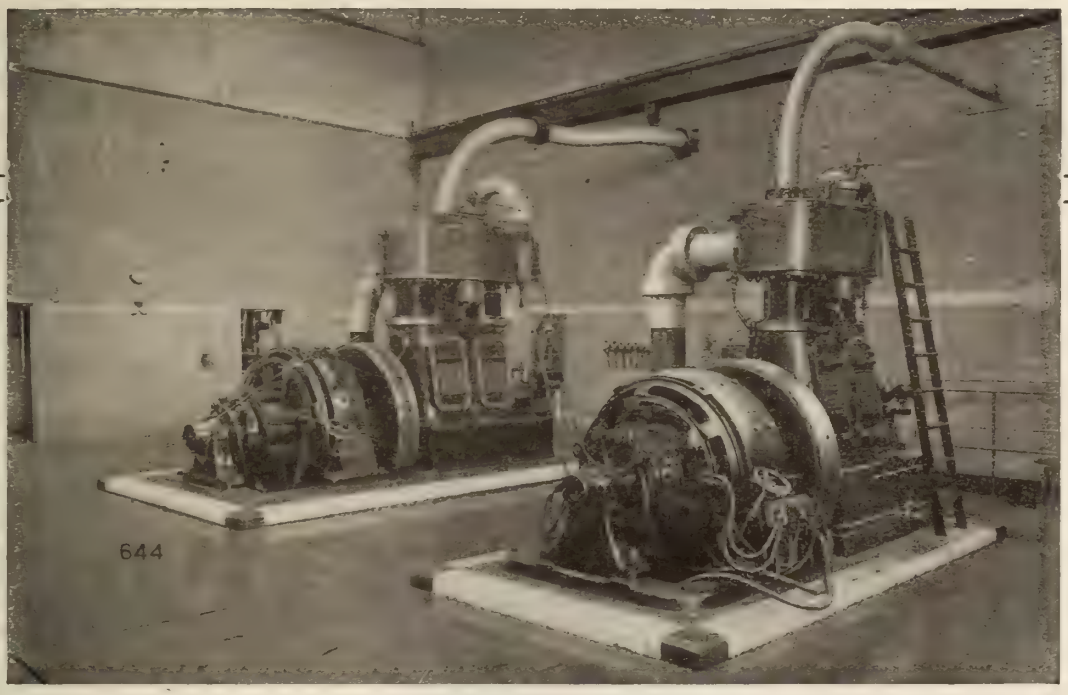
FIREPROOF COLD STORAGE DOORS AND WINDOWS

Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK

Norwalk Iron Works Co., South Norwalk Con.

Belliss & Morcom
LIMITED
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

Are you using your exhaust Steam ? Belliss engines are in use working against back pressures up to 190 lb. per square inch. In this way exhaust steam can be furnished to suit all heating requirements.

Write for Exhaust Steam Pamphlet.

Send us your enquiries for the following

Steam Engines
Gas Engines
Oil Engines
Diesel Engines
Steam Turbines

Air Compressors
Condensing Plants
Centrifugal Pumps
Boiler Feed Pumps

Pressure Filters
Gravity Filters
Water Softening Plants
Refuse Destructors

All enquiries carefully and promptly answered

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. **Montreal, Quebec**

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMEL-WARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd. Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co. Waynesboro Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd. B. F. Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co. Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

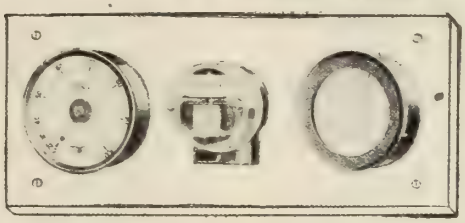
Republic TWINS

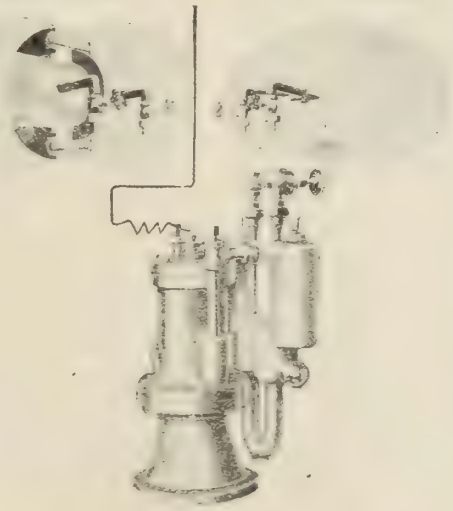
Trading Flow Meters for Boilers

BY installing Republic Flow Meters on a battery of six boilers, a well-known traction company avoided ordering two additional boilers to take care of its peak load. Not only was the cost of the boilers avoided, but also the continual expense of keeping additional boilers banked under light load during the off-peak part of the day. This Company traded Flow Meters for boilers at a tremendous profit.

When you consider that a saving like this is merely incidental to the many economies brought about by tracing erroneous conditions during the regular operation of the boiler room, you begin to realize how really indispensable an installation of Republic Flow Meters IS.

In every-day operation the Republic is a constant guide to furnace efficiency—a continual indication of the performance of individual boilers—an indisputable record of power costs by Departments.





Trading CO_2 Recorders for COAL

COMBUSTION means a combination of carbon with the correct amount of air. If too much air is admitted then coal is wasted. The only method of checking continuously and correctly is by the use of a CO_2 RECORDER. If a CO_2 Recorder is installed, the amount of air cut down, then the amount of coal is lessened; in fact, you have traded CO_2 Recorder for coal.

With coal at the prevailing prices, a CO_2 Recorder is a very good investment under such conditions.

Also by the use of a CO_2 Recorder **Black Smoke is avoided.**

Republic CO_2 Recorders have no valves, no glass (tubing or otherwise), only two moving elements, no complication of mixtures, absolute absorption insured by long travel of gases through absorbent.

Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

145 Wellington Street West
TORONTO

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Mon
MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
MACHINE TOOLS
Ministry of Munitions, London, England.
MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.
MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.
MECHANICAL STOKERS
abcock & Wilcox, Ltd., Montreal.
mes Underfeed Stoker Co., Toronto.
urphy Iron Works, Detroit, Mich.
nford Riley Stoker Co., Worcester, Mass.
METERS, AIR
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.
METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS, GAS
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.
METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Republic Flow Meters Co. of Canada, Toronto, Ont.
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
Republic Flow Meters Co. of Canada, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
MIXING VALVES
Crane's Limited, Montreal.
MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont
MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.
MOTOR VEHICLES
Ministry of Munitions, London, England.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
OILS, QUENCHING
mperial Oil, Ltd., Toronto.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.
OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.
OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.
PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.
PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.
PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.
PIPE, ACID RESISTING
Hoyt Metal Co.
PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.
PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.

NORWALK AIR & GAS COMPRESSORS

Specialization

The Norwalk Iron Works Company was first to use the compound principle of compressor construction in this country, and first, also, to give successful application to the multi-stage compression of air and gases.

Under the circumstances it was to be expected that the Norwalk Company would develop these fundamental principles of compression with exceptional success. The pioneer, by force of circumstances, becomes a specialist—and the specialist, in any field, is the party you wish to deal with.

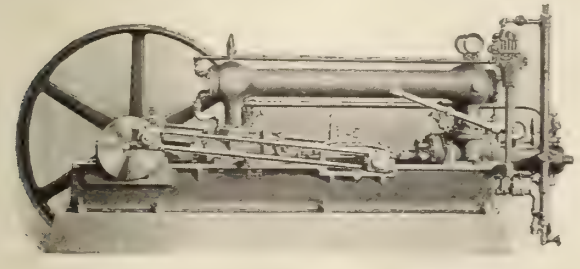
When contemplating the purchase of a Compressor for any branch of service—write us.

THE NORWALK IRON WORKS COMPANY

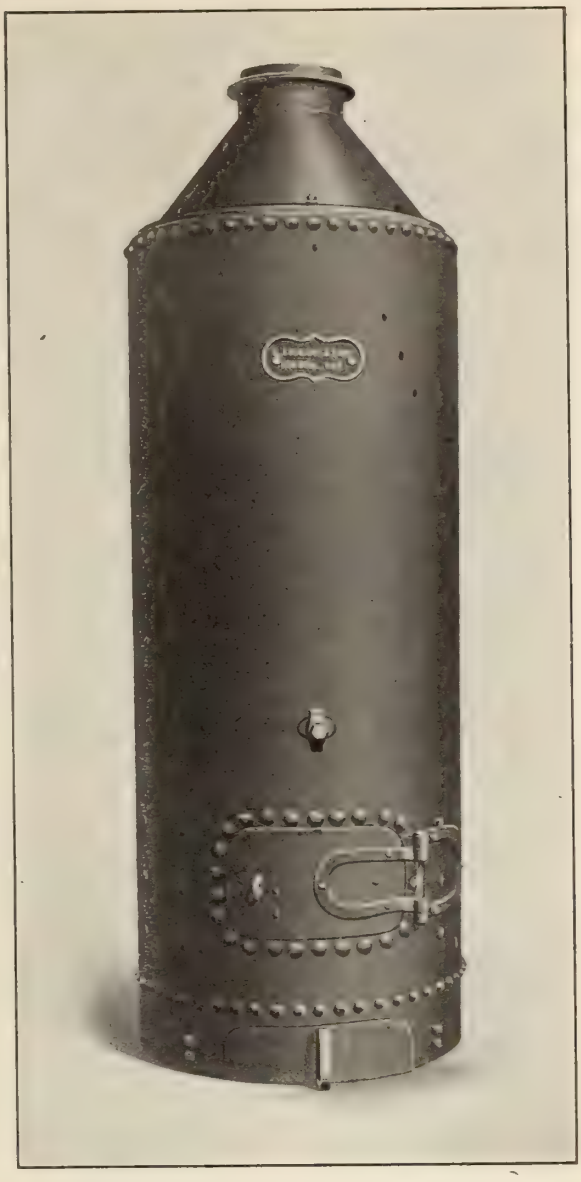
Pioneer Builders of Compressors

SOUTH NORWALK, - - CONN.

Canadian Sales Representative:
A. S. Leitch Company Toronto, Canada



A Norwalk Three-Stage, Belt-Driven Compressor for Oxygen. Also made for Hydrogen and Carbonic Acid Gas.



UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers:

Connelly Water Tube (*Patented U.S. and Canada*)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

Head Office and Works: LONDON, CANADA

86th Year

Branches and Agents from Coast to Coast

LEONARD

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SOOT CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co. Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can. Ltd. Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co. Inc. New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOL
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

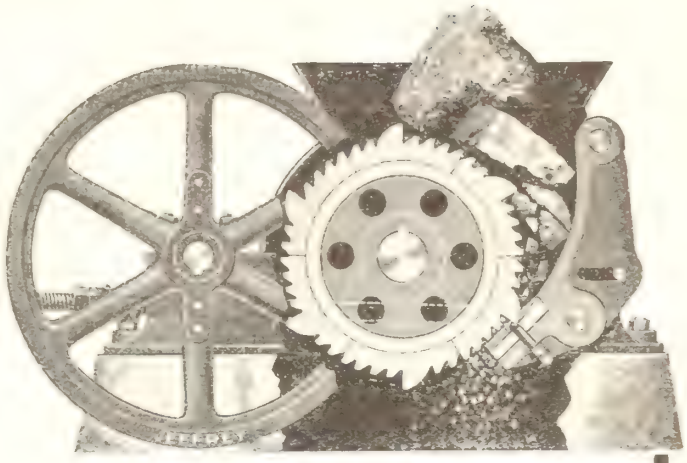
UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd Sarnia.
Valve Engineering Company.

Patented

The Jeffrey Single Roll Crusher



Helps Solve Car Shortage

There is only one way to beat the scarcity on fine coal deliveries that is sure to come with the extraordinary car shortage that is now affecting the country, and that is to ***Crush Your Own Coal.***

Make yourself independent of mine and traffic conditions by installing a

Jeffrey Single Roll Crusher

right in your own plant.

Reduces run-of-mine or lump coal to stoker size in a single operation.

Rugged in design and construction, with cut steel gears, renewable segments, wearing shoes and bushings, accessible for adjustment, having a safety device, incapable of being choked—it consumes but little power, costs little, compact.

The Jeffrey Mfg. Co., *Canadian Branch and Warerooms,* **Montreal**

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)

C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR

H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbit Steam Specialty Co., New Haven.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg Co., Toronto
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh Pa

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal

WELDING SUPPLIES

Holden Co., Limited, The, Montreal
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co. Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS

Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE

Williams Machinery Co., A. R., Toronto

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

TRIMO

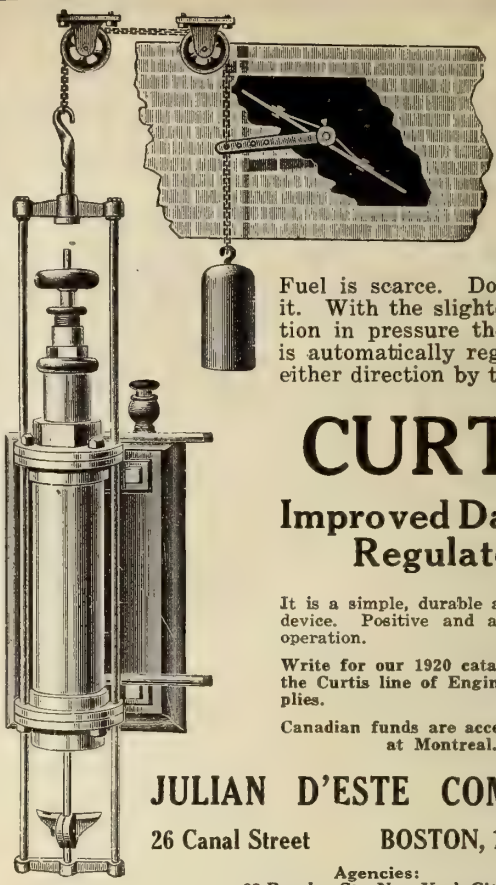
THE WORD TRIMO

Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut — and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston,) Mass., U.S.A.



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1920 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
26 Canal Street BOSTON, 14, MASS.

Agencies:
83 Barclay St., New York City
174 North Market Street, Chicago, Ill.

INDEX TO ADVERTISERS

A
American Steam Gauge and Valve Mfg. Co. 52
American Steam Pump 64
Anderson Co., V. D. 64
Armstrong Cork & Insulation Co. 11
Audel & Co., Theo. 35

B
Babcock & Wilcox 71
Badger & Sons, E. B. 57
Bailey Meter Co. 52
Betson Plastic Fire Brick Co. 68
Brown, Wm. J. 54
Boving Hydraulic Eng. Co... 55
Bowser Co., Ltd., S. F. 4
Busch-Sulzer Bros. — Diesel Engine Co. 56

C
Can. Consolidated Rubber Co. 59
Can. Fairbanks-Morse Co.... 33
Can. Johns-Manville Co. 7
Can. Mead-Morrison, Ltd..... 50
Can. Steam Boiler Equipment 60
Cole, Ltd., Geo. W. 60
Chaplin-Fulton Mfg. Co. 54
Coppus Engr. & Equip. Co... 43
Crane, Ltd. 56

D
Darling Bros. 59
Dart Union Co. 50
D'Este Co., Julian 80
De Laval Separator Co. 61
De Laval Steam Turbine Co.. 46
Diamond Specialty Co. 68
Direct Separator Co. 42
Dominion Coal Co. 54
Dunham & Co., C. A. 52
Durabla Mfg. Co. 39

E
Economy Fuse Co. of Can., Ltd. 66
Empire Brass Mfg. Co. 3
Engr. & Mach. Works of Can. 62
Escher, Wyss & Co. 57

F
Frick Co. 11

G
Garlock Packing Co. 41
Garth Co., The 55
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co... 8
Greene, Tweed & Co. 40
Green's Economiser, Ltd. 71
Gutta Percha 49

H
Hayes Corp., The Jos. W..... 37
Holden Co., Ltd., The 6
Holmes Metallic Packing Co. 55
Homestead Valve Mfg. Co... 56
Hoyt Metal Co. 54

I
Inglis Co., John. Inside back cover

J
Jamison Cold Storage Door Co. 12
Jefferson Union Co. 51
Jeffrey Mfg. Co. 79
Jenkins Bros. .....Front cover
Jointless Fire Brick Co..... 57

K
Kellogg & Co., E. H. 39
Kerr Engine Co. 58

L
La Clede Christy Clay Products Co. 14, 15
Laurie & Lamb 55
Leitch, The Arthur S. 2
Leonard 77
Lincoln Electric 48
Linde Can. Refrig. Co. 10
Long, J. T. 39
Lunkenheimer Co. ..... Inside front cover

M
MacGovern & Co. 46
Magnolia Metal Co. 5
Manny Co., E. S. 54, 56
Mason Regulator & Eng. Co. 67
Ministry of Munitions 47
Morrison Brass Mfg. Co., Jas. Outside back cover

N
Northern Electric Co. 65
Norwalk Iron Works Co. 77

P
Page-Hersey Iron & Lead Co., Ltd. 63
Peacock Bros., Ltd. 69
Penberthy Injector Co. 34
Petrie Co., W. H. 56
Pilley Packing & Flue Brush Mfg. Co. 55
Pratt & Cady Co., Inc. 5

R
Robb Engineering Co. 63
Republic Flow Meter Co. ... 75

S
Sanford Riley Stoker Co. ... 48
Sexton Boiler Setting Co..... 58
Scaife & Sons Co., Wm. B... 80
Schaeffer & Budenberg Mfg. Co. 61
Starrett Co., The L. S. 62
Steel Mill Packing Co. 5
Sterling Engine Co. 68
Superheater Co., Ltd., The.. 53
Sturtevant Co. of Can., Ltd., B. F. 44, 45

T
Trimont Instrument Mfg. Co., The 80
Taylor Instrument Co. 55

U
Uehling Instrument Co. 62
Under-Feed Stoker Co. of Can., Ltd., The 13

V
Victoria Foundry Co. 56
Vilter Mfg. Co. 10
Voorhees Rubber Co., Ltd.... 42

W
Wall, W. J. 55
Waterous Engine Works Co.. 1
Watson & McDaniel Co. 55
Williams & Co., J. 42
Worthington Pump & Machine Co. 9

Y
Yarnall-Waring Co. 66
York Mfg. Co. 12

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

BOILERS

TANKS AND ENGINES

Of All Kinds for Any Service

Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.

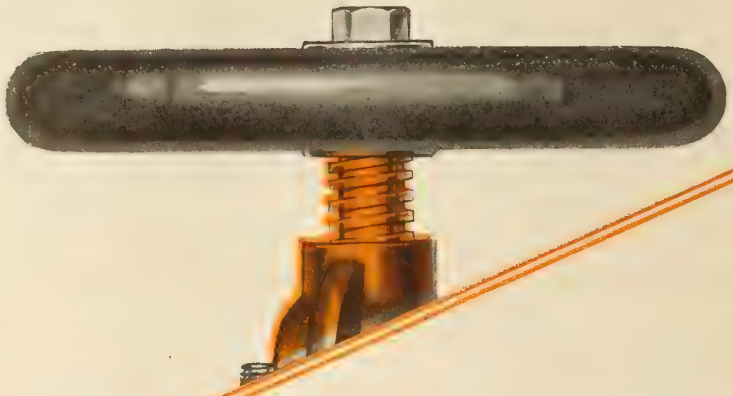
14 Strachan Ave., TORONTO

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada:
JAMES W. PYLE & CO., LIMITED
232 St. James St., MONTREAL

MORRISON

Steam Specialties



You know the class of service your present steam specialties are giving—is it all that you desire?

Give Morrison Steam Goods a trial! Isn't a probability of greater satisfaction worth testing?

"Every installation is a demonstration of merit"

The James Morrison
Brass Mfg. Co., Ltd.
93-97 Adelaide St. W.
TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 22. Publication Office, Toronto—November 20, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

Uehling Instruments Stop Fuel Waste

Check FUEL WASTE

MOUNTAINS OF COAL and RIVERS OF OIL are wasted daily by burning fuel with incorrect air supply. Every pound of combustible material requires about 16 pounds of air. More than this means money wasted up the chimney, as the table shows. CO_2 in the flue gas is the tell-tale that enables your boiler operators to regulate air supply for maximum economy.

THE TELL-TALE OF FUEL WASTE

Lbs. Air per Lb. Combustible Burned	Per Cent. CO_2 in Flue Gas	Loss Up Chimney per Dollar Spent for Fuel	Needless Waste per Dollar Spent for Fuel
16	16	$.15	
21	12	.19	$.04
32	8	.28	.13
42	6	.38	.23
62	4	.56	.41

*Average practice in plants not equipped with CO_2 recorders.

UEHLING CO_2 EQUIPMENT

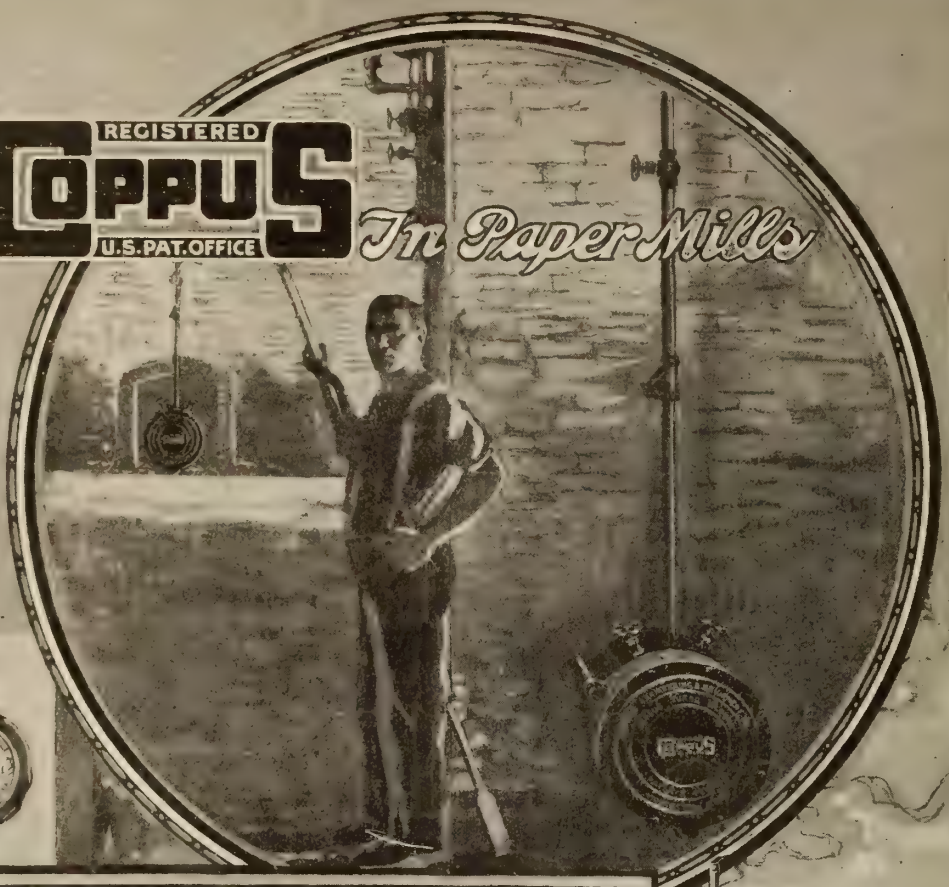
is inexpensive, in fact most plants are saving enough to wipe out its cost in a few months—some even in a few weeks. The Uehling system guides the fireman at the boiler while simultaneously recording results in the engineer's office.

Send for New Bulletin 111.

UEHLING INSTRUMENT CO.
Combustion Engineers
2008 EMPIRE BLDG. NEW YORK

REGISTERED COPPUS U.S.PAT.OFFICE

In Paper Mills



STEADY steam pressure is a vital factor in making good paper. A sudden drop at the gauge might mean serious loss in the mill. Keeping up steam is a matter of prime importance.

That is why modern paper mills are equipping their power plants with COPPUS Turbo Blowers to maintain constant steam pressure under varying conditions of load, fuel, and weather.

For instance, the COPPUS Blowers shown above operating in the plant of the Hampshire Paper Company, makers of good paper, at South Hadley Falls, Mass., have kept steady steam pressure with very satisfactory results. Peak loads are quickly met, steam pressure is always constant, and cheap fuel is economically burned.

COPPUS Turbo Blowers are helping out engineers and speeding up boilers in power plants the country over. Their good work is not confined to the paper industry—it extends wherever power is used and coal is burned. If they are not already working for you it is likely that they could save time, money and labor in YOUR boiler room.

Write for Blower Catalog.

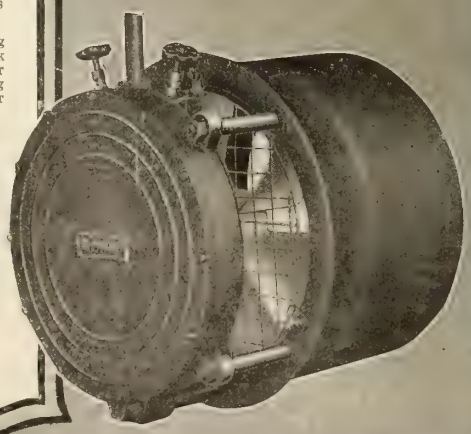
"COPPUS Equipment can Save You Money"

The COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine.

341 Park Ave., Worcester, Mass.

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.



COPPUS TURBO BLOWER

WORTHINGTON
SPIROJECTOR CONDENSER

Utility and Economy are both served by Worthington

FOR installations of condensing machinery where first costs, economical maintenance and efficient performance are equally vital, Worthington Spirojector Condenser enjoys great favor.

Worthington Spirojector is of the syphon type with particular Worthington construction features that assure steady, perfect vacuum without aid of vacuum or dry-air pump. Air and non-condensable vapors are entrained and carried out by the falling water which is injected at opening below elbow in exhaust pipe and discharges as a rapidly descending spiral current of water.

Worthington builds all types of condensing machinery and since 1840 has developed a service and organization which is world-wide. Engineering service is freely tendered and carries with it no obligation to you.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

Other Worthington Products:
Steam, Power and Centrifugal Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

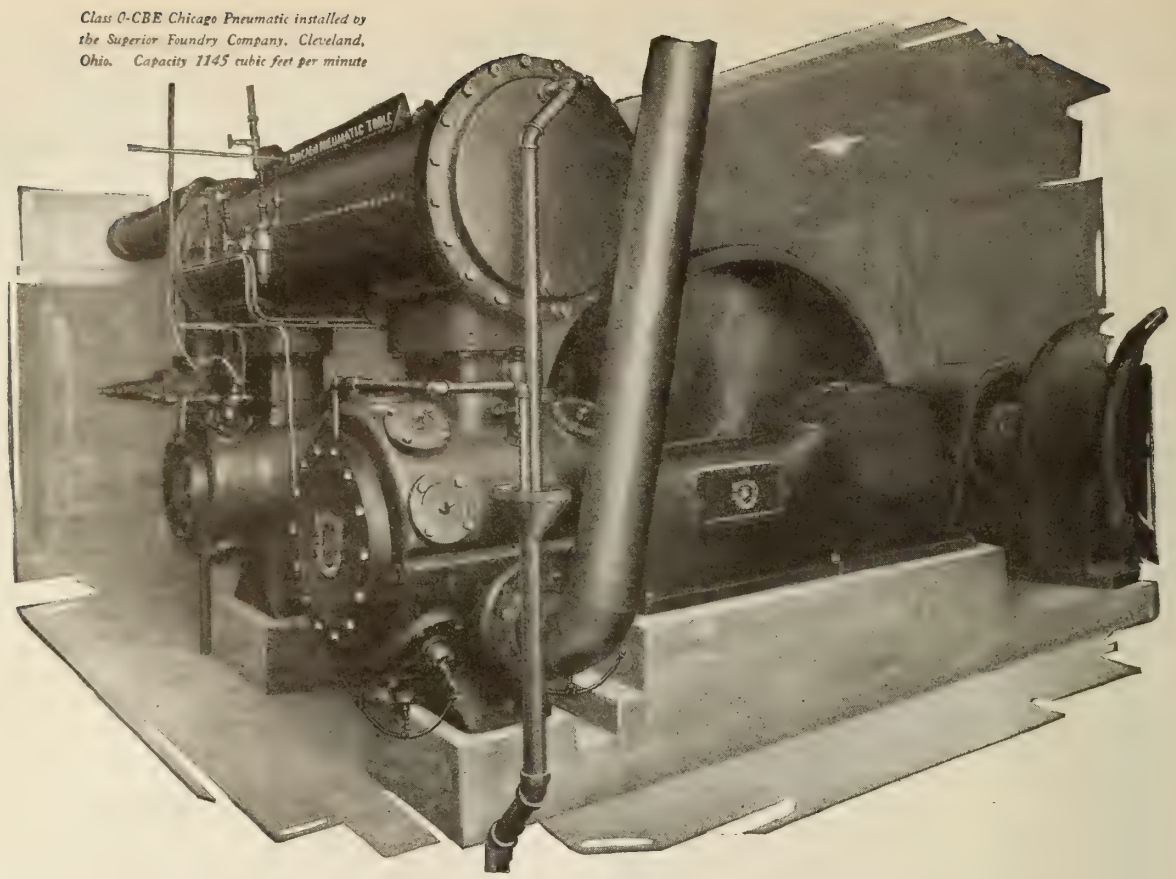
W-302.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

POWER HOUSE, November 20, 1920. Vol. XIII., No. 22. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Class O-CBE Chicago Pneumatic installed by the Superior Foundry Company, Cleveland, Ohio. Capacity 1145 cubic feet per minute

"A man's services are of value in proportion to the amount of supervision he requires"

AIR COMPRESSORS, like men, are worth most that require least supervision.

Power input, lubrication and air output of Chicago Pueumatic Air compressors are automatic—conserving both driving power and man power under all loads.

Other C-P features that insure further productive efficiency are—Simplate flat-disc indestructible valves, exceptionally large bearing surfaces, totally enclosed frame construction, and unusual simplicity of construction and operation throughout.

These features are embodied in over 300 distinct types and sizes—an air power unit to fit *your* purpose with least supervision.

Ask for bulletins.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-74 H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

The Compressor with the Simplate Valve

Full Time and Overtime

HEAVY service imposes a tremendous strain on your plant machinery. Every individual part of every unit must be properly lubricated to carry the load.

Scientific selection of your lubricating oils is every bit as important as the careful choice of mechanical units themselves.

Imperial Lubricants, backed up by Imperial Service, will solve your lubricating problems. Increased production, minimum depreciation and lowered lubricating costs surely follow.

There's a right grade of oil for every service condition; the quality is always uniform, with ample supplies conveniently available. Imperial Lubrication Engineers will gladly advise you on all lubricating problems.

Write to 56 Church St., Toronto.

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Junior Red Oil
Imperial Bayonne Engine Oil
Imperial Renown Oil
Imperial Gas Engine Oil
Imperial Arlo Compressor Oil

IMPERIAL OIL LIMITED

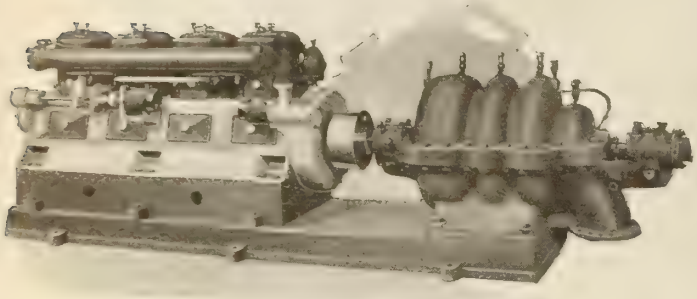
FIVE CANADIAN REFINERIES

Power Heat Light Lubrication

BRANCHES IN ALL CITIES

If You Can't Get Coal

Use a High Duty Sterling Gasoline Engine to Drive Your Generators or Centrifugal Pumps



Model FC 8-cyl. 200 H.P. Sterling direct connected to Goulds 3-stage centrifugal pump, capacity 1,000 G.P.M. against 280-ft. head. To be installed at Gastonia, N.C.

12 to 300 H.P. for emergency service, fire pumps, etc.

May we send literature?

Sterling Engine Co., Dept. C.-4
BUFFALO, N.Y.

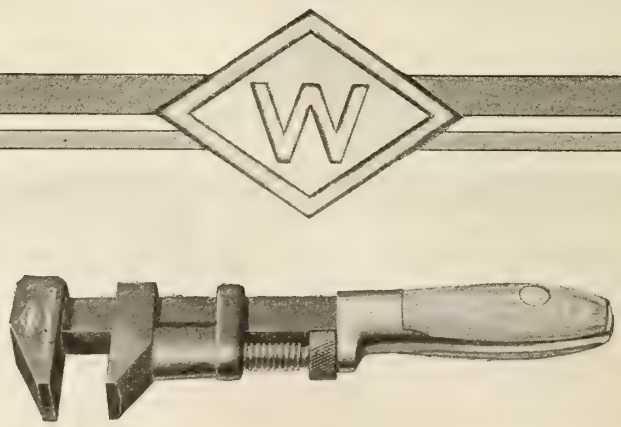
GATES
Refractories, Ltd.

Contractors for all kinds of

Power Plant Brickwork

Experts on Repair Work

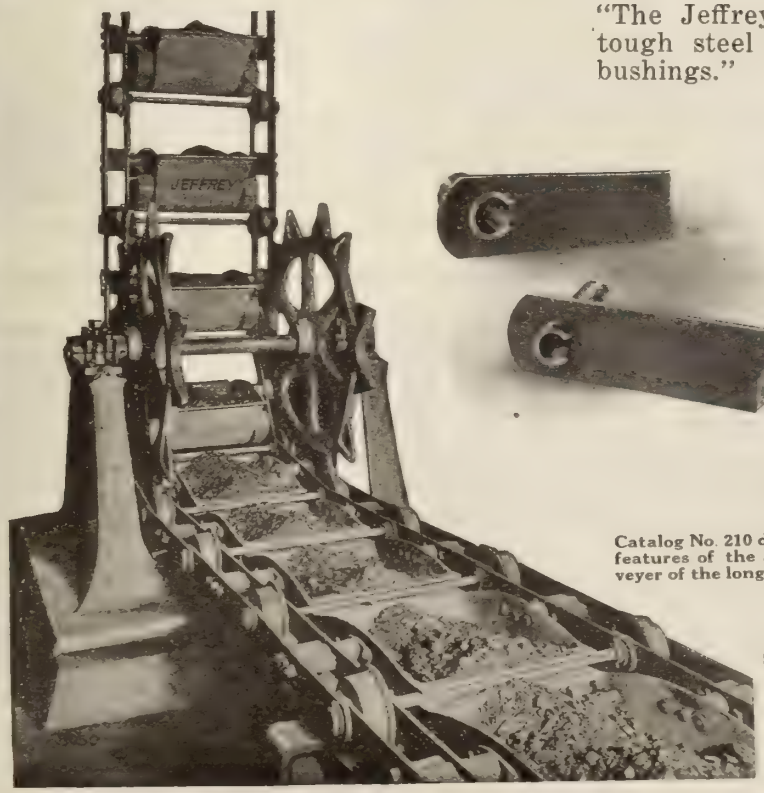
Gates Refractories, Ltd.
382 St. James St., Montreal



Where strength and dependability are requisite specify Williams' "W & B" Machinists' Knife Handle Wrenches. Fitted with the "W & B" easy-acting screw. At your dealers. Write for catalog.

J. H. WILLIAMS & CO., Ltd.
"The Wrench People"
ST. CATHARINES - - - ONTARIO

"That Thimble, Mr. Wescott, Locks Tight in The Side Bar of The Jeffrey Pivoted Bucket Carrier"



"The Jeffrey Company use a chain made of tough steel side bars with hardened double bushings."

"Lugs in the steel side bars are locked tight to notches in both ends of the bushings —confining all wear to the renewable bushings."

"The two steel bushings are assembled one within the other, the outer one (which serves as a bearing for chain roller) is fixed to the inside bars, while the inner bushing (which acts as a chain pin and receives the carrier cross rods) is fixed to the outside bars."

Catalog No. 210 describes in detail many other strong features of the Jeffrey Carrier which insure a conveyer of the longest life on the market to-day.

Let's send you a copy

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

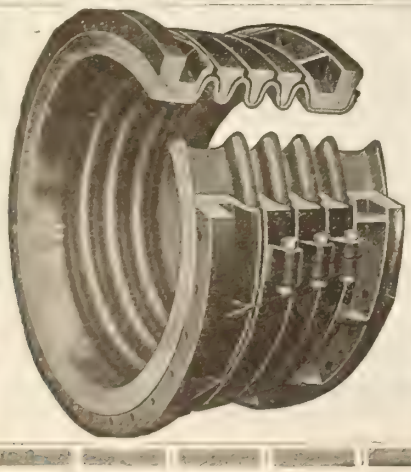
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.



BADGER

SELF-EQUALIZING EXPANSION JOINTS

Prevent leaks in all pipe lines

E.B.Badger & Sons Co.

101 PARK AVE. NEW YORK 75 PITTS ST. BOSTON 616 S.MICHIGAN AVE CHICAGO

We Design and Construct Power Plant Equipment

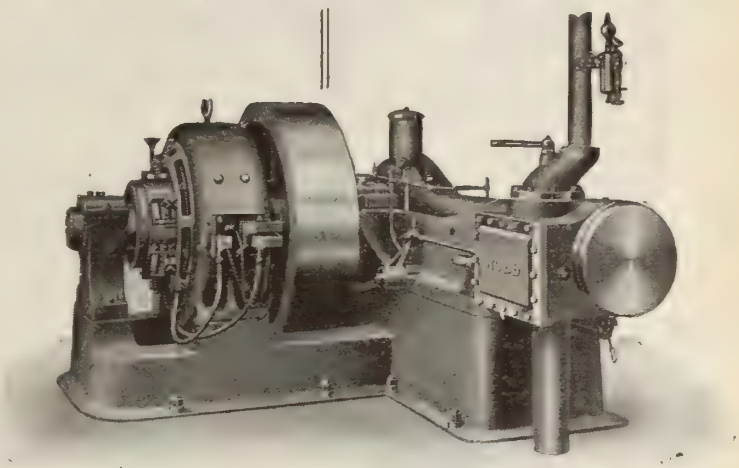
WE specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water Tube, Return Tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market —remember it will pay you to purchase equipment that has won the confidence of leading engineers.

ROBB

Power Plants



Robb Engineering Works Co., Ltd.

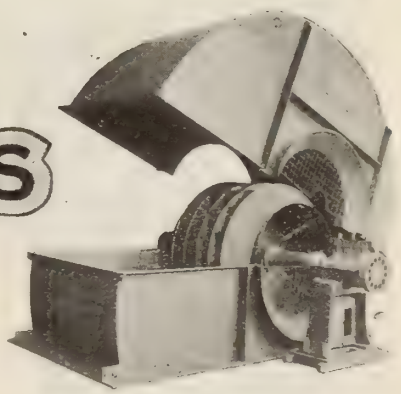
Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

GREEN'S

HI-EFFICIENCY HI-SPEED RADIAL FLOW FANS



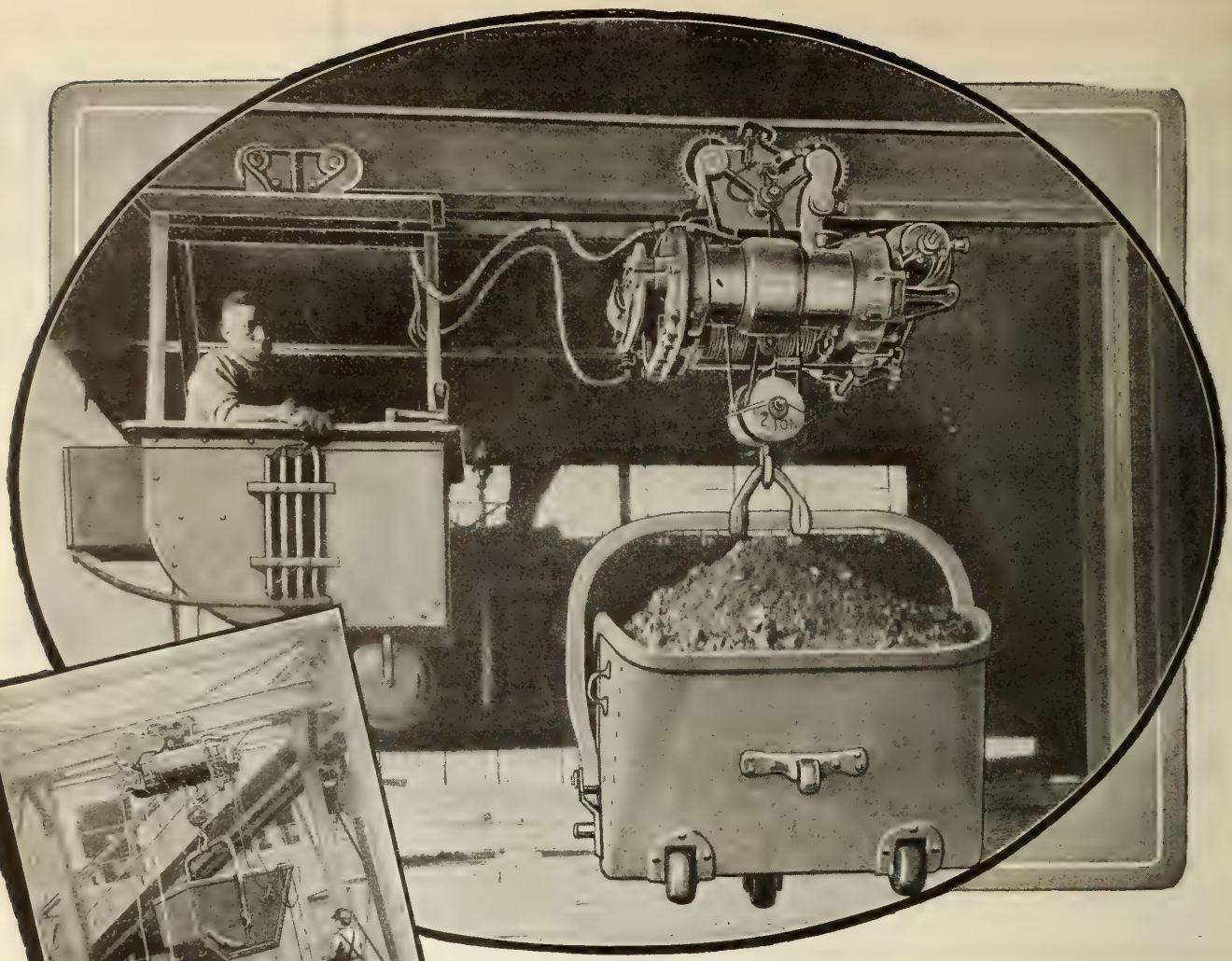
All parts of Green's Radial Flow Fans are easily accessible. Their power consumption is exceedingly low and their sturdy construction assures long wearing qualities.

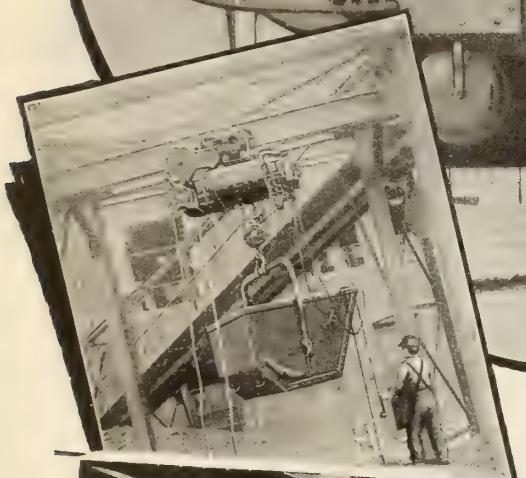
These are but a few of the many features which recommend Green's fans to careful buyers. Write for our new booklet No. 152; it contains detailed information.

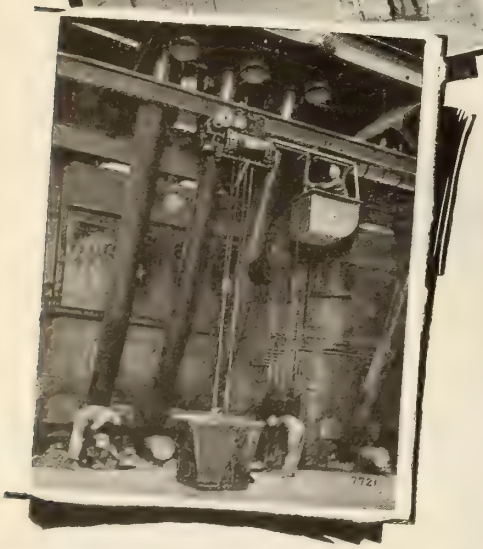
Consult our engineers. They will gladly furnish you complete information with regard to fans to cover your individual requirements.

GREEN'S ECONOMISER, LIMITED.

TORONTO







Reduce Fuel Costs

Handle your coal and ashes mechanically.

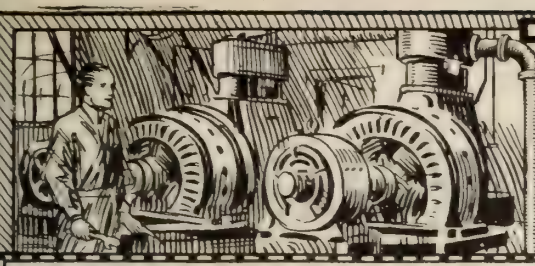
The Link-Belt electric hoist makes an ideal machine for this purpose, in most power plants of small capacity. Our Catalog No. 421 gives the facts on this method, while Catalog No. 220 covers the "Peck Carrier" for larger power houses.

Let our engineers help you in the solution of your coal and ashes handling problems.

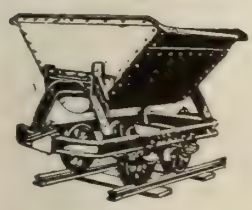
Canadian Link-Belt Company
LIMITED

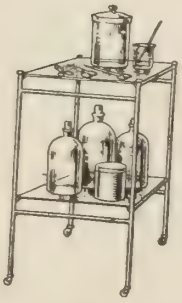
Wellington and Peter Sts. **TORONTO**
10 St. Michael's Lane **MONTREAL**

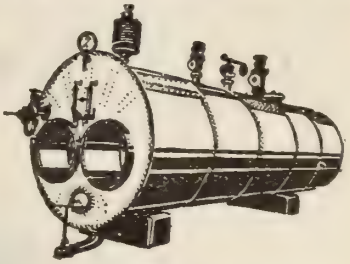
LINK-BELT
ELECTRIC HOISTS

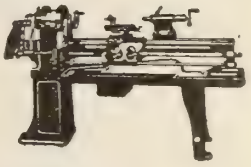


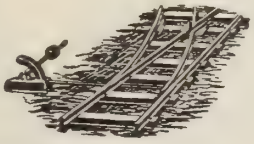
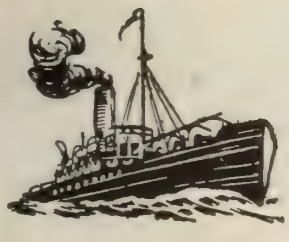
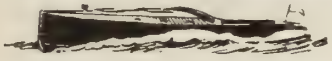
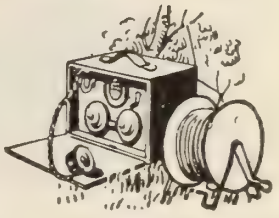
MINISTRY of MUNITIONS G R









The
Disposal Board have

STOCKS

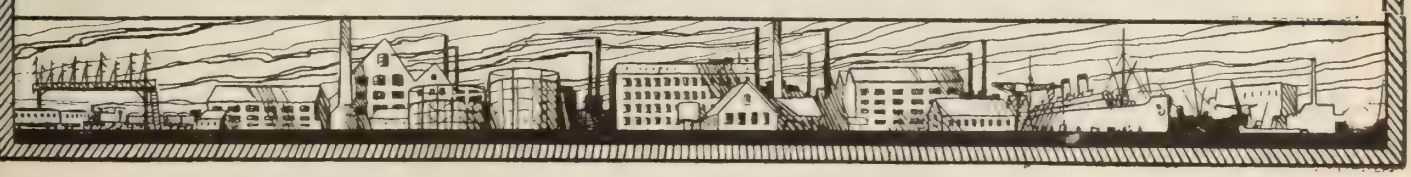
lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

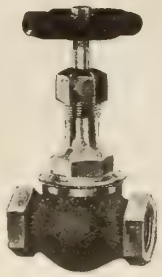
Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."



Dependable Valves



BRASS GLOBE VALVE

Standard Pattern
Screwed

Suitable for 175 pounds working steam pressure or 250 pounds working water pressure

BRASS GLOBE VALVE
With Yoke

Standard Pattern
Screwed

Suitable for 150 pounds working steam pressure or 250 pounds working water pressure

Because dependable valves are an indispensable part of efficient plant equipment, genuine **Jenkins Valves** are rightly regarded by Canada's leading engineers as a permanently paying investment.

There is a sense of security in dependable Valve equipment and there are actual dividends on savings of labor, time and shut-down charges for repairs and replacements.

Genuine Jenkins Valves (with the Diamond Trade Mark cast on the body) assure dependable and economical valve service over a period of years. The fact that Jenkins Valves have satisfactorily stood the test in every line of industry and have behind them a service record of some 56 years is a guarantee of lasting satisfaction under every condition of usage.

Catalog No. 8, free on request, pictures and describes the complete Jenkins line—a Valve for every Service.

TRADE JENKINS MARK
Jenkins Bros

Jenkins Bros.
LIMITED

Head Office and Works: 103 St. Remi St. Montreal Can.
TORONTO *European Branch* VANCOUVER
6 GREAT QUEEN ST., KINGSWAY, LONDON, W.C.2. ENG.
AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

TRADE JENKINS MARK
Jenkins Bros

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam: 275-300 lbs. pressure; 275°-300° superheat.
Oil: Pressure still joint re-made over 160 times.
Gasoline: Cylinder heads of gasoline engines and pumps.
Acids: All acids that can be carried in pipe lines.
Water: Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia: Both absorption and compression systems of refrigeration.
Air: Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

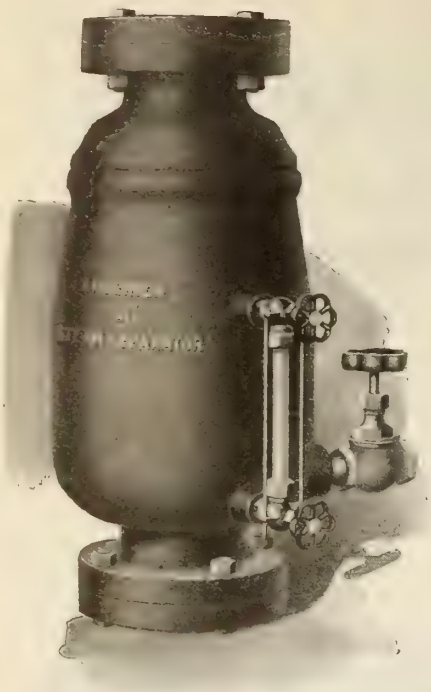
The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative.

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St
CALGARY: 605 Second Street



This Anderson Separator will save you money, time and trouble. Install it in your engine room.

The ANDERSON
STEAM SEPARATOR
DRY Steam Under All Conditions

Engine breakdowns, due to accumulated moisture in engine cylinders and turbine casings, will be unknown if you use the Anderson Steam Separator.

The Anderson delivers **dry steam** under all operating conditions. The moisture is completely separated by the combined action of centrifugal force and the sudden reversal of high velocity steam current—and the moisture cannot be picked up again, when once separated.

Write for illustrated catalogue giving complete description of all Anderson Power Plant Specialties.

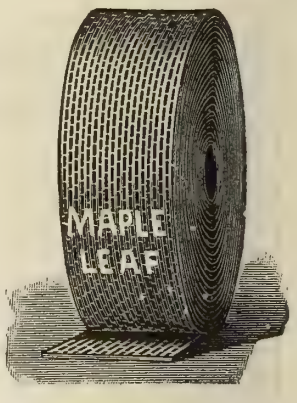
The V. D. ANDERSON COMPANY
1935 West 96th Street, CLEVELAND, OHIO

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



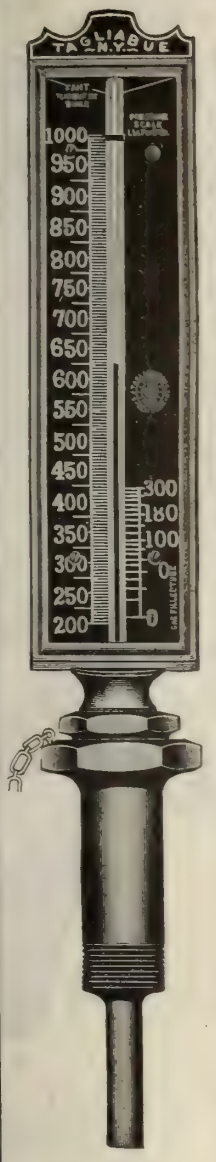
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal



TAG

POWER PLANT THERMOMETERS INDICATE THE EXACT HEAT *INSTANTLY*

Getting *instantly* the exact heat indications of live or exhaust steam isn't possible with ordinary power plant thermometers.

Because all instruments haven't the required sensitiveness that eliminates every sluggish tendency. All do not everlastingly indicate true temperatures, regardless of time and constant use.

But with TAG Power Plant Thermometers, pre-precision is guaranteed *permanent*—due to the TAG method of scientific construction.

The special annealing process seasons the glass bulb for all time, preventing shrinkage and assuring extremely correct indications. The graduations intervals are individually marked according to the particular application.

TAG Power Plant Thermometers faithfully indicate the exact heat instantly—and our positive guarantee protects this unfailing service.

Get Bulletin PP 505

C. J. TAGLIABUE MFG. CO.
18 TO 88 Thirty-Third Street
BROOKLYN, N.Y.

No Stoker is Better Than its GRATES

Back of every feature of MURPHY GRATE construction are *many* sound reasons. Consider how these features save you dollars—in fuel—in labor—in maintenance.

The long—narrow—but deep sections give eighteen to twenty-eight square inches of cooling surface to every inch of exposed grate surface.

The liberal air space (47% to 52%) gives double the capacity of the boiler "without one penny for draft."

The correct proportion and distribution of ribs on the stationary grates, combined with the greatest accuracy of machine moulding have solved the sifting problem.

The continuous movement of the ribless grates ¾" above and ¾" below the surface of the stationary grates—breaks up the fuel bed — prevents avalanching — keeps the grates clinker-free—and advances the ash gradually to a point where it is removed by the clinker grinder. It is this action that gives the Murphy Furnace the faculty of ***burning anything that has heat in it.***

Yet with all these advantages, the Murphy Grate of to-day is built to the same policy that has characterized every improvement. First, to make all parts standard; second, to make every piece interchangeable; third, to advise users of new developments so that they may keep their equipment up to date---and operating at top-notch efficiency.

For information on the Riley Underfeed Stokers for large boilers, see February 5 advertisement or send for Riley Stoker catalog HR-11.

MANUFACTURED EXCLUSIVELY BY

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

"It's Working Fine!"

Mr. Chief Engineer—

If you specify that the new belt your plant is buying be

D. K. McLaren's

Genuine British Oak Tanned

Leather Belting

You'll be able to point to it and say, "It's working FINE!" It means a lot to you personally and to your firm to have you report that all is well, rather than the trouble every little while which follows the use of belting purchased without proper care.

D. K. McLaren's leather belting is made exclusively from the close-trimmed butts of the finest selected hides, tanned by the reliable, old-fashioned British Oak Tanning Process. When in use there is practically no slippage and it seldom requires tightening.

Many of the largest Canadian plants are steady customers of ours. We shall gladly send you their names and addresses so that you can write and ask their opinion of this belting.

D·K·McLAREN

LIMITED

HEAD OFFICE AND FACTORY:

351 ST. JAMES STREET, - MONTREAL, P.Q.

TORONTO, ONT. 194 King Street West
ST. JOHN, N.B. 90 Germain Street
VANCOUVER, B.C. 334 Cordova Street West

The Joint of Dart Union Pipe Couplings is

Bronze to Bronze

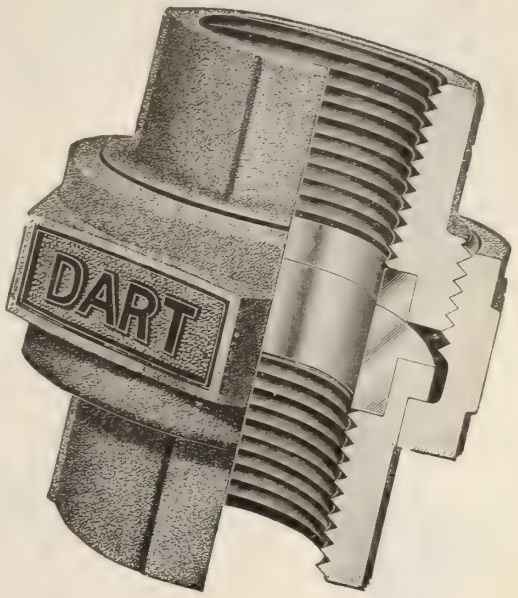
(Both Face and Seat)

This feature prevents deterioration at the vital point and is the reason why

DART UNIONS STAY TIGHT

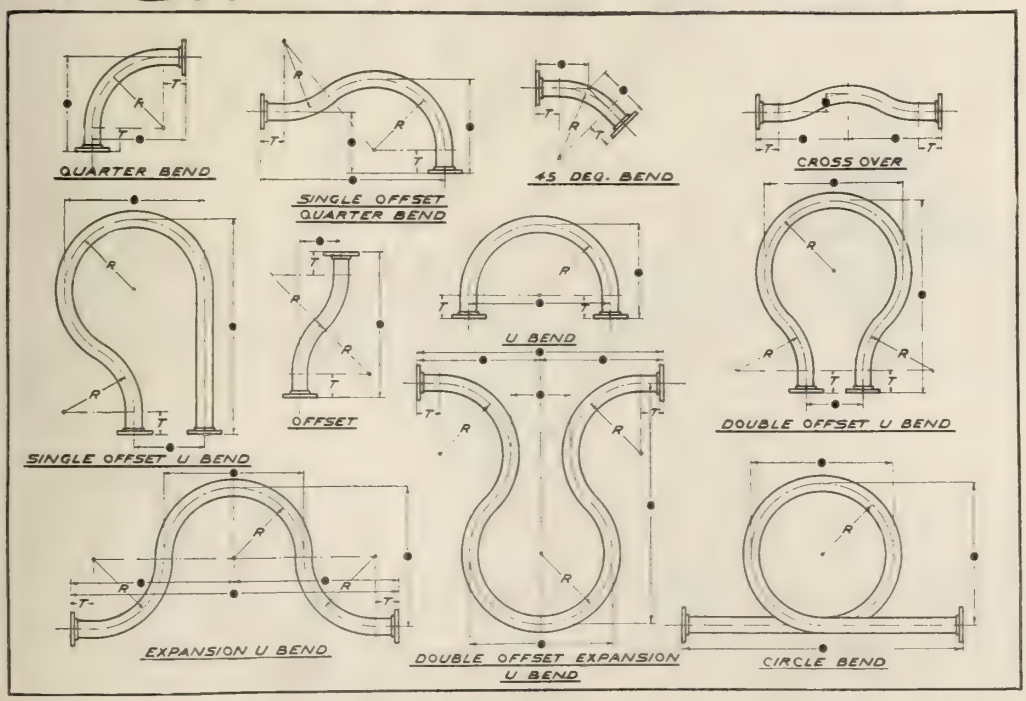
permanently

Dart Unions are really Economical and Troubleproof. Have you tried them? **Sold by all Jobbers.**



DART UNION CO., LIMITED
Toronto - Ont.

P⊗H WROUGHT PIPE BENDS



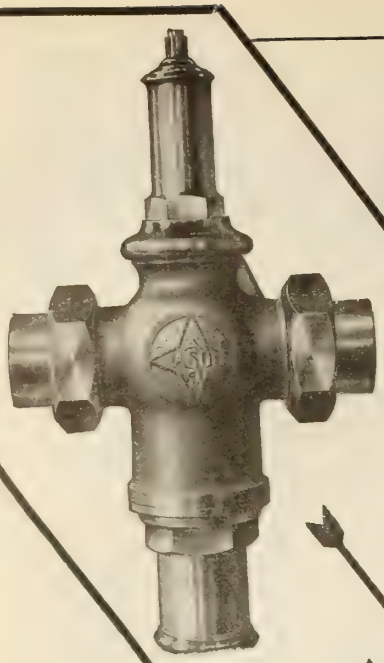
ALL KINDS AND SIZES UP TO 10" DIAMETER

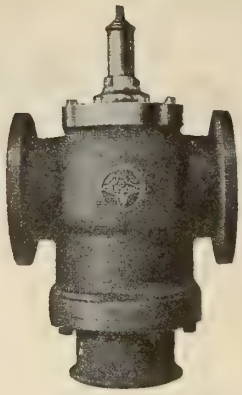
—

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

100 Church Street, TORONTO, Ont.

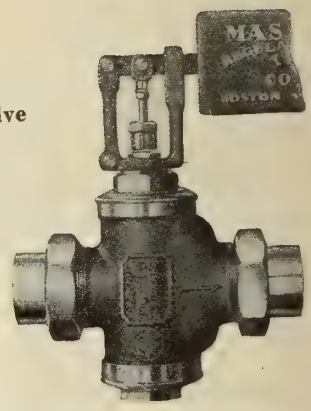




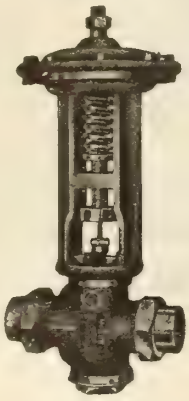
Standard Reducing Valve
Iron Body

LOOK FOR IT—
IT'S YOUR GUARANTEE

Genuine Mason Regulating Appliances
have this
TRADE-MARK cast on the body



Balanced Valve



Pump Pressure
Regulator

Standard Reducing Valve
Bronze Body

Made in Canada by

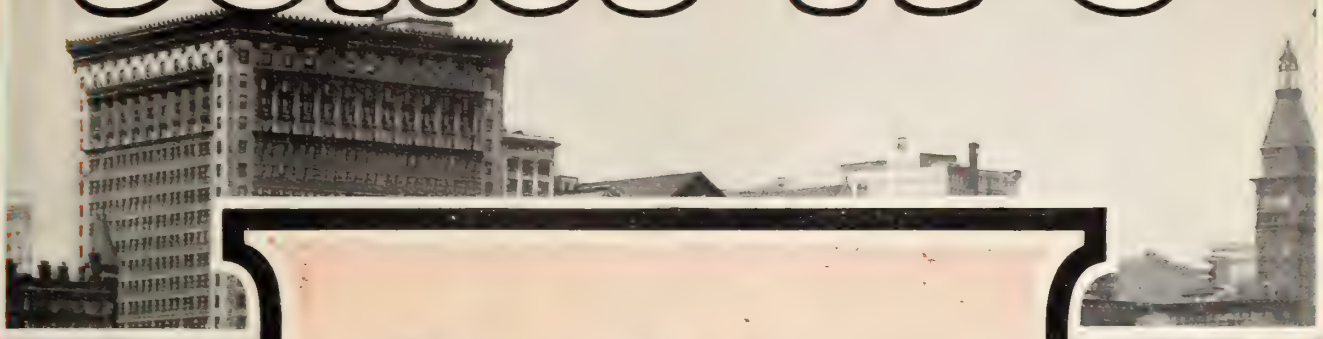
THE MASON REGULATOR & ENGINEERING
Company Limited

Montreal
135-153 Dagenais St.

Toronto
145 Wellington St. W.

TRADE MARK. MASON MASON

Jones "A-C"

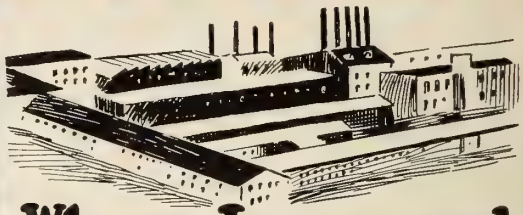


The Stoker for Every Load and Every Fuel

Which Is

Where the Peak Load is the Rule

Canadian Central Stations and Public Utility Plants in general will find the Jones "A-C" exactly suited to the fluctuating load. The automatic control of fuel and air in the Jones "A-C," and individual control of retorts provide unequalled flexibility. From banked fires to 300 per cent. of boiler rating in a very few minutes is typical Jones performance.



Where Increased Production Calls for Continuous Over Loads

Large Canadian Industrial Plants operated at peak capacity will find the ability to operate continuously a marked advantage. The "automatic-cleaning" feature of the Jones "A-C" and the extreme simplicity eliminating shutdowns, permit continuous operation at high capacity. Two hundred per cent. of rating for 24 hours a day is regular practice in many Jones-equipped plants.

Your Plant?

Where Smokeless Operation Ranks First

The Jones "A-C" is the ideal stoker where rigid smoke ordinances are in force. The under-feed principle of combustion, as originated and perfected in the Jones Stoker, insures smokeless operation. In the words one Jones user, "We have boosted our load from 150 per cent. of rating to 340 per cent. in eight minutes without visible smoke."

Where Only the Lowest Grades of Fuel are Available

The smaller isolated plants, limited to a single fuel diet, offer a great field for the Jones "A-C." The Jones "A-C" insures complete combustion of the lowest grade fuels, and permits the firing of high-ash coals without clinker trouble. Bone coals containing as high as 41 per cent. ash have been burned efficiently.

Saves Coal for Plants of Every Type and Size

TO-DAY stoker firing is an acknowledged economic necessity—not alone stoker firing, but *high duty stoker firing*.

Hand firing is being discarded in Canadian plants because with present-day coal and labor costs, plant owners have found they can no longer afford hand firing.

If you cannot afford hand firing, you cannot afford to be without the *highest duty* stoker, the Jones "A-C."

The stoker that combines the fundamental advantages of all types, while sacrificing the incidental advantages of none, is naturally the best for any plant.

It is because the Jones "A-C" (Automatic-Cleaning) Stoker has had the advantage of 25 years of development by an organization comprised entirely of engineers—because our experience has covered every conceivable variation of load and fuel condition because the under-feed principle, originated by this Company, has become universally accepted, that we claim the Jones "A-C" to be exactly such a stoker.

Your stoker firing problem probably falls within one of the four general classes described above. Since the Jones "A-C" meets not only the requirements of your plant, but of any plant, you equip not alone for the present, but for any possible future condition as well, when you install the Jones "A-C."

JONES STOKER

IN installing the new Jones Automatic-Cleaning Stoker, this Company will draw on the greatest fund of engineering facts ever placed at the disposal of Canadian power users.

The accumulation of twenty-five years of stoker firing experience, which has made possible the Jones "A-C" Stoker, is available for the solution of the stoker firing problem of the individual plant.

The combined engineering resources of two companies which have long been famous for comprehensive service is now massed behind a stoker which after three years of severe test in some of the most modern and progressive plants in the United States has been acclaimed the greatest single stride ahead in the entire history of stoker firing.

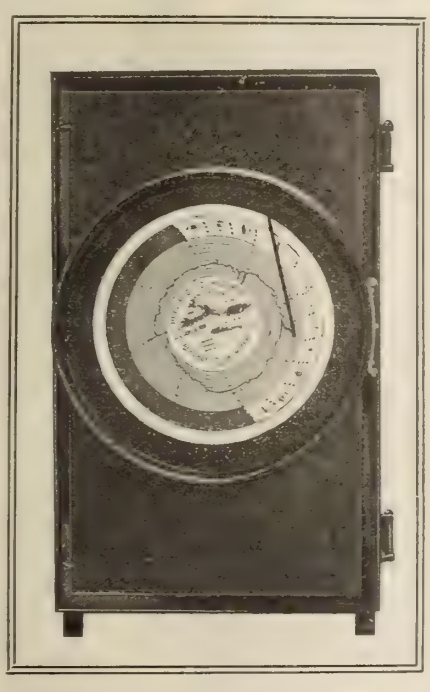
The alert engineer will make profitable use of this broad engineering service.

The Under-Feed Stoker Co. of Canada, Limited

81 Victoria St., Toronto

Republic

CO_2 RECORDER



Think of the Price You Now Pay For Coal

You Can't Afford to Waste It!

UNLESS your firemen know exactly every minute of the day the conditions of their fires, waste of fuel invariably follows. They should know precisely what changes in firing, coal feed or air supply are necessary, in order to secure maximum results. Guesswork won't do—not even the guesswork of the most experienced operators. There is but one safe way. That is by placing reliance upon a CO^2 Recorder of Proven Merit.

The "Republic" is Proving its Worth To-day in Many Plants

Furnaces in these plants are giving neither too much, nor too little air. What's the result? They are burning less coal and securing higher efficiency. This is easily explained:

In order to evolve the total amount of heat contained in the fuel, it is necessary that each atom of carbon (C) should unite with two atoms of oxygen (O_2) to form the compound known as carbon dioxide (CO_2). If the supply of air is insufficient and there is not enough oxygen to combine with the elements of the fuel, some atoms of the carbon will combine with only one atom of oxygen and will escape in the form of carbon monoxide (CO). This combination produces only about one-third of the heat in the fuel, while the other two-thirds remain in the carbon mon-oxide compound which is escaping in the waste gases.

If the supply of air is more than necessary for the complete combustion of the fuel, the excessive amount of free air passing through the furnace carries enormous quantities of heat with it up the smoke stack. An excessive supply of air usually results in the greatest loss of fuel in the furnace.

The REPUBLIC CO. RECORDER has been developed to operate continuously under all boiler room conditions. The operator is enabled to observe the conditions of combustion at all times and to obtain the highest efficiency WITHOUT WASTE OF FUEL!

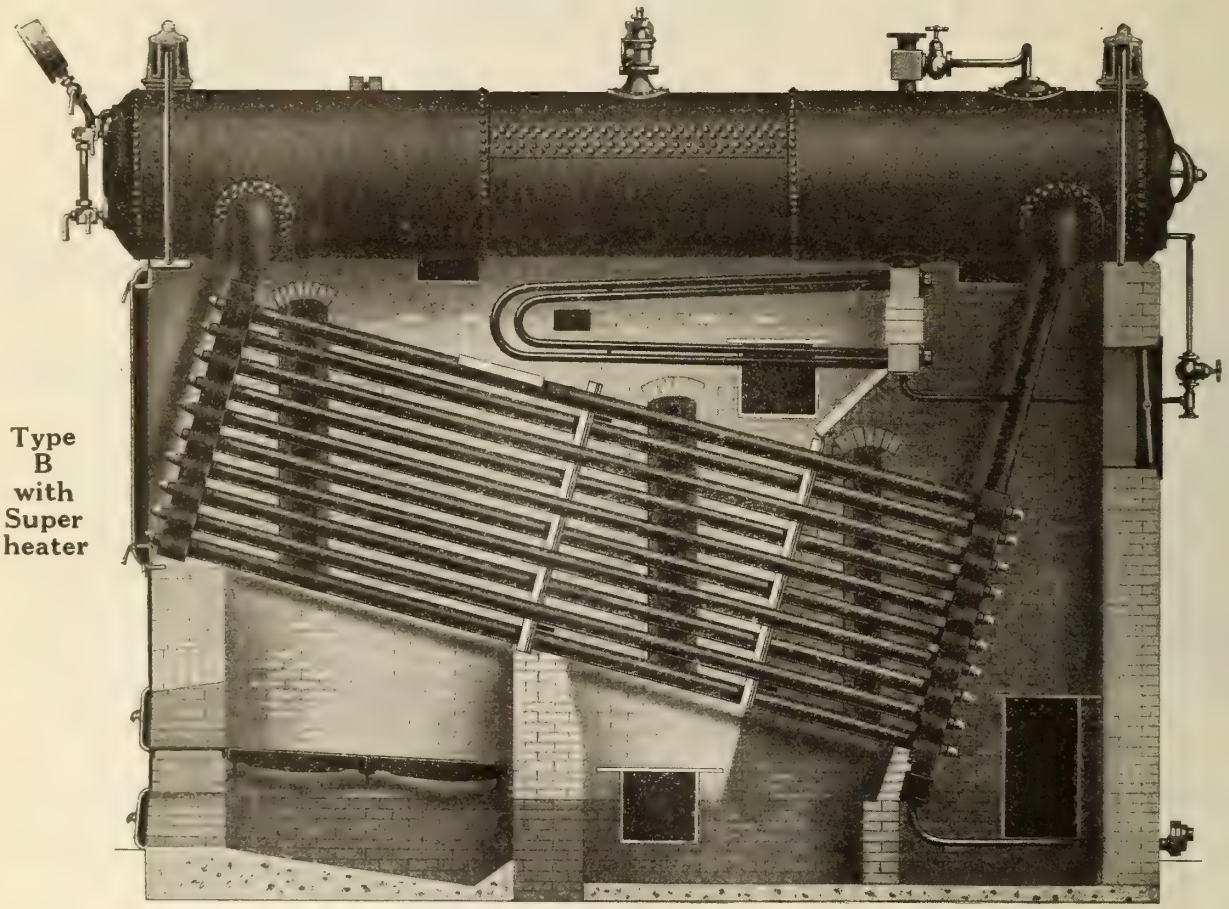
Bulletin No. 9 contains valuable information. May we send it?

Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

145 Wellington Street West
TORONTO

DEPENDABLE POWER EQUIPMENT



Type B with Superheater

G. & McC. Co.

SECTIONAL WATER TUBE BOILERS

Superior in Design and Construction

Greater combustion area and increased steaming capacity are two important features of Goldie & McCulloch Water Tube Boilers that distinguish them from ordinary boilers—they can be forced without danger.

They are equipped with large steam and water drums and connecting nipples of increased sizes, and every part subjected to steam pressure is made of FORGED STEEL. Send for full description.

The Goldie & McCulloch Co., Limited

Head Office and Works, GALT, Ontario, Canada

Toronto Office:
Suite 1101-2,
Bank of Hamilton Bldg.

Quebec Agents:
Ross & Greig,
400 St. James St., Montreal, Que.

Western Branch:
248 McDermott Ave.,
Winnipeg, Man.

British Columbia Agents:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Sem-Month

A Series of Articles on Power Plant Management

This Article Deals With the Various Conditions of Boiler Operation Requiring Natural, Forced or Induced Draft, With the Considerations Influencing the Choice of Either

By ROBERT JUNE

THE attainment of high efficiency in the combustion of fuel is, to a large extent, dependent upon proper draft regulation. If there is no draft, combustion cannot take place. If there is insufficient draft, an immense amount of fuel is wasted and the boilers will not produce enough steam to meet plant requirements. If there is too much draft, you heat all out doors with the B.t.u.'s emitted from your stack. So you must have draft and you want just the right amount.

The ideal draft enables the boiler to carry the full load, while producing the highest practicable percentage of CO_2, and the lowest percentage of CO in the uptake gases. This ideal draft naturally varies with the individual plant, and with changing conditions in the boiler room. Among the factors which determine the amount of draft required are kind and grade of fuel, design of furnaces and grates, and in particular the rating at which the boilers are driven. Thus, other things remaining constant more draft is required to produce 20,000 lbs. of steam an hour from a boiler than to produce 10,000 pounds.

A consideration of the facts just recited leads inevitably to the conclusion that every boiler should be equipped with a draft gauge. You must find out what the proper drafts are for different loads and other varying conditions on your boilers, and then see that exactly the required drafts are supplied. It is not our present purpose, however, to discuss draft gauges, but rather the means of supplying the pre-determined drafts.

Before starting our discussion let us define the term "draft." Ordinarily this word is applied to two different conditions: First, the difference in head or pressure available for producing motion to gases; the second, the actual motion of gases themselves without regard to pressure. We will ignore this second meaning, and use the word "draft" as denoting the difference in density and pressure of the gases and air at various points.

Natural Draft

Forty years ago, nature alone was used for furnishing draft for furnaces. Since the weight of the column of hot gases in the chimney is less than the weight of an equal column of the cooler outside air there is produced at the grate a difference in pressure which forces the hot gases up and out of the chimney.

With natural draft the chimney has to do three essential things:

1. Draw the air through the grates and fuel bed.
2. Draw the gases through the setting and tubes.
3. Draw the gases through the breeching to the stack.

With free-burning bituminous coal at moderate rates of combustion, the draft required for operations No. 2 and No. 3 may be approximately equivalent to the draft required for operation No 1. However, if the coal is of poor grade, considerably more draft may be required for No. 1 than for Nos. 2 and 3. As a matter of fact, with fine anthracite, we may require five times as much draft for operation No. 1 as for the others. This means that our chimney must be designed to take care of operation No. 1, whereas, with the use of mechanical draft, we can reduce considerably the functions of the chimney for this particular operation.

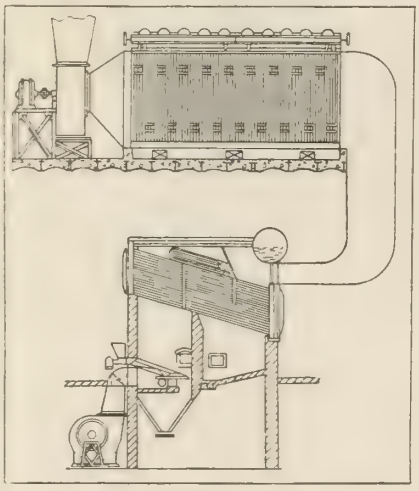


FIG. 1.

With natural draft, every time the fire door is opened a blast of cold air is drawn in which scrubs the tubes and boiler shell, placing strains on the metal and furnace walls, decreasing the rate of heat absorption and cooling the fire. In addition the gases are "short circuited," the strong suction pulling them through the boiler at high velocity, so that they take the shortest path to reach the stack, and come in contact with only a portion of the tubes and shell, so that they leave the boiler with much of the heat in them which they would give up, if made to pass through with lower velocity.

The draft produced by a stack depends mainly upon its height and the temperature of the uptake gases. Chimneys should always be designed to meet the maximum requirements, permitting the damper to be closed at times. There is usually no practical means of increasing natural draft per se after the maximum has been reached. It must also be remembered that natural draft is particularly susceptible to atmospheric influence and may be seriously impaired by adverse winds.

Mechanical Draft

In view of the limitations of natural draft it is not surprising to find that in many cases mechanical draft possesses very great advantages and under certain conditions is indispensible. Mechanical draft is very flexible and readily adjusted to effect various rates of combustion.

Among the advantages of mechanical draft are:

1.—It costs far less to install a compact and efficient mechanical draft system than it does to lay foundations and build a great chimney.

2.—It makes possible any percentage of overload, thus going far beyond the limits of chimney draft. It is not at all unusual, with a properly designed mechanical draft equipment, to develop from 125 per cent. to 225 per cent. of the rated output of the boilers. If underfeed stokers are used, much higher overloads can be carried. The mechan

ical draft system of handling peak loads is usually found more desirable than the method of installing sufficient rated boiler capacity to take care of the maximum peak loads, and it has found especial favor in those plants which are forced to take care of high peaks during short periods of the year, as well as those which run at continuous heavy overloads.

3.—Inferior and cheap grades of coal which require a strong draft can be burned efficiently. Thus, the installation of mechanical draft at times makes possible the substitution of a cheap coal for a more expensive one.

4.—It is independent of climatic conditions.

5.—It assures individual draft control of each boiler, thus enabling operators to meet the requirements of complete combustion under existing conditions. This is very important. With natural draft the boiler nearest the stack receives more than its share of the draft, and the boiler farthest from the stack gets much less than its share, hence rendering accurate individual draft control of the various boilers very difficult, if not impossible.

6.—It enables operators to get up steam, or take on heavy overloads very quickly.

7.—Short circuiting of gases is eliminated, as a boiler may be operated with a partially closed damper. This makes the entire heating surface of the boiler effective, increases the production of steam, and prevents strains due to uneven temperatures.

8.—Where with natural draft, manufacturing losses would result from the shutting down of one or more boilers such losses can be eliminated by the use of mechanical draft which permits increasing the output of the remaining boilers.

Types of Mechanical Draft Equipment

Mechanical draft may be produced by any one of three distinct systems:

1.—Vacuum or induced draft.

2.—Forced draft.

3.—Balanced draft.

With the first or induced draft systems, a partial vacuum is created above the fire, the effect being similar to, but more pronounced, than natural draft.

Forced draft is produced by pressure developed in the ashpit, the effect being to force air through the fuel bed.

Balanced draft is a combination of forced and induced. Forced draft is used to drive the air through the fuel bed only. Beyond this point, induced draft is depended upon to create a suction throughout the furnace and setting. The adjustment, or balance, is such as to provide for practically atmospheric pressure in the combustion chambers, an extremely desirable condition.

Induced Draft

The earliest form of induced draft consisted of the application of jets of live steam over the fuel bed or at the base of the stack. Tests have shown these jets to consume from five to eleven per cent. of the total steam generated. They are extremely wasteful and should be tolerated only in plants where boilers need to be forced for very short and infrequent periods.

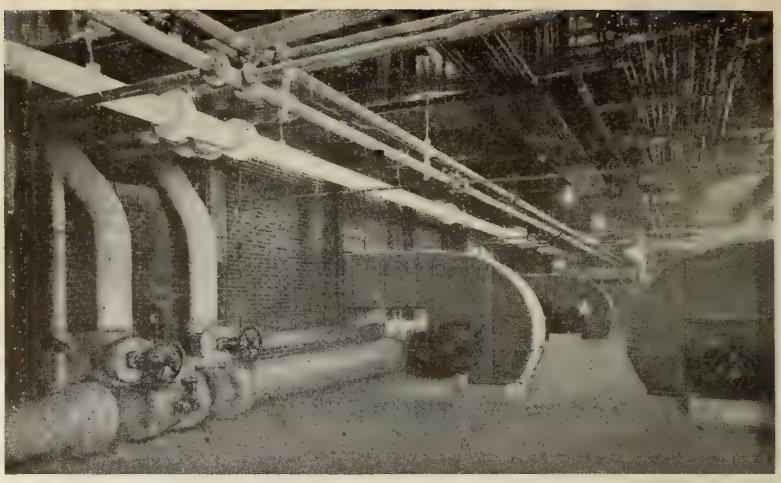


FIG. 2.

In the modern plant, induced draft is produced by means of a fan, the suction side of which is connected with the uptake or breeching of the boiler or batteries of boilers. The products of combustion are usually exhausted through a stub stack. In a typical installation, two fans of the duplex type are placed above the boiler setting. A by-pass is usually provided so that the fan can be cut off entirely in case of accident or when mechanical draft is not required. Since the induced draft fan handles hot gases it must, under average conditions, have a capacity approximately double that of the forced-draft fan which delivers cold air, but at the gases of lower density the power required per cubic foot handled is less.

The advantages of induced draft over forced draft are very pronounced. Among the advantages are:

1.—With induced draft, fires will burn evenly all over the grates; there is no trouble from holes or patches burning in certain parts of the fuel bed, as with forced draft unless carefully watched.

2.—It is never necessary to shut off the draft when firing, as there is no pressure in the combustion chamber to force scorching gases and dust out of the firing doors when opened. The ashpit can be cleaned any time without shutting off the draft as at all points the flow is toward the place at which the greatest suction or depression in pressure prevails this, of course, being within the induced draft.

3.—The ventilation of the boiler-room is better, as the air is drawn into the furnaces from the boiler room, and is replaced by fresh air from the outside, whereas with forced draft, there is a tendency for smoke and ill-smelling gases to escape through crevices in the boiler setting and through leaks in the flues, especially when the path of the waste gases to the atmosphere is restricted by economizers.

4.—The boiler flues can be kept cleaner as there is less lifting effect at the fire and consequently ashes and dirt are not carried in suspension and deposited in places where the velocity of the gases is lowered, to the same extent as is the case with forced draft.

5.—With induced draft, very much larger fuel economizers can be used, as the temperature of the gases can be reduced to a very low point, enabling a large percentage of the heat leaving the boiler to be recovered without bad effects.

Induced draft can be used with all kinds of fuel and it is adapted to ordinary grates, rocking grate bars, chain grates and other types of furnaces except those in which underfeed stokers and hollow blast grates are employed.

An induced draft plant costs considerably more than a forced draft, on account of the larger fan required, but the operating expenses are but little greater. With a boiler plant of 1,000 horsepower, or more, the cost of a single induced draft fan, engine, stack, etc., will approximate from 40 to 50 per cent. of the outlay required for a brick chimney of equivalent capacity, and the double-fan outfit will approximate from 50 to 60 per cent. The double-fan system is particularly adapted to plants which operate continuously and where even a temporary break-down is a serious inconvenience.

Forced Draft

Whenever the greater portion of the resistance offered to the flow of air is encountered in the furnace, it is advisable to use forced draft. Forced draft is created by the development of pressure in the ashpit through the agency of a fan or turbo-blower. The most approved method is to pass the air through the bridge-wall, thence toward the front of the grate, though it may enter through an underground duct or through the side of the setting. Forced draft is usually adopted in old plants where increased demands for

power require that the boilers be forced far above their rating to save the heavy expense of new boilers, or in plants burning refuse, anthracite culm or screenings, which require an intense draft for efficient combustion. Forced draft is also well adapted for underfeed stokers of the retort type, hollow blast grates, and the closed fire-hole system. The air supply may be taken from an air chamber built around the breeching, thereby supplying the heated air to the fan and effecting a lower temperature in the breeching and a higher temperature in the furnace. The objection is sometimes raised against forced draft that the gases tend to pass outward through the fire door when the fire is cleaned or replenished, since the pressure in the furnace is greater than atmospheric. This objection may usually be overcome by suitable dampers in the blast pipe which are closed on opening the fire doors, or by having sufficient stack action to create a partial vacuum in the combustion chamber. With a boiler plant of 1,000 horsepower, or more, the cost of a forced-draft fan, engine and stack will approximate from 20 to 30 per cent. of the outlay for an equivalent brick chimney. The power consumption will depend upon the character and efficiency of the motor or engine and will range from 1 to 5 per cent. of the total capacity.

In recent years there has been a very marked increase in the use of turbo-undergrate draft blowers, in place of the forced draft fan. Turbo-blowers are installed in each setting. They consist essentially of small impulse steam turbines directly connected to special design propeller fans fixed in the side walls of the setting. The fan discharges below the grate and may be automatically controlled by damper regulation. The turbine exhaust may be discharged into the ashpit to prevent clinkers, or it may be used in the feed-water.

Turbo-blowers are the least expensive of all kinds of mechanical draft to instal, and their ease of regulation is a point which commends them very much to the average plant engineer.

Types of Fans

Centrifugal fans used with either forced or induced draft may be divided into two general classes; those having rotors with a few straight or slightly curved blades of considerable length, commonly designated as steel-plate fans; and those having rotors with a number of short curved blades, generally known as multi-vane fans. In general the multi-vane fan is more efficient than a steel-plate fan, as ordinarily constructed, and requires less space than the latter for equal capacity and efficiency. Another important advantage lies in the fact that the higher speed of the multi-vane fan permits of direct connection to high speed prime movers. The steel-plate blower, however, is not necessarily a low efficiency device since by special design it may be made to give higher efficiencies than obtained from the curved short blade construction In small plants the power requirements for mechanical draft systems are low and the type of fan has but little effect on the over all cost of operation, but in large central stations the power requirements are considerable and the type and attending pressure characteristics greatly influence the ultimate economy.

FIG. 3.

Balanced Draft

In the balanced draft system a uniform pressure, nearly atmospheric, is maintained in the furnace for all rates of combustion. In actual practice, this ideal condition does not obtain, the pressure of the furnace gases being slightly below that of the atmosphere.

To maintain atmospheric pressure in the furnace, natural draft cannot be used, but instead a system of forced draft is utilized which gives a constant volume of air at variable pressure for a given speed of the blower, the pressure being controlled automatically according to the resistance of the fuel bed.

There are several ways in which this may be done. One method consists of a damper in unison with the varying speed of the blower that supplies the air to the furnace, the speed of the blower in turn being varied by the steam pressure. Another method, and the more preferable, is by using a furnace pressure regulator controlled by the pressure of the gases in the furnace chamber. When a change of gas pressure occurs the damper regulator operates the flue damper in such a way that it counteracts the change in pressure, tending therefore to maintain a uniform pressure in the furnace chamber for all rates of combustion. In this way the excess suction of the chimney, beyond that required to remove the gases from the boiler, is eliminated, and the chimney has but one function to perform, that of removing the gases of combustion from the boiler fires instead of having also to supply air to the furnaces. As the entire supply of air is controlled by the power-driven blower, which is independent of atmospheric conditions, the fire temperature may be controlled closely with great rapidity.

In analyzing the effect of balanced draft, in raising the efficiency and capacity of boilers, it is necessary to consider the matter from several points of view. About 12 pounds of air are required per pound of carbon burned to complete combustion, and since any air in excess of this amount does not combine with the coal in combustion, but merely dilutes and cools the gases, it can be seen that only when the correct amount of air is obtained does the fire develop its maximum temperature.

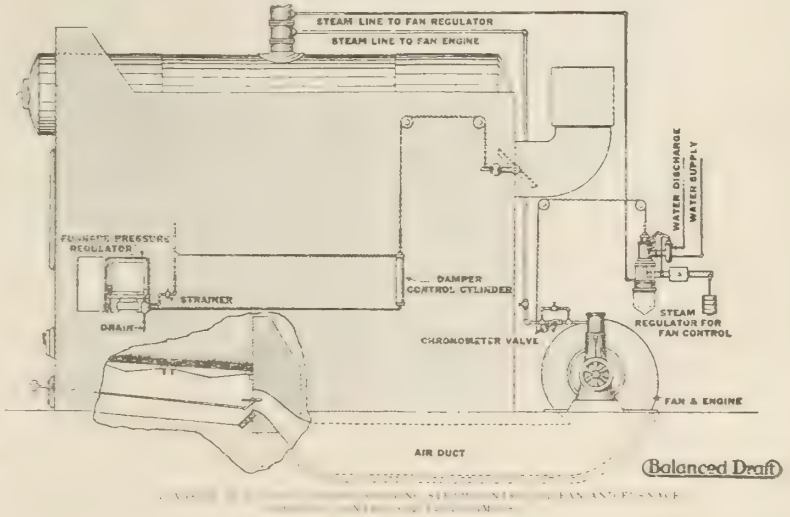


FIG. 4.

As a boiler absorbs heat in proportion to the difference of temperature between furnace gases and itself, the higher the temperature of the furnace gases above that of the boiler, the more rapid and greater, obviously, will be the absorption of heat by the latter. It is not only in this way that the thermal efficiency of the fuel is raised, however. By eliminating all excess air, the volume of gas for any definite weight of coal consumed is reduced to a mini-

mum, and it follows, therefore, that the velocity of these gases in passing from the furnace through the boiler and into the chimney is proportionally reduced. The time during which the gases are in contact with the boiler is an element which affects the heat transfer from gas to boiler, hence it naturally follows that the reduction in the velocity of these gases represents a direct gain in the heat absorbing capacity of the boilers, and is somewhat analagous to increasing the heating surface but without increasing the radiation and construction losses incident thereto.

The comparatively slow movement of gas made possible by the balanced draft is giving most gratifying results by enabling increased evaporation per pound of coal, permitting in many instances the use of a lower grade of coal than could be used otherwise, lower depreciation and lower maintenance charges, while the smaller coal consumption affects reduced labor costs.

TRIED TO SEND WORD TO BOSTON

Ontario Section of A. S. M. E. Observed the Fortieth Anniversary of Society's Inception

The fortieth anniversary of the founding of the American Society of Mechanical Engineers was celebrated by the Ontario section of the society at a meeting in the School of Science building, Toronto, on Nov. 5th. Telegrams were received and read from the parent society in New York and from a number of local sections in the United States, and other engineering bodies expressing the cordial feeling between engineers and congratulations on the fortieth birthday. There was also received a cablegram from the Institution of Mechanical Engineers of London, England, reading:

"Heartiest greeting on occasion fortieth anniversary. Events recent years, which demonstrated importance of engineers to civilization and established their power in industrial world, indicate necessity for continued expansion of engineering societies' activities, signed Institution of Mechanical Engineers of London."

Prof. James Trail gave an illustrated talk on the Power Canal of the Chippawa development of the Hydro Electric Power Commission. This was specially arranged as advance information for the members, who have been invited by the Commission's engineers to visit the canal. This trip to Niagara will take place within a few weeks and further announcement will be made.

After the lecture, an attempt was made to get in touch by wireless telephone with the Boston Section of the A. S. M. E., who were expected to be sending out messages in connection with their part of the anniversary celebration. The local receiving apparatus under the care of Messrs. Rosebrugh, Duncan and Hill, of the Faculty of Applied Science of the University, was working perfectly and picked up messages from a number of sources but none from Boston. The audience listened through multiple telephone receivers to a concert received over the wireless telephone and were much interested in a description of war time wireless by Mr. Duncan. As the expected Boston message later came by ordinary wire it would appear that the local electrical engineers had done their full duty.

CHEAP POWER FOR ALBERTA IS URGED

Public opinion in Alberta appreciates the fact that the production and distribution of cheap electrical energy is of cardinal importance to the general progress and prosperity of the province. At a recent meeting of the Alberta Associated Boards of Trade the following resolution was passed:

"That in view of the beneficial results in other provinces, we urge on the Provincial Government the extreme importance of the development of cheap power in Alberta, whether from water-power, coal, natural gas, or other source, at the earliest practicable moment."

The urgent necessity of providing for a comprehensive system and policy of power production and distribution in the Prairie Provinces has on a number of occasions been pointed out by the Commission of Conservation. Mr. James White, deputy head of the commission, in a paper read at the Calgary Industrial Congress last year, indicated that the proper future solution of Alberta power problems lies in electric generation from coal in comparatively large super-power central stations properly located both with regard to coal mines and power distribution centres and using small coal that would otherwise be wasted. The paper reviews the various other possible sources as follows:

"Owing to the unique characteristics, its special adaptability for various purposes, and the possibility of its rapid exhaustion, natural gas should be zealously conserved for use in its sphere of greatest efficiency. In my judgment, this sphere is not in the development of power on a wholesale scale.

"The water-powers of Alberta, valuable though they be, are, nevertheless, limited both with respect to magnitude and situation. Owing to low-water conditions, water power must be augmented by power from others sources.

"Now the great source to which Alberta must look for power is her coal. During recent years, the great advance made in the art of the production of steam power is phenomenal. This advancement has given coal, as a prime agency for power development in competition with other prime agencies, almost a premier position. Those interested in the furnishing of power on a wholesale scale in Alberta must make their research into, and selection from, the achievements made in recent years in the field of power produced from coal."

In connection with this move for public or co-operative efforts towards well organized power production and distribution, it is of interest to note a recent statement by Mr. H. G. Acres of the Ontario Hydro-Electric Power Commission:

"Under co-operative municipal ownership, a block of power delivered to the outgoing lines at Niagara is not valued by what it can profitably be sold for, at so many dollars per horse-power per annum, but by what it means to the individual citizen as an agency for increasing his comforts, conveniences and general standard of living, and for facilitating increased commodity production. Such conditions tend toward the building up of the greatest asset any country can possess, an increasingly prosperous and contented population."

WATERWORKS LOSSES

The great benefits derived from a water waste survey cannot be too strongly stated. In almost every waterworks system which has not been tested in this way, large leaks or other wastes are certain to exist.

Even the most efficient systems, when tested by pitometer surveys, almost invariably reveal poor, but easily remedied conditions at one or more points. These conditions, if allowed to remain, usually involve an unknown, but very expensive, drain on the operating expenses or a loss in revenue.

A recent example, typical of conditions revealed by such a survey, is that of the waterworks system of a city in the state of Indiana, which supplies a population of some 75,000. In this case, the survey exposed conditions which when corrected reduced a daily consumption of some 10,000,000 gallons by an average of 669,000 gallons. The underground leakage amounted to over 500,000 gallons per day which, at 5 cents per thousand gallons, represented a waste of over $9,000 per annum. Many other defects were brought to light, including the service to a large packing plant supplied on meter rate; a supposedly disused 4-inch service had never been shut off and unmetered water was being supplied through it. The meter on the other supply pipe for this packing plant, due to a wrong set of gears on the dial, was registering 45 per cent slow. The annual loss to the department in this case alone was estimated to be over $3,000. In another portion of the system, where the piping was old, the night consumption was out of all proportion to the day rate. Investigation exposed a 1-inch connection discharging full into an abandoned vault and three 1-inch services broken off at the mains. Approximately 35,000 gallons were wasted daily in a public school where the fixtures were running continuously night and day.—L. G. Denis.

Increasing Conduction and Decreasing Fuel Costs

The Effects of Scaly Deposits on the Water Side and Sooty Deposits on theFire Side of Heating Surfaces in Fire Tube and Water Tube Boilers.

By WM. R. VAN NORTWICK

DUE to its scarcity and high price the problem of fuel conservation is to-day receiving more attention than at any time in the past. Great thought has been given to the development of the modern stoker so as to get every heat unit out of the fuel and into the furnace. Thousands of dollars have been spent by the boiler manufacturers in order to take the heat units from the furnace and turn them into increased steaming capacity. One of the well-known boiler companies recently spent over a year experimenting and testing in order to ascertain the most efficient type and arrangement of the baffles.

Makers of prime movers, generators and motors retain expensive designing and testing departments to add a fraction of a per cent. to the efficiency of their products. While all this expense and refinement in design naturally is more than returned in the form of reduced fuel consumption, a great many plants are wasting materially larger amounts through lack of attention to the continually decreasing conductivity of the boiler.

The ideal design of a steam generator would be one in which the fire would come in direct contact with the water—with no wall of metal between. Of course this is impossible and we are compelled to interpose the wall of metal between the fire and the water. Great pains have been taken to reduce this wall to its smallest possible thickness with a maximum conductivity.

However, the very operation of the boiler tends to decrease the ability of the boiler to transmit the heat units from the fire to the water with a constant decrease in efficiency and increase in fuel consumption to accomplish a given result. This is due to the soot deposited on the tubes from the fire and the scale deposited from the water.

The fuel in burning produces a fine soot or ash which, carried by the draft, finds lodgment on the top of the tubes of a water tube boiler or in the flues of a fire tube boiler. It is strange that progressive engineers failed for so many years to realize that this soot (which is one of the best heat insulators known) retarded, more or less effectually, the transference of heat to the water. It is only of comparatively late years that any mechanism has been developed for mechanically blowing this soot from the tubes. Even after equipment of this character was developed it was extremely hard to interest the otherwise progressive consulting and large operating engineers. The sales engineers who were pioneers in the introduction of this type of equipment in New York city found it almost impossible to make any headway in its exploitation. In fact the speaker was, through his acquaintance with the consulting engineers on the job, largely responsible for the first installation secured in New York city. I mention this to indicate to you how recently this subject received real engineering consideration.

It is true that the steam lance has been used in plants for some time, but this was principally used to partially blow the soot from the tubes when it had accumulated to such quantities as to interfere with the draft and tended to slow down the fire. The fact that there is only one insulator more efficient than soot had apparently escaped notice and the soot was allowed to remain on the tubes in sufficient quantities to cause a considerable fuel loss. To-day the use of the mechanical soot blower is becoming more common, although there are many boilers to-day which are not so equipped.

The soot, which is referred to, is not necessarily unconsumed carbon, but is more often ash. It resembles but little our common conception of soot in that it is more often white, red, brown, gray, or green than black. The soot often fuses at fairly low temperatures, with the result that the tubes being insulated cannot absorb the heat and the chimney temperature rises. The higher temperature causes the soot to fuse, thus further insulating the tubes and raising the temperature.

The possible loss due to soot is indicated by a recent test run at the plant of one of the largest electric light plants in the country. Figures from a new and perfectly clean horizontal water-tube boiler of 600 h.p. capacity showed the uptake temperatures to average 550 degrees on the first day and 650 degrees on the fifth. This increase of 100 degrees in only four days indicates an increased fuel consumption of about 5 per cent., due to failure to blow the soot from the tubes. Service tests have indicated that boilers blown every six hours show an increased efficiency of 4 to 5 per cent. over those blown every 24 hours.

"Tests made by Mr. A. W. Conklin, combustion engineer, showed the following temperatures:

	Near bottom 1st pass	Top 1st pass	Bottom 2nd pass	Top 3rd pass
Hand blown	1697	954	727	618
Cleaned by steam blower	1691	934	649	527

"as temperatures were read at the points indicated in a horizontal water-tube boiler. In the first case the tube surface was blown thoroughly by a steam lance and the average temperature of the flue gas was 618 degrees. In the second case with the steam blower in use the exit temperature was 527 degrees, the difference in temperatures representing between 4 and 5 per cent. gain."

The removal of soot by mechanical methods is a comparatively simple task provided a properly designed and installed soot blower is obtained. However the elimination of water scale in the same boiler is a much more complicated problem. This is due to the character of the substance as well as the location in the boiler in which it forms. This water scale is not only an excellent heat insulator but is the cause of numerous more or less serious boiler failures. One of the large boiler insurance companies in New York reports that the large majority of their claims arise from burnt tubes due to scale incrustations.

These scale incrustations are due to the presence, in the feed water, of foreign material carried either in suspension (as clay and fine vegetable or organic matter) or in solution—as the carbonates, sulphates and chlorides of the various earth salts. The most common mineral substances so found are the carbonates and sulphates of calcium and magnesium, although the chlorides of these salts are often present in lesser quantities.

This scale thrown out of suspension or solution in the boiler appears in three forms: (1) scum; (2) mud, and (3) solid scale. The scum, which floats on the surface of the water, may, when first formed, be removed by means of the surface blow-off. If allowed to accumulate it will finally sink and attach itself to the tubes or shell in the form of mud or scale. The mud is soft, very often in an almost liquid condition, and may be blown out through the blow-off. If allowed to remain in the boiler it may combine with the other scale-forming material to form hard scale or may be baked to the boiler surface. The scale occurs as a stone-like deposit ranging from a porous, chalk-like substance, which is brittle and easily broken, to a dense cement-like stone which is often hard to break with a hammer.

The carbonates will, if present in certain forms, be thrown out of solution by heating to a temperature slightly in excess of 212 degrees for a sufficient

period. This drives off the extra molecule of carbon dioxide, leaving a monocarbonate which is insoluble in water. This scale will be found usually in large quantities in the third pass of a water-tube boiler.

While fairly hard this form of scale is inclined to be more porous and softer than the sulphate scales which are deposited on the application of heat of much higher temperatures. This harder scale will be found in the first and second passes, particularly near the baffles where the tubes are subjected to the highest temperatures.

Where the scale-forming material is (like sodium chloride, or common table salt) incapable of being thrown out of solution by heating, it is often precipitated in crystalline form, due to concentration.

In addition, scale is often formed by the introduction into the boiler of oils or grease. This takes the form of lime soap, iron soap, etc. An indication of the amount of scale which may form, from these various causes, is found when it is realized that in a 100 h.p. boiler during one month's operation, 300 pounds of solid matter may be precipitated on the tubes from water containing only 7 grains per gallon, while with some spring waters 2,000 pounds may be deposited in the same period.

Many long and accurate tests have been made to determine the cost to the plant owner, as measured at the coal pile, due to the accumulation of scale in the boiler. No hard and fast rule can be laid down as to these losses, due to the fact that the character of the incrustations varies with the different feed waters.

Professor Schmidt, of the University of Illinois, from a series of tests with boiler tubes coated with scale of varying thicknesses up to ⅛ inch, draws the following conclusions: (1) Scale varying in thickness up to ⅛ inch causes a heat loss varying from insignificant amounts up to as much as 10 or 12 per cent. (2) The loss increases somewhat with the thickness of the scale. (3) The mechanical structure of the scale is of as much, or more, importance as the thiskness in producing this loss. (4) Chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat-transmitting qualities.

An example of the varying effect which scale may have on the conductivity of the boiler tube may be noted from the following table showing results of sixteen tests made at the University of Illinois:

Influence of Scale on Heat Transmission

No.	Thickness of Scale inches	Character of Scale	Dec. in Conductivity due to scale Per cent.
1.....	trace	Hard, dense	9.1
2.....	.02	Hard	2.02
3.....	.033	Soft	4.3
4.....	.033	Very hard	3.5
5.....	.038	Medium	4.03
6.....	.04	Soft	6.82
7.....	.04	Hard, dense	3.07
8.....	.042	Very soft	9.54
9.....	.047	Hard	2.75
10.....	.065	Medium	2.39
11.....	.07	Soft	2.38
12.....	.07	Hard	4.43
13.....	.085	Soft	19.0
14.....	.089	Very soft	4.95
15.....	.11	Hard	16.73
16.....	.13	Hard, dense	6.75

While there is considerable range to the reduction of conductivity noted, any of the losses found, if reduced to the coal pile cost, would amply repay for the removal of the scale.

Tables have been prepared by various interested parties showing that 1-16 in. of scale will increase the fuel consumption 15 per cent; ¼ in., 60 per cent., etc. It will be seen from the foregoing remarks that this relation does not strictly hold. If the scale is hard and dense and practically waterproof, it will doubtless be an effective heat insulator, while if it is porous, as many scales are, the water will be able to permeate the scale, and, reaching the boiler metal, transmit the heat with comparatively small fuel loss.

One hundred and twenty tests made by the Illinois Central Railroad indicated an average increased efficiency, due to thoroughly cleaned tubes of 11 per cent., while E. M. Fiske states that as a result of tests made for three months, previous to and three months after scale was removed from a boiler, it was found that the result, at the coal pile, was 10 per cent. in favor of the clean heating surface.

It is needless to recite further instances of savings effected by thoroughly removing the scale incrustations from the tubes, to indicate the possible savings in any plant embodying steam boilers. However, it might be well to state that while the instances cited have dealt with water-tube boilers, equal or greater results may be shown in those of the fire, or return tube type. One instance which came to the speaker's attention may suffice as an illustration. A well-known varnish company, whose factory, in Newark, N.J., incorporates fire tube boilers, of a well-known make, were recently overhauling their entire plant.

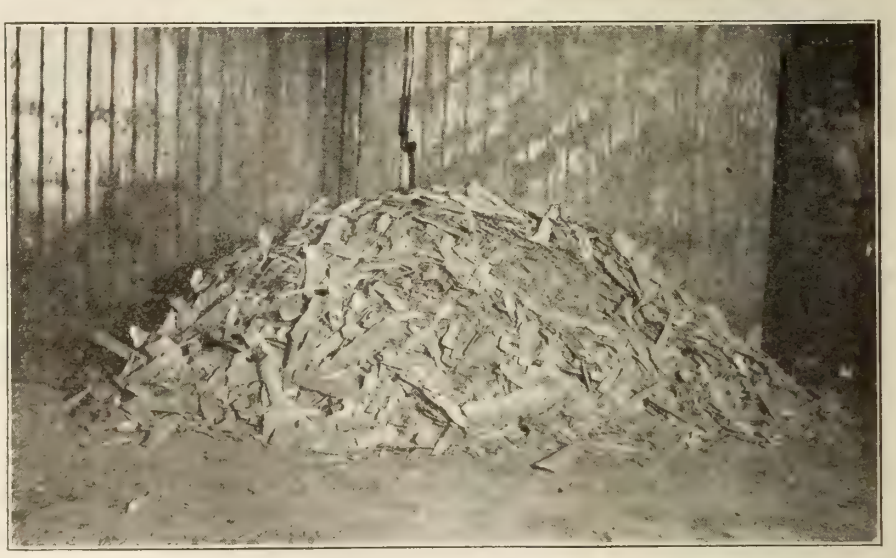
Although they doubted the necessity of doing so, they were persuaded to thoroughly clean the three boilers, removing the smoke scale or soot from the interior of the tubes and the water scale from the exterior. Previous to this cleaning they had been consuming daily, fuel to the value of $135. The boiler test, which followed the cleaning, showed a saving of 20 per cent. of this amount, or $27 per day.

Many additional similar instances might be recited, did this case need further proof. However, as previously indicated, aside from the fuel loss, there is a far more serious feature due to scale incrustations.

William Kent says in his "Steam Boiler Economy": "The effect of scale in a boiler ordinarily is to reduce both its steam generating capacity and its economy, since it is not a good conductor of heat and therefore diminishes the transmission of heat through the plates. It is also often highly dangerous whenever it accumulates to such an extent at a part of the shell which is exposed to the flame or to very hot gases that the plates become overheated and weakened."

In "Steam," published by the Babcock and Wilcox Company, we read:

"Not only has the presence of scale a direct bearing on the efficiency and capacity to be obtained from a boiler but its absence is an assurance against the burning of tubes.



SCALE REMOVED FROM THREE FIRE TUBE BOILERS

"Any formation of scale on the interior surface of a boiler keeps the water from such surface and increases its tendency to burn. Particles of loose scale that may become detached will lodge at certain points in the tubes and localize this tendency at such points.

"It has been proved beyond a doubt that a very large percentage of tube

losses is due directly to the presence of scale which, in many instances, has been so thin as to be considered of no moment, and the importance of maintaining the boiler heating surface in a clean condition cannot be emphasized too strongly."

The Hartford Steam-boiler Inspection and Insurance Company reports, as the results of one year's inspection, 157,804 boiler defects due to 22 causes. Of these, those due to deposits of scale or sediment numbered 41,026 or approximately 26%.

Could these scale incrustations be eliminated from the fuel burning plants of the country the saving effected in the national coal pile would be of staggering proportions and one of the direct results would be an appreciable price reduction to the consumer. Inasmuch as it is readily possible to secure this saving the apparent indifference of many engineers to this important matter assumes an aspect of almost criminal negligence.

One of the large central stations within a short distance of the heart of New York City was for some months ordering tubes in large quantities. During the war there was a great scarcity of material of this type and it was suggested that the speaker see them in regard to the advisability of thoroughly cleaning their boilers. They were readily responsive and after removing the scale incrustations from the tubes it was found that further tube renewals were unnecessary. In addition they also found that they no longer required the additional boiler capacity which they had contemplated installing.

The ideal feed water would, of course, be one which was neither acid or alkaline and which contained no traces of the earth salts. However, those waters which do not contain scale forming material invariably carry material which will pit or corrode the tube. While it is not the intention of this paper to enter into an extended discussion of corrosion and pitting of the boiler metal it is worthy of note that this action is far more serious than is the accumulation of scale. It cannot be easily detected and if not taken in time ultimately leads to ruptures in the boiler.

It might be well to note in passing however that the usual cure for this type of boiler trouble is to add some scale forming material to the feed water—such as carbonate of soda.

While there are no theoretically perfect feed waters, various treatments have been developed with the idea of purifying the feed water so as to eliminate the scale incrustations. Let us examine these very briefly.

Filtration. — Those materials which are in suspension, may often be filtered out by use of properly designed filters of sufficient capacity. Such material of this character as passes into the boiler may to a great extent be removed by the surface blow-off.

External Heat Treatment.—Where the principal scale-forming material is the bicarbonate of lime, magnesium or iron, beneficial results may be obtained by means of the application of heat to a temperature above 220° for periods of sufficient length to drive off the one particle of carbon dioxide, leaving a mono-carbonate which is insoluble in water and which is therefore precipitated and removed from the feed water.

Most waters, however, contain material other than the carbonates so that this treatment, which is expensive to install and maintain, only partially removes the trouble, allowing the harder sulphates to be introduced into the boiler.

Some waters carry salts which will not react to heat or other treatment and require to be evaporated and condensed. Even in cases of this kind sulphate of lime may make its presence known in the boiler. As shown in marine experience evaporation of sea water leaves scale-forming material in the water.

External Chemical Treatment.—This treatment, being only partially effective, is subject to the same criticism as the heat treatment. It allows scale to be formed in the boiler and the high cost of installation, interest on this cost and the cost of maintenance is practically wasted.

Combined External Heat and Chemical Treatment.—This system of feed water treatment is the best system as yet developed for external treatment. If anything it may be criticized for being too efficient. In plants in which it has been installed it has been found necessary to introduce scale-making material into the treated feed water to stop the pitting of the tubes. However, the principal objection to this system is that its cost is prohibitive. For the average plant the cost of such an installation would at least equal the cost of the boilers while the interest and maintenance costs could not be expected to be any lower.

Internal Chemical Treatment. — For many years the American power plant engineer has been buried under literature advocating the use of various "Boiler Compounds." The makers of practically all of them guarantee their product to successfully remove old scale and prevent the formation of new, regardless of local conditions. However, authorities are agreed that boiler compounds are not successful and should not be used. Mr. Albert A. Cary, the eminent consulting engineer, says "Never use any compound unless you know positively just what it is composed of, and how it will affect the impurities in your boiler and the boiler itself. In the treatment of boiler-waters, always start with a careful analysis of the water, made by a competent chemist who has experience in this line. Next, if you are thinking of using any chemical that has been offered for treatment of your boiler water, let your chemist analyze it. If you are dealing with straightforward people, they will generally tell you the exact composition of their material, which your chemist can verify easily, after which he will be prepared to advise properly."—(Engineering Magazine, June, 1897.)

Again in The American Machinist of December 7, 1899, Mr. Cary says: "The treatment of feed-waters inside of the boiler has been a practice of many years' standing, but in the light of recent progress is not to be commended. A boiler certainly has all that it can be reasonably expected to do when it is generating steam without being called upon to perform the functions of a chemical laboratory."

Even where the boiler compound is successful, or practically so, it is subject to criticism. Mr. William Kent says in his Steam Boiler Economy: "A thin scale may form on the tubes, be detached by the action of some 'boiler compound' and may then be carried by the circulation and deposited in a thick mass on the shell over the fire. This may cause a 'bagged' plate, or a crack and an explosion."

It is hard to tell just where to look for misrepresentation in the sale of boiler compounds so that it behooves the owner and engineer to be doubly on their guard in dealing with this type of material. One maker of a "boiler metal treatment" advertises that it is not a boiler compound and guarantees the claims made for the preparation, as presented in such high class power plant papers as "Power," "Combustion" and "Power Plant Engineering."

The U.S. Government made a test of this preparation and found after extensive experimentation that not a single claim was actually met and that the preparation was really injurious as pitting increased.

Despite the fact that the results of this test were printed and distributed, the company still continues to advertise the "Guarantee" of its claims.

One of the most rational criticisms made against the addition of chemical reagents to the feed-water may be found in the discussion by Mr. M. F. Newman on a paper entitled "A Novel Method of Handling Boilers to Prevent Corrosion and Scale" as read by Mr. Allen H. Babcock before the Annual Meeting of the American Society of Mechanical Engineers, December, 1915.

He says, in part: "While the method described by the author may be considered novel, it is by no means rational, since to impurities already present in the boiler feed there is being added more impurities, so that the final effect is to increase the impurities in the water in the boiler without any compensation in the way of removing or freeing the water from suspended matter.

"The application of precipitants to water within the boiler is irrational and at the best is a mere makeshift. In the process of generating steam nothing but pure water is evaporated so that there is a constant building up of impurities in

the water remaining in the boiler. This applies to soluble salt as well as the suspending matter.

"When the reactions for the precipitation of lime and magnesia are carried on within the boiler the result is to befoul the water with suspended matter and increase its density with soluble salts, so that more fuel is required for the generation of steam and a more frequent changing of the water to eliminate the soluble solids, as well as the suspended matter collected."

This required frequency of blowing down becomes very expensive and in time may exceed the savings expected from the treatment of the feed water.

Mechanical Scale Removal from the Boiler.—This then brings us down to the removal of the accumulated scale by mechanical methods. There is every reason to believe that the large power plants and central stations have adopted the most modern and economical practice in this portion of their boiler room procedure. These people have staffs whose duty it is to develop the plant efficiency to its highest point.

It has been the speaker's experience that every one of these large central stations is using mechanical methods of scale removal. The advocates of internal chemical treatment argue that by allowing the scale to accumulate the efficiency of the boiler is gradually dropping until the boiler is again cleaned. Engineers of experience believe this method of handling is far more economical than to concentrate the feed water by the addition of impurities to those impurities already in the water.

The engineers of the Babcock & Wilcox Company have made extensive and intensive study on the subject under discussion. Their conclusions are partially outlined in the following quotation from "Steam":

"It is necessary that in each individual plant there be a basis on which to judge the cleanliness of a boiler. It is, of course, impossible to keep boilers absolutely free from scale at all times, but experience in each individual plant determines the limit to which scale can be allowed to form before tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, the operatives should be impressed with the danger of allowing it to be exceeded."

It will be readily appreciated from the foregoing that the dense hard scale will form the most rapidly in that portion of the tube surface which is subjected to the highest temperature of the gases. This portion of the boiler is naturally found in the lower four or five rows of tubes in the first pass.

The practice of the large central stations consists of the frequent cleaning of these bottom rows together with three or four of the upper rows at each time. In this way the entire boiler is cleaned at least twice a year while the lower rows are cleaned every thirty to sixty days.

It but remains to bring to your attention a few requisities in connection with mechanical cleaners. The cleaner should be so designed and constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost to operate and should require a minimum of expense to maintain and repair, working with absolute safety to the boiler and operator.

Without reviewing the history of tube development to the present high standard, I would call to your attention that three methods of driving mechanical cleaners present themselves, i.e., air, steam and water. Where the plant is equipped with compressed air in sufficient quantities and pressure, the air driven cleaner is preferable. Failing in this steam may be used. The majority of plants have water at sufficient pressure, either from the feed or fire pumps,

TYPE OF CLEANER

to enable them to operate a water driven machine if compressed air is not installed and the plant conditions prohibit the use of steam.

A description of machines which will meet the requirements outlined above may not be out of place. The cleaners in question were designed by Mr. P. J. Darlington, a pioneer in the development of the air driven machine, although not now connected with the trade.

The action of the cleaner depends on the cutters being thrown out against the scale by centrifugal force. Inasmuch as centrifugal force depends directly on rotative speed the interior of the machine is designed for high speed over long periods. An examination will reveal a single steel blade, at all times subjected to the pressure medium. This blade is fitted to an eccentric cylinder bore which is necessarily out of round. The relation of the metals in blade and cylinder are as dictated by good engineering practice. A small portion of the blade's rotation utilizes the expansion of pressure medium.

Straight edged ports are provided for admission and exhaust, giving clean, quick action. The bearings are full, generous and placed far apart, insuring ease of running, smoothness of action and long life. At the air inlet end where it is hard to supply lubrication a roller bearing is furnished. The body of the motor is of bronze, giving lightness, while hardened steel wearing rings are provided where the motor slides against the tubes. This motor is furnished in two different strengths—one twice that of the other and may be driven by steam pressure as well as air.

The water driven motor has its bearings in one long inner shell, held always in line and away from the great mass of water operating the machine. The nozzle plate located at the extreme outlet end of the motor directs the water to a turbine wheel which, being shrouded, compells each drop of water to deliver all the work stored up in it before it is discharged into the boiler tube. No back pressure being present, the maximum efficiency is obtained. The body is of light bronze construction with steel wearing rings.

The parts of both types of motor are designed and constructed, having the purpose in mind for which they are intended. The bodies of the motors are made as large as possible and still permit the cleaner to pass through the tube. In fact so large are they that they act as tube gauges and the passage of the cleaner through the boiler tube is an assurance that it is clean.

With both air and water driven cleaners a swing frame head is furnished, so designed that three sets of cutters are thrown out against the scale. The arrangement is such that these cutters make contact with the scale and tube along a straight line. The cutters are so designed as to eliminate sharp points scratching or damaging the tube. Other cutting heads are furnished to meet peculiar scale conditions, each so designed as to properly do its work without damaging the tube.

Having secured efficiency through design and great rotative speed we find that this same speed and design enables the cleaner to quickly do its work—reducing waste boiler time and labor costs in cleaning.

In addition this excess speed and power, removing the scale quickly, allows the cleaner to advance rapidly, eliminating the necessity of the cutters laboring for long periods in one spot, cutting scale at the bottom of the tube and working against the uncovered tube at the top. This feature in addition to the design of the cutting head with its parallel action insures freedom from tube damage. This is particularly desired in cleaning fuel economizers incorporating cast iron tubes.

It but remains in closing to state that the conditions outlined as pertaining to boilers likewise hold for fuel economizers, condensers, evaporators and other tubular and pan mechanisms used in the power plant and chemical industry. Mechanical cleaners properly designed may be obtained for each size and type of mechanism which it is desired to clean.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

D. C. Generators

IF one examines the field windings of direct current generators or motors, three different types will be observed, the field may be wound with comparatively coarse wire of few turns, with a large number of turns of fine wire or a combination of both may be employed. These three windings are different in character and produce different characteristics in the operation of the machine to which they belong.

Fig. 1 illustrates what is known as the shunt winding. It will be seen that it consists of a large number of turns of fine wire, the free ends of which are attached to the brushes of the machine. The external leads leading away from the machine, whether dynamo or motor, are also attached to these same brushes. The full voltage of the machine, if a generator, is available for sending current through the field coils. If we consider the case of the shunt wound generator first, as in all dynamo-electric machinery the generation of current is first started by the action of a certain amount of residual magnetism, present in the field magnets no matter how soft the iron. This generates an extremely weak voltage which, however small, causes current to flow through the field coils and thus creates a magnetic flux which in turn increases the generated voltage. The action is cumulative and the voltage rapidly builds up to a value fixed by the characteristics of the machine. It should be noted that a shunt wound generator should always be started up under no load, that is with the

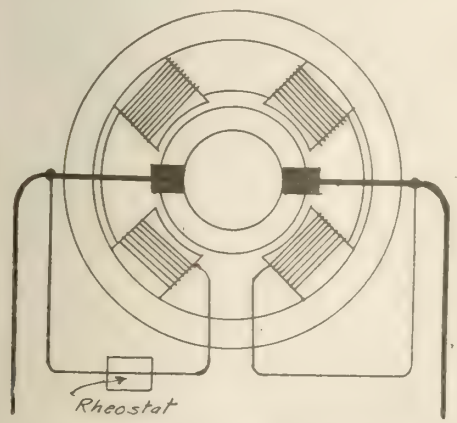


FIG. 1—SHUNT WOUND GENERATOR

exterior circuit to motors, lamps, etc., disconnected or open, for if it were closed the initially weak voltage generated would cause current to flow through the load as well as through the field and so doing would delay the building up of voltage or prevent it altogether. In the shunt dynamo field circuit is usually placed an adjustable resistance or rheostat for varying the voltage of the generator. Assuming the speed to be constant if more resistance is cut into this circuit the current through the field coils is lessened and the magnetic flux decreased in consequence. Since armature conductors are rotating at the same speed they will not be cutting as many lines of force and in consequence the voltage of the machine will automatically fall off. On the other hand if the rheostat be cut out the field current will be increased, more flux will

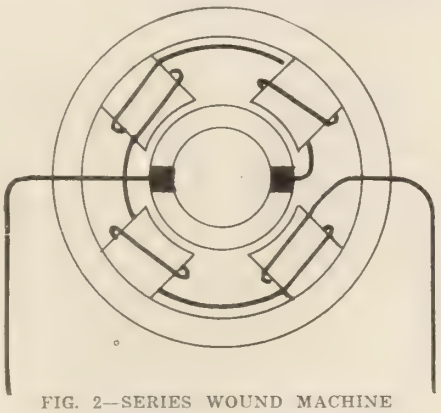


FIG. 2—SERIES WOUND MACHINE

pass across the air gap and in consequence the voltage will be raised.

Fig. 2. shows how the voltage varies with increased load on a shunt generator. The load is represented on the horizontal line at the bottom, while the voltage generated is shown to the left. With increasing load the voltage drops slightly for the first part of the curve as shown. For instance, at no load, the terminal voltage of the machine chosen will be about 120 volts and at a 25 ampere load it will have fallen about 2½ volts. At 30 amperes it will only be about 115 volts, while at 52.5 amperes, a voltmeter across the line would only register about 100 volts. From this point on in this particular instance the voltage drops off with increasing rapidity until when the machine is short-circuited only about twelve volts will flow.

The reason for this voltage drop is seen in the comparative resistance of the field circuit to that of the exterior or load circuit. At no load the field circuit is the only path through which the current generated can flow and full voltage is available for this purpose. As a load is applied the resistance of the load circuit falls off and that of the fields remains stationary. More and more current flows through the exterior circuit and less through the fields until with a dead short across the brushes the field coils carry no current whatever and thus generate no magnetic flux. The small current flowing at this period will only be that due to the residual magnetism inherent in the iron of the fields. This feature of the shunt-wound machine fits it for certain uses since it can never be overloaded to any great extent. Shunt-wound machines find considerable use in storage battery charging, being the only suitable form for the purpose. In ordinary practice the voltage generated is controlled by a field rheostat and a fairly constant voltage over a considerable load range can thus be maintained.

The Series Generator

As will be seen from Fig. 3, the series machine has a few turns of comparatively heavy wire in place of the many turns of fine wire on the shunt machine. Two machines of similar design and of the same size, one shunt-wound and the other of the series type, will require the same number of ampere turns for field excitation. In the series type the product of the whole generator current flowing through the fields by the number of turns equals the smaller current of the shunt type multiplied by the larger number of turns. The series wound generator cannot build up voltage unless it is connected to an external load since there would be no current flowing through the fields and any voltage generated would be due to residual magnetism only. Consequently the no load voltage of the series machine is zero as compared to the shunt-wound machine whose voltage under similar conditions is at its greatest value.

It may be remarked that the series wound generator is very seldom met with in practice, although the series motor is an extremely useful type and one used very largely where large starting torque and variable speed are required.

The Compound Wound or Motor Machine

The compound wound generator or motor combines the characteristics of both shunt and series machines. It has a shunt winding composed of many turns of comparatively fine wire and a series winding of fewer turns but heavier wire. The compound-wound generator has both a shunt and a series field winding. As the current supplied by the generator to the external circuit increases, the current through the series field is also strengthened and this in turn causes an increase in the magnetic flux generated by the series wind-

ing. While this is occurring the shunt winding is taking less current as the load increases, just as in the shunt-wound generator and by proper proportioning the increasing strength of the series winding can be made to balance the decrease in the shunt and so maintain the magnetic flux constant. It is thus possible to maintain a constant voltage irrespective of the load imposed, as shown by the line a, b, in Fig. 2.

The series winding can be made relatively stronger than the shunt and when this is done the machine is said to be over-compounded. The magnetic flux in this type of generator will increase with increasing load and the voltage in consequence will rise. This characteristic

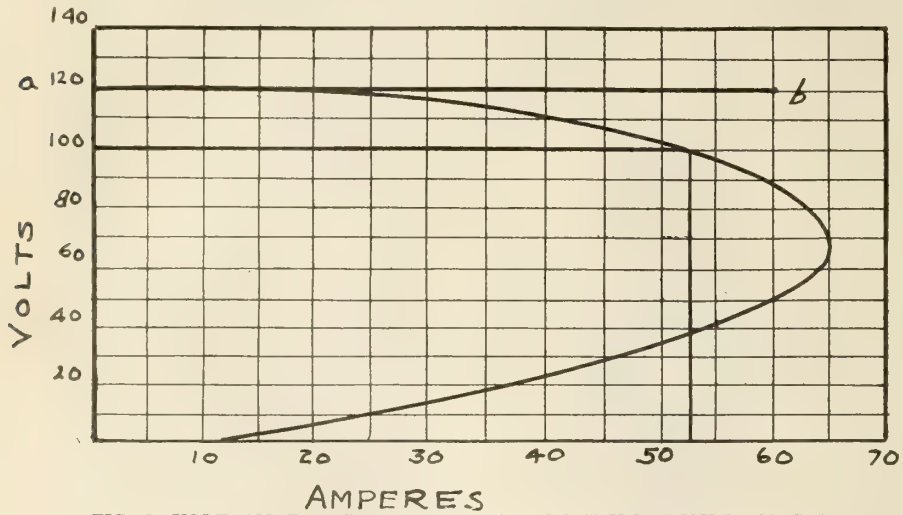


FIG. 2—VOLT AMPERE CHARACTERISTICS OF SHUNT WOUND MACHINE

is of use in the case of a d. c. generator feeding a transmission line, since it takes care of increased line-drop with increasing load and thus maintains the voltage constant at the receiving end.

If the series field is relatively weak the voltage will drop with increasing load and the machine is said to be under-compounded. It is possible to regulate the compounding effect of a generator by means of a resistance shunted across the series fields and by thus passing a certain amount of current weaken the series field.

It is also possible to have the series and shunt windings oppose each other. In this case the term differentially compounded is used, while if in a generator or motor the two windings assist each other, the term cumulative compounded is given.

D. C. Motors

It is a well known fact that a d. c. generator operates equally as well as a motor and it is sometimes of use to know what changes would be necessary if it be desired to make this change. The direction in which a direct current generator will operate if run as a motor can be quite easily determined.

It is well to remember that in the dynamo the armature conductors are pushed by the mechanical force applied from outside in a direction opposite to that in which they would go in a motor if the current in each case had the same direction. With this in mind, then, if the direction of the armature current and the direction of the magnetic flux through the machine both remain unchanged or if both are changed when the machine is changed from a generator to a motor, the direction of rotation will be reversed.

If either one of the above directions be changed, and the other remain the same, the direction of rotation will remain the same.

To reverse the direction of rotation of a motor either the direction of the armature current or of the magnetic flux must be changed, but not both.

If a shunt generator be changed to a motor it will run in the same direction as before, no matter which way the current enters or leaves it, for, if the polarity remain the same, the direction of the magnetic flux, due to the shunt

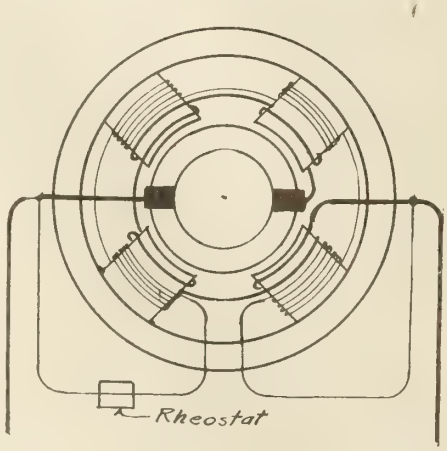


FIG. 4—COMPOUND WOUND GENERATOR

field will remain as before, while the direction of the armature current will be reversed and if the polarity be changed the magnetic flux will reverse in direction, while the armature current will remain unchanged.

This leads to the general statement that a shunt generator when changed to a motor will operate in the same direction regardless of the polarity of its terminals, if no change in connections has been made.

If a series generator be changed to a motor it will reverse in direction, for if the polarity is kept the same both armature and field currents will be reversed and if the polarity is reversed the armature and field currents will both remain as they were.

The compound wound generator presents a slightly more difficult problem when changed over into a motor, for it will combine the characteristics of both shunt and series motors and if a cumulative compound wound generator will become a differentially wound motor, and if it were a differentially wound generator it will become a cumulative compounded motor.

If a motor be connected up differentially it will present a curious phenomenon. It may start up under the influence of the series winding, and after the shunt field current has had time to build up in value the armature may stop and start to rotate in the opposite direction.

AIR BOOSTER FOR CENTRIFUGAL PUMPS

Two single-stage centrifugal pumps were sufficient to keep down the water at the Algoma mine, Ironton, Minn., when the flow increased owing to the cessation of pumping at an adjoining property, says H. H. Hunner in Engineering and Mining Journal. One pump was driven by a 75-h.p. motor at 1750 r.p.m., rated at 1290 gal. per min. against a 165-ft. head, and was pumping at approximately this head. The second pump was direct-connected to a 100-h.p. motor making 1750 r.p.m., and was rated at 1500 gal. per min., with a 170-ft. head. Suction and discharge for both pumps were 6-in. diameter pipes.

Elbows on the discharge pipes were tapped for 1-in. pipe connections about five feet from the pumps, connected to an air line, and the valves were slightly opened on a 90-ft. air pressure. The added pressure increased the capacity of the pumps by 200 or 300 gal., which was sufficient to take care of the increased flow of water. The small amount of air used was not noticeable on the air line.

HARDENING CONCRETE

Experiments by the United States Bureau of Standards to develop a method of accelerating the hardening of concrete, especially when it is to be used in wet or damp situations, have shown that 4 per cent. of calcium chloride added to the mixing water increases the strength of concrete at the age of one day 100 per cent. or more. In some cases in two days the strength equalled 75 per cent. or more of that normally attained in one month.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

HAVING discussed in previous articles the construction of the boiler, it will be in order to take up now the operating features of the furnace and boiler.

In an externally fired boiler, such as is generally used in stationary plants, the furnace is really a separate and distinct apparatus, apart from the boiler. The function of the furnace is to provide a proper receptacle for the efficient combustion of the fuel and the setting is to confine the products of this combustion to a certain path, in which is contained the boiler. The function of the boiler is to contain the fluid to be heated, and to transmit the heat from the products of combustion on the outside to the fluid on the inside. It is, therefore, quite evident that one may have a perfectly efficient furnace, and a very inefficient boiler, or on the other hand a very efficient border, with an inefficient furnace.

Boiler efficiency will depend on the external and internal condition of the boiler shell, tubes, and all heating surfaces. It will also depend to some extent on design, in so far as that affects the circulation of the water. That, however, is a condition entirely out of the reach of the operating engineer, whereas the condition of the heating surfaces is entirely under his control. The careful engineer will therefore see that the fire side of heating surfaces is kept free from deposits of carbon, or soot, and the water side free from deposits of scale, grease, etc. The following experiment, carried out by Professor Durston, will illustrate what a very little deposit of grease can do in reducing boiler efficiency. A piece of tube, 2½ inches diameter, and .135 inches thick, was used for the test, and was first tried when clean, and next with a thin coating of grease on the water side of the tube. The decrease in efficiency was 11%, an average of several experiments.

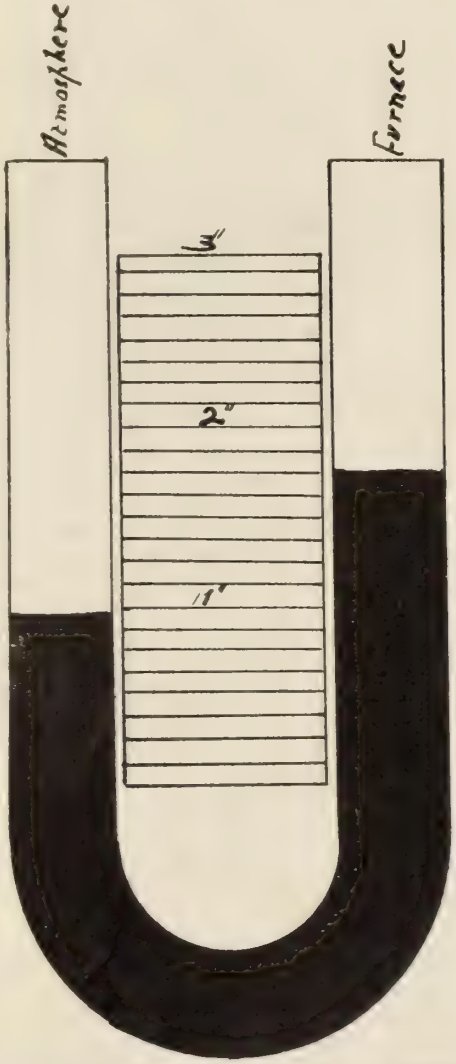
The accumulation of soot on the fire side of heating surfaces is also very bad, soot being one of the worst conductors of heat that can be found.

There is another evil connected with soot or sooty deposits on heating surfaces, which does not come into play while the boilers are operating, but is sometimes very active when they are shut down. There is often a certain amount of sulphur contained in this deposit, and when boilers are standing idle, and moisture is present, very favorable conditions for corrosion are present.

These conditions are, as we have said, entirely under the control of the man in charge, and he should watch them carefully, and keep them right.

Furnace Efficiency

Furnace efficiency depends on the construction and condition of the setting, type of grate bars, intensity of draft, and condition of the fuel bed. In the final analysis, the horsepower that can be developed by any boiler depends entirely on the number of pounds of coal that can be burned per square foot of fire grate per hour. This again depends on the physical condition of furnace and setting, and the quantity of air that can be delivered to the furnace.



DRAUGHT GAUGE SHOWING ¾-IN. WATER COLUMN

If natural draft is used, this will depend on the chimney. If forced or induced draft is used, the chimney then becomes merely an apparatus for delivering the gases, and not a means of creating draft. Whichever means are employed for securing the necessary air for combustion, the air should only be allowed to enter at points where it can be controlled. That is under the grate bars, and over the fire if necessary, through openings under the control of the attendant. Unfortunately, the whole boiler setting is susceptible to air leakage, and to keep it tight is a continuous fight on the part of the man in charge. Every opening where a pipe is brought through the setting is a potential leak, also the frames of cleaning doors, as well as the doors themselves. Unless the brickwork is covered with an airtight composition there is a certain amount of leakage, through the bricks themselves, which are porous. Every crevice where a connection can be made between the outside and inside of the setting is a menace to efficiency and should be guarded against. It is not difficult. A lighted candle passed around the setting wherever a leak is suspected will give sure indication of its presence, by the drawing in of the flame. This should be done very frequently, as little defects are constantly developing. There has been so much said on this subject that it seems almost a waste of time to mention it again, but the fact remains that many engineers do not even yet realize the importance of airtight settings. Every ounce of air which leaks through the brickwork of a furnace takes heat from the products of combustion, and carries that heat away up the stack. There is enough heat lost in that way which cannot be avoided, as we shall see later, without adding avoidable losses. Air leakage is then one great source of loss of efficiency. Over supply of air in the proper place is another, and under supply is still another. The first of these lowers the efficiency in the same way as air leaks do, while the latter affects efficiency through incomplete combustion. Perfect combustion can only be assured by the admission of the right quantity of air, and we will go into the methods of determining that quantity very carefully. Before doing so, however, we will obtain an understanding on the chimney and its relation to draft, that will help us in our consideration of the whole subject.

Meaning of Draft

Draft may be defined as the difference between the pressure of the atmosphere and that of the column of hot gases in the chimney. The force of this draft is usually expressed in inches of water,

and to make this clear we will show here what exactly is meant by 1 inch of water column.

The pressure of the atmosphere is 14.7 lbs. per square inch. This is sufficient to balance a column of water 33.8 feet in height. In other words, P or pressure is equal to the head of water multiplied by .434, or P=.434 H. Then

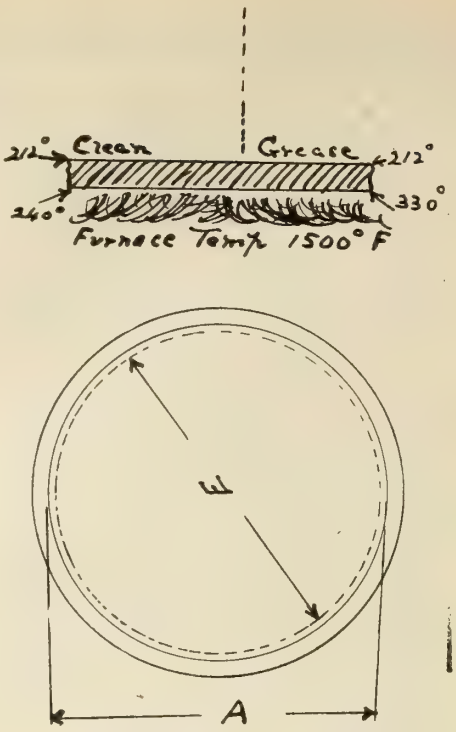
$$H=\frac{P}{.434} \text{ or } H=2.304 \text{ for 1 lb. pressure.}$$

That is a column of water 2.304 ft. high and 1 square inch in area is equal to 1 lb. per square inch pressure. Then 1 ounce per square inch will be equal to 2.304 ft. divided by 16. This is equal

$$\text{to } \frac{2.304\times 12}{16}=1.728 \text{ ins.}$$

Then 1.728 inches of water column is equal to 1 oz. pressure. Draft is usually expressed in inches of water because it is most convenient to measure in those units. There are numbers of draft gauges on the market which all have points of merit, but the ordinary U tube can be made in a few minutes by any engineer. All that is needed is a piece of gauge glass and a rubber tube. The glass is put in the flame of a gasoline torch and heated till it can be worked into shape by hand. A piece of rubber tubing is fitted over one end, and the loose end of this tube can be fitted over a pipe communicating with the space where the draft is to be measured. A length of a wooden rule is secured between the two legs of the U, and water is put in about half the height of the legs. As one end of the tube is free to the atmosphere, any difference of pressure is immediately shown by a difference of level in the water in the two legs, and the force of the draft in inches of water read directly from the rule.

The intensity of the draught is dependent on the difference between the density of the column inside the chimney and that outside the chimney and the height of the column. The density of the gases will depend upon their absolute temperature. Absolute temperature is found by adding 460 to the reading of the Fahrenheit thermometer or 273 to the reading of the Centigrade thermometer. As air is increased in temperature, it is increased in volume, and the column of gases in the chimney is very largely composed of air. There are, however, other gases present, such as carbon dioxide, carbon monoxide, and slight traces of other gases. These will make some slight variation to the specific heat of the gases in the chimney and therefore affect the volume at different temperatures. However, we do not have to go into this question as these matters have been dealt with by Rankine and others, who have given us the result of their labors. All we have to do is to apply the formulae they have given us. The following formula, deduced by Rankin, gives



TOP—EXPERIMENT ON PLATE.
BOTTOM—PLAN OF CHIMNEY

the force of the draught with a given height and density.

$$F=.192\ (D-d).$$

$$F=$$

Where F=force in inches of water. The factor .192 is used to convert pressure per square foot into inches of water. As density is reckoned in lbs. per cubic foot, the height or head would give pressure in lbs. per square foot. The factor .192 is obtained by dividing the pressure of 144 ozs. per square foot, which is equal to 9 lbs. per sq. foot, into the height of water column due to that pressure, 1.725 ins., or .192 ins. water column is equal to 1 lb. per square foot. The density of the hot gases varies with the absolute temperature, and can be found by dividing the absolute temperature at 32° by the absolute temperature of the hot gases, multiplied by .084. The density of the atmosphere is found by dividing the absolute temperature at 32° by the absolute temperature of the atmosphere, multiplied by .0807. Suppose we have a chimney 100 feet high and the outside air is 60, and the gases 600, we will have

$$F=.192\ h\ (D-d),$$

$$\text{Then } D=\frac{460+32}{460+60}\times .0807$$

$$\text{and } d=\frac{460+32}{460+600}\times .084$$

which works out to D=.076 and d=.038.

$$\text{Then } F=.192\ h\ (.076-.038)$$
$$=19.2\times .038.$$
$$=.72 \text{ inches.}$$

It must be remembered that these are purely theoretical formulae, and in practice results may vary considerably from them.

It has been found that the weight of gases discharged is a maximum when the absolute temperature of the hot gases, divided by the absolute temperature of the outside air, gives a quotient of 2 1-12. That is with the air at 60°, and gases at 622°, the result is

$$\frac{1081}{521}=2\ 1\text{-}12$$

This does not mean that the force of the draught or difference of pressure is greatest, but that the actual weight or quantity of gases is greatest.

The draught at the chimney base will always be higher than that over the fire, and it often occurs that when a large battery of boilers are attached to one stack, by a long breeching, the draught on the boiler furthest from the stack will be much less than on that nearest the stack. Restricted passages affect draught pressure in the same way that short bends and narrow openings in steam or water pipe affect steam or water pressure.

Calculations on heights of chimneys for any particular draught are apt to be considerably out, due to these conditions. Draught that may be adequate with a large size of anthracite will be useless with a small size of buckwheat.

Horsepower of Chimneys

The formula and table given here are from Kent's Hand Book, and may be accepted as good practice. In drawing up the table, a consumption of 5 lbs. coal per horsepower hour has been allowed, which is, of course, very high. The author, however has adopted that figure as a factor of safety to allow for worst conditions.

The area of the chimney is supposed to be diminished by a lining of gas which has no velocity. This is to allow for the friction of the ascending gases. The effective area of the chimney will therefore be the actual area less this 2 inches all round, and the formula for determining this is, if E=effective area.

$$E=A-.6\sqrt{A}$$

The horsepower varies directly as the area, and as the square root of the height. From this Professor Kent deduces the formula,

$$\text{H.P.}=3.33\ (A-.06\sqrt{A})\ \sqrt{H}$$

$$\text{and } E=.3\ \text{H.P.}\div\sqrt{H}$$

$$\text{and } H=\frac{.38.P}{F}$$

Suppose we have a plant of 2000 h.p. and the height of chimney is 175 feet, then the effective area will be

$$E=2000\times .3\div\sqrt{175}$$
$$=600\div 13.22$$
$$=45.38$$

Then actual area for square chimney would be

$\sqrt{E}+4$ inches=equivalent side

$6.73+.3=7.03$ feet side

$=49.43$ sq. ft. actual area

With H. R. T. boilers it is often the rule to take chimney area as 1-9 the grate area, irrespective of height. If we apply this to the last case, we may compare results.

$2000\times 15=30000$ sq. ft. heating surface

$3000\div 40=750$ sq. ft. grate surface

750÷9= 83.3 sq. ft. area of stack
With water-tube boilers
2000×10=20000 sq. ft. heating surface.
20000×40=500 sq. ft. grate.

Size of Chimneys for Steam-boilers.

Formula, H.P. = 3.33 $(A - 0.6\sqrt{A})\sqrt{H}$. (Assuming 1 H.P. = 5 lbs. of coal burned per hour.)

Diam. inches.	Area A. sq. ft.	Effective Area. $E = A - 0.6\sqrt{A}$ sq. ft.	Height of Chimney. 50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft	175 ft	200 ft	225 ft.	250 ft.	300 ft	Equivalent Square Chimney. Side of Square $\sqrt{E} + 4$ ins.
			Commercial Horse-power of Boiler.														
18	1.77	0.97	23	25	27	29											16
21	2.41	1.47	35	38	41	44											19
24	3.14	2.08	49	54	58	62	66										22
27	3.98	2.78	65	72	78	83	88										24
30	4.91	3.58	84	92	100	107	113	119									27
33	5.94	4.48		115	125	133	141	149	156								30
36	7.07	5.47		141	152	163	173	182	191	204							32
39	8.30	6.57			183	196	208	219	229	245	268						35
42	9.62	7.76			216	231	245	258	271	289	316	342					38
48	12.57	10.44				311	330	348	365	389	426	460	492				43
54	15.90	13.51					427	449	472	503	551	595	636	675			48
60	19.64	16.98					536	565	593	632	692	748	800	848	894		54
66	23.76	20.83						694	728	776	849	918	981	1040	1097	1201	59
72	28.27	25.08						835	876	934	1023	1105	1181	1253	1320	1447	64
78	33.18	29.73							1038	1107	1212	1310	1400	1485	1565	1715	70
84	38.48	34.76							1214	1294	1418	1531	1637	1736	1830	2005	75
90	44.18	40.19								1496	1639	1770	1893	2008	2116	2318	80
96	50.27	46.01								1712	1876	2027	2167	2298	2423	2654	86
102	56.75	52.23								1944	2130	2300	2459	2609	2750	3012	91
108	63.62	58.83								2090	2399	2592	2771	2939	3098	3393	96
114	70.88	65.83									2685	2900	3100	3288	3466	3797	101
120	78.54	73.22									2986	3226	3448	3657	3855	4223	107
132	95.03	89.18									3637	3929	4200	4453	4696	5144	117
144	113.10	106.72									4352	4701	5026	5331	5618	6155	128

For pounds of coal burned per hour for any given size of chimney, multiply the figures in the table by 5

SIZE OF CHIMNEYS.

500÷9=55.5 sq. ft. chimney area.
This rule then gives ample areas.
In general, it is better to be on the large side in area, as the area can always be checked by the damper.

Authorities differ as to whether it is better to have the gases pass through the setting with a high or low velocity. One school says that the high velocity gases scrub the heating surfaces, preventing a film of stationary gases from settling and forming an insulator. The low velocity school claim that with high velocities the gases do not have time to give up their heat, but go out of the stack at high temperature.

Every engineer can determine the point of damper setting at which he gets best results, at different loads, and, by noting the reading of his draught gauge, get a very good guide for his fireman to work to. A couple of hours' experimenting with a draught gauge, adjusting the damper to various points, and observing effects, will do a world of good without the help of any other instrument at all.

SEMI-ROTARY WING PUMPS

Prior to the war the manufacture of these pumps was very largely in the hands of German firms, but since that time British firms have been giving more attention to the production of these articles with a considerable measure of success.

A further extension of this manufacture is indicated in the announcement recently made that the well-known firm of William Beardmore & Co., Ltd., Parkhead Forge Rolling Mills, and Steel Works, Glasgow, have taken up the manufacture of semi-rotary wing pumps and are now in a position to fulfil orders for these.

Messrs. Beardmore are manufacturing these pumps in two different classes, the one being of a cast iron body with solid bronze fitttings, and the other of brass throughout.

Spindles in all cases are of high quality steel, and screwed pipe flanges are fitted to all pumps.

The firm intends to manufacture this pump in 12 different sizes and draws special attention to the complete accessibility for repairs, which can be carried out by removing the cover without disturbing the existing pipe line. The pumps are double acting and easily worked, can be operated either by hand or power, and can be used for lifting or forcing water, oil, petrol, and liquids generally.

SCREWED FITTINGS

The writer noticed in the October 20th issue of Power House an article headed "Screwed Fittings" in answer to an inquiry, stating that there is no rule limiting size of which screwed fittings may be used on working steam pressure to 125 pounds.

Wish to advise this is an incorrect statement. As contractors, we are obliged to instal work of this nature to the approval of the Government Boiler Inspection Department, who demand that all fittings on steam lines over 15 pounds pressure have flanged fittings on all piping 2½ inches or over.

We trust that this statement will be corrected in your next issue.

Yours very truly,
GRINNELL COMPANY OF CANADA, Limited.
A. E. CLARK, Heating Engineer.

Editor's Note:—The answer was to a correspondent from Quebec, where there is no such law, as far as we know. In our answer we recommended the use of flanges in pipe over 2½ inches diameter, for convenience in installing and repairing.

MEETING OF THE W. A. M. E. E.

The Western Association of Mechanical and Electrical Engineers held their annual Grand Lodge convention in the city of Edmonton on the 4th, 5th and 6th of October last. A good time was spent, several important matters being discussed by the delegates present from various parts of the province. Among these important matters was the question of asking the Department of Education to organize through the Department of Technology instruction classes for stationary engineers, to be run on similar lines to the classes in mining instruction now run under the above department. It was the feeling of the engineers that the Steam Boilers branch of the Department of Public Works should draw out the syllabus of instruction for these classes in order that the instruction shall be of the greatest benefit to the engineers when writing for higher certificates. A committee waited on Mr. Ross, the Deputy Minister of Education, and Mr. Campbell, the director of technical education, with this request and were assured that the department was in every way favorable to the idea.

What is Supersaturated Steam?

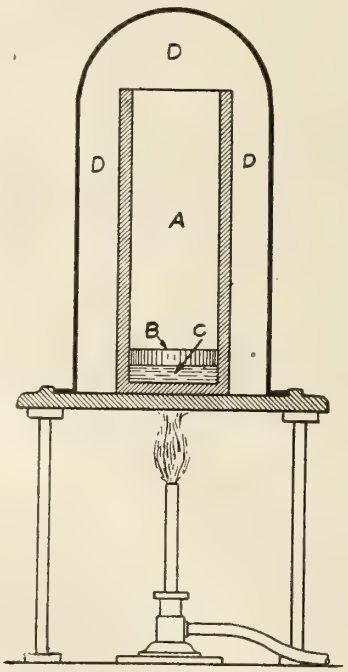
THE following article, which gives a very clear definition of the term "supersaturated steam," is reprinted from the Locomotive, a little monthly published by the Hartford Steam Boiler Insurance Co. The article seemed to us to cover the matter so clearly that we pass it on to our readers, feeling it may help some one to a better understanding of a term much used, but not always clearly understood.

The terms "wet steam," "dry or saturated steam" and "super-heated steam" are so familiar to every one who has but a slight acquaintance with water and its vapor that it would seem unnecessary to say anything further in regard to them. But now that we are hearing a good deal of the term "supersaturated steam," indicating, as it does, a condition of vapor somewhat unique, it may be well, before we discuss this condition of steam, to hark back to some first principles.

Let us suppose that we have an apparatus as shown in fig. 1 which consists of a cylinder A which has a piston B of an ideal nature such that it fits the cylinder perfectly and yet will move with absolutely no friction. Its weight is such that it will exert a pressure of 14.7 pounds on each square inch of the surface of the water C. We will suppose also that the water weighs exactly one pound. All the air has been exhausted from the surrounding space D so that the only pressure that can be exerted on the water will be 14.7 lbs. per square inch. By the nature of the arrangement the pressure will always be constant at 14.7 lbs. per square inch and cannot change as long as the piston is within the cylinder A. We will assume further that we have some means of supplying heat to the water as indicated in the sketch. If we start with the water at the temperature of 32° Fahrenheit and add heat to it the water will increase very slightly in volume, but will still remain a liquid until the temperature of 212° is reached. At this point, if we continue to supply heat, the temperature will remain constant at 212° and the water will begin to change from a liquid to a vapor. It will continue to follow this change with a very rapid increase of volume at a constant temperature until the water is all vaporized. When and just when the vaporization is complete the volume occupied by the vapor will be 26.79 cubic feet. Of course, to do this, our apparatus would necessarily have to be of somewhat different proportions than indicated in the sketch. We will now have in our cylinder one pound of dry saturated vapor. We will have in that space occupied by the vapor a definite number of molecules or particles of extremely minute size, although we shall not attempt to state the exact number.

If we continue to add heat to the vapor it will continue to increase in volume and it now also will undergo a temperature rise. It is no longer "dry saturated steam" but "superheated steam" and if we raise the temperature of it to 262° F. it will be 50° higher than when it was "dry saturated" and we would speak of it as being "steam at 14.7 lbs. and 50° superheat." Since the total number of molecules has not changed but the volume has increased it necessarily must be true that each cubic inch of the superheated vapor contains a smaller number of molecules than did a cubic inch of the saturated steam.

If now we cool the steam it will return to the dry saturated condition and if we cool it still further it will begin to condense and this condensation will continue until it returns to its initial condition of a liquid. In the condition in which it exists between dry saturated steam and a liquid it is known as wet steam or, more correctly, as wet saturated steam. This latter term, that of wet saturated, might appeal to us as incorrect. Actually, however, it is entirely proper. The steam in this condition consists of a mixture of a vapor and a liquid. The liquid may be present as a spray or mist or it may exist as one body of water. The vapor part, however, is still a dry saturated vapor. Each cubic inch of the vapor contains just as many molecules as it did when the entire pound was "dry saturated." This term, saturated, is a very good one. It means that we have put into a cubic inch of the vapor as many molecules as can conveniently be placed in that volume. In other words, we have saturated the cubic inch with water vapor molecules.



ILLUSTRATING HEAT ABSORPTION

Using the same apparatus we might have had a piston that would have exerted a pressure of 100 pounds per square inch. We would have found, under this condition, that the water could not exist as dry saturated steam until the temperature was raised to 327.8° F. For this steam to be superheated 50° the temperature would have to be 377.8° F. And in the same way we would find that for every other pressure that we might impose there would be a corresponding temperature for the dry saturated steam.

It is important to note that the temperature of the dry saturated steam and of the wet saturated steam is the same. The vapor and the liquid are both at the same temperature and, provided no heat is removed from or added to the mixture, they will remain indefinitely in the proportions in which they are existing. If 75% of the pound is vapor and 25% is liquid then the mixture is known as 75 per cent. "quality" steam. This condition of both vapor and liquid being at the same temperature with no tendency to change in relative proportion is known as "thermal equilibrium." There is no more tendency to heat to leave the vapor and enter the liquid and thereby vaporize that liquid than there is for heat to pass from the liquid to the vapor.

As a further illustration of what is meant by thermal equilibrium we may consider that we have a vessel filled with vapor at a given temperature and pressure. If we introduce some water the temperature of which is lower than that of the vapor into this vessel some of the vapor will condense until it has given up enough heat to raise the temperature of the liquid to that of the vapor. If the water is at a temperature higher than the vapor then some of the water will vaporize until the temperature of both becomes the same.

This idea of thermal equilibrium plays an important part in super-saturated steam. It might be said at this point that the condition of super-saturated steam is an unusual one in that it is a very unstable condition. While scientists long have known of the possibility of its existence it has not generally been supposed that it would be found in practice to any appreciable extent.

In order to appreciate this condition of supersaturation it must be fully realized that when we have thermal equilibrium the water vapor at any pressure must have a perfectly definite and easily determined temperature. Furthermore, if it is dry saturated, it will occupy a certain definite volume known as the Specific Volume. If it is 50 per cent. wet it will occupy very nearly 50 per cent. of the Specific Volume.

In investigating the conditions under which steam turbines operate it has been found repeatedly that if a pressure gauge and a thermometer are used to read the pressure and temperature of the steam in the exhaust passage the thermometer will read a temperature several degrees below the value corresponding to the pressure. If thermal equilibrium existed

no such discrepancy in readings could exist. The condition has sometimes been spoken of as "under-cooling" and this term is a very good one. As a matter of fact the vapor is lower in temperature than it would be under equilibrium conditions for the observed pressure. And yet it is a difficult matter to obtain the exact temperature of the vapor. The thermometer, if placed in a pocket where it will be protected from the rush of the steam, will soon be covered with a film of moisture due to condensation of the vapor. Condensation of the supersaturated vapor under these conditions will always occur because, as has been said before, this unique condition is a very unstable one. The vapor will always tend to return to a condition of thermal equilibrium with the condensate and the thermometer mentioned above will therefore read very nearly or exactly the temperature corresponding to the observed pressure. If, however, the thermometer bulb is exposed to the high velocity steam the film of moisture will be swept away and the molecules of vapor which are at the lower temperature will be given an opportunity to register their true value. Even this method of taking the temperature must give only approximate results.

While the above discussion of "undercooling" serves to bring out some remarkable facts concerning supersaturated steam it does not give us a conception of just what is meant by the term "supersaturation." An attempt will now be made to explain this term.

The conditions under which steam flows through a nozzle and the theoretical laws which govern this flow have long been known. These laws had always been considered very exact and absolute. It was thought that the actual flow of steam through a nozzle would have to be less than the theoretical on account of friction impeding the flow. When, however, tests showed that the actual flow of the practically dry steam used in the tests was greater than the theoretical it was realized that something unusual had occurred. At first it was thought that moisture in the steam was the explanation of the greater weight discharged. But when calculation determined that from 10 per cent. to 20 per cent. moisture would have to be present to give the results obtained it was realized that some other explanation must be secured. Since the weight discharged must be in direct relation to the number of molecules passing in a given time the only possible solution is that the vapor must carry more molecules per cubic inch under the actual conditions of flow than when the unit volume is "saturated" with molecules. In other words, the unit volume is "supersaturated." As an actual fact we do not know how many molecules it would be possible to crowd into a unit volume but we do know that only a certain definite number will stay there naturally and with this number in the unit volume the steam is saturated. Note that this is the only natural condition in which vapor will exist. While it may become supersaturated it will very readily and upon the slightest disturbance revert to the saturated state with consequent condensation of its excess molecules and when this change is effected thermal equilibrium will be established.

The subject of supersaturation is one that is demanding very close study by the steam turbine designer. The matter has been the more forcibly brought to the attention of engineers and scientists in this field by an article entitled "A New Theory of the Steam Turbine" by H. M. Martin in Engineering (London), Vol. CVI. Mr. Martin brings out the point that reciprocating engine design has been largely cut and try methods with theoretical considerations giving aid only in a most general manner. The varying conditions in different engines such as temperature changes within each cycle of operation, valve leakage and clearance have been most difficult of correlation between any given engine and a new design. It is true that theory has been largely by cut and try methods, possible but the gap between theory and practice has been a wide one. The steam turbine, however, has lent itself most favorably to theoretical design. Predictions of the performance of a given design have been possible to a remarkable exactness. Even here considerable experience has been necessary to determine certain correcting factors for discrepancies between theory and practice. Mr. Martin suggests that some of these apparent discrepancies may be explained by the fact that the steam is supersaturated during all, or very nearly all, of its passage from the nozzle to the condenser.

The variable quantities encountered in an investigation of this nature are many. It would seem almost impossible to develop formulae for use in design. Similar obstacles have arisen in the past, however, and sooner or later have been surmounted. It is therefore confidently expected that the investigators in this field will reach a complete and satisfactory solution of the whole problem.

WILL NOT PAY IF POWER IS CUT OFF

Toronto Firm Says It Is Almost Impossible to Go On Under Present Conditions

Following is copy of a letter sent to the Board of control of Toronto: "It is absolutely impossible to do business on this basis," stated the firm, "and unless some definite arrangement can be made we will have to shut down entirely. Our business is quite slack and we have cut down from 65 to 15 or 20 employees, and while we do not care to be obliged to handle it in this way, we would much rather have our power, say four days a week, and none at all the other three days. We should imagine that other companies would be in the same position. We are today advising our men that from now on we will not pay them for the time for which the power is cut off."

TO GUARANTEE THE COMPANY'S BONDS

Town of Paris to Lend Aid to the MacFarlane Engineering Firm

A proposition has been made to the Paris, Ont., Council by the MacFarlane Engineering Company for the municipality to guarantee bonds for the firm to the amount of $40,000. A committee appointed to investigate made a highly favorable report to a special meeting of the Council as regards the security offered. There were also present some thirty representative members of the Board of Trade, of whom a number spoke in favor of the adoption of the offer. On request of Mayor Patterson, a unanimous vote was passed to support the Council in the movement. A by-law has been prepared and will be submitted to the ratepayers early in December. The firm has already some 75 or 80 men employed, and it is confidently expected that within a few months after the passing of the by-law 200 men will be on the pay roll.

INCORPORATIONS

The Superheater Company of Canada, Transportation Building, Montreal, and with works at Sherbrooke, Que., has been incorporated to manufacture steam superheaters for all classes of service. The company is giving special attention to locomotive, marine and stationary equipment and have Canadian rights for manufacturing the "Electo" Superheater. Equipment for stationary power plants is designed to suit each installation and this is particularly true in case of stationary power plants, the superheaters being applicable to any type of water or fire tube boilers. Superheaters of the type manufactured by this company are now in general service in locomotive and marine and stationary plants throughout the world. The company uses a patented form of bending the tubing in its superheater which is termed a forged return bend which is formed from the metal of the pipes themselves without any autogeneous welding. This is also being largely sought after for use in various styles of pipe coils and condensers.

G. M. Arnold, for the past ten years Ontario's Government inspector of boilers, died in Toronto, and the funeral was largely attended. Mr. Arnold, who was very widely known and highly esteemed, had been previous to his government appointment for some twenty years with the Niagara Navigation Company.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)

A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, NOVEMBER 20, 1920 No. 22

PRINCIPAL CONTENTS

A Series of Articles on Power Plant Management	499
Increasing Conduction and Decreasing Fuel Costs	503
Theoretical and Practical Electricity	507
A Course of Instruction	509
What Is Supersaturated Steam?	512
Editorial	514
Operators' Point of View, etc.	515

A NEW CHAIRMAN APPOINTED

THE appointment has been announced of Mr. J. M. Brown, in succession to the late Mr. W. C. McGhie, as chairman of the Board of Examiners of Stationary Engineers for the Province of Ontario. The new chairman brings to the position qualities of practical and technical experience which should help materially towards his success in a situation which is more arduous than is sometimes thought. Mr. Brown is a native of Ontario, having been born in the town of Fergus. He entered the School of Practical Science of Toronto University in the year 1899, and graduated three years later. He entered the drawing office of Webster, Campbell & Lane, of Cleveland, which firm later became the Wellman, Siever, Morgan Co., and remained with them about one year, leaving there to enter the employ of the Westinghouse Machine Co., Pittsburgh. In 1908 Mr. Brown came to Toronto to instal the high-pressure turbines in the John Street Pumping Station, and after completing the installation remained for about one year with them. He then returned to Pittsburgh and remained with the Westinghouse Co. till 1914, when he went to the Nobel munition plant, installing and operating the steam turbines used there. From there he went to the East End station of the Dominion Power Co., Hamilton, again being connected with steam turbines, and remained in that position till his appointment to the Board of Examiners a few months ago.

In Mr. Brown and Mr. Mosely the Board have two men who know the engineer's problems from the viewpoint of actual experience. This is a good feature, both for the public and for the engineer who comes up for examination. He will be assured of sympathetic treatment, and will have the satisfaction of knowing that the men who are examining him know exactly what is required, and will not reckon his ability from a purely academical standpoint.

Adequate Boiler Inspection

IN an article published in the Toronto Star Weekly the Hon. W. R. Rollo has something to say on the subject of making labor safe. In connection with this, he states, there is a demand for the inspection of every boiler in the province, in addition to the insurance inspection. Mr. Rollo intimates that this demand among others will probably be met.

While we are entirely of the opinion that every boiler should be inspected, we can see no reason why a boiler owner who wishes to carry insurance should be penalized by two inspections. If he carries no insurance, then the Government should undertake the inspection in the interest of the public and at the owner's expense. Where the owner carries insurance, an inspection is made by the insurance company's inspector, who is generally, at least, as capable as the Government inspector. Getting a boiler ready for inspection is a matter entailing time and expense, and whereas an insurance company usually make their inspection fit the owner's convenience, this will hardly enter the Government official's mind. In many cases the insurance company make their inspection at a time when the factory is closed down, and the boiler opened up for cleaning in the ordinary way.

The Province of Quebec makes every insurance inspector carry a Government certificate of competency as a boiler inspector, and holds regular examinations for candidates for these positions. Having given this certificate, the inspector has all the status of a Government official as far as his reports and inspections go. Most large and many small concerns carry insurance for the protection it gives them. To compel them to submit to two inspections would be inflicting an unnecessary hardship.

"I Wonder if he Has Really Reformed?"

Gas Engine Drive and Turbine Pumps

The Pumping Work of a Large Dry Dock is Very Efficiently and Economically Performed by Gas Engine Running on Producer Gas, Showing the Possibilities of This Type of Prime Mover*

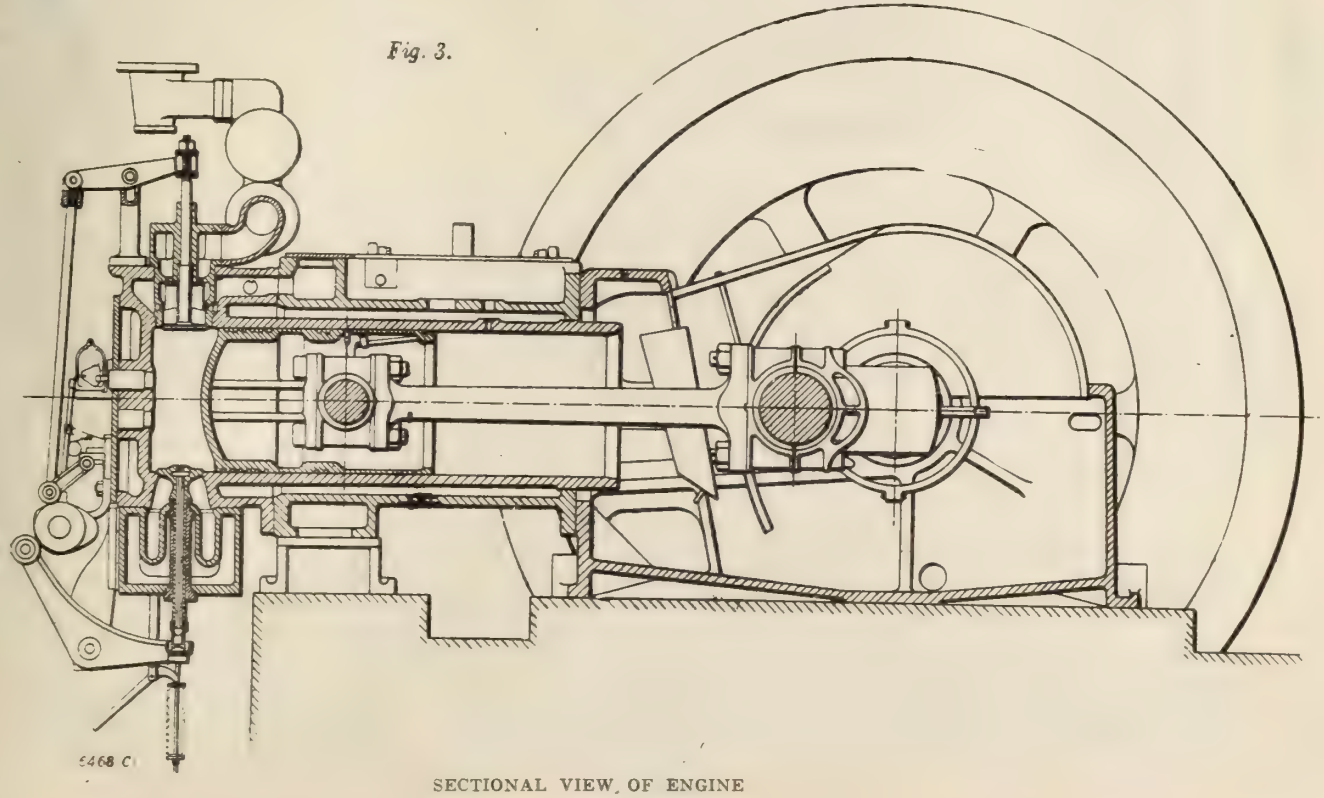
DURING a critical period of the war, the engineers for the Port of London Authority were called upon materially to reduce the time required to pump out the dry docks at Tilbury, which were then being used for the examination and repair of torpedo craft and other vessels for the Admiralty. It was recognised that the existing steam pumps had become obsolete and needed replacing. A thorough investigation was, therefore, made into the respective merits of centrifugal pumps driven either by "gas," "oil" (Diesel) or "steam" engines, and the decision was given in favour of gas engines to operate from producer gas, and using anthracite as fuel. Two sets of multi-cylinder gas engines were built and installed by the Premier Gas Engine Co., Limited, Sandiacre, near Nottingham (now associated with Messrs. Crossley Brothers, Limited, Manchester). Each engine is coupled directly through its crankshaft to a centrifugal pump made by Messrs. Gwynnes, Limited, of Hammersmith. By the courtesy of Mr. C. R. S. Kirkpatrick, chief engineer to the Port of London Authority, we are able to illustrate and describe this interesting plant.

A diagram of the performance of the pumps and a general lay-out of the installation are given in Figs. 1 and 2 on this and the opposite pages, while Fig. 3, on the opposite page, is a cross-section of one of the engines. As will be seen from these illustrations the engines and pumps are arranged in a deep pit, or chamber, forming an engine room with sloping walls. The general appearance of the plant is well indicated in the general views given in Fig. 4 and Fig. 5, on page 534. By sinking the pumps in this manner the suction is materially reduced, and under certain tidal conditions a drowned suction is obtained. This latter makes it possible to obtain the maximum efficiency for the centrifugal pumps. The water enters each pump through piping connected to large drainage culverts arranged below the engine-house floor, and in communication with the various docks to be de-watered. The Gwynne pump impellers are of the double-inlet type with shrouded vanes, smooth finished and carefully balanced. The charging of the pumps, when necessary, is effected by electrically-driven duplex wet vacuum pumps made by Messrs. F. W. Brackett & Co., Limited, Colchester. These pumps are gear-driven, the gear-box being so arranged that when the pumps are working on vacuum only, they operate at a speed of 92 r.p.m. When it is desired that the pumps should run pumping all water, the ratio of the gears is such as to obtain a reduced speed of 18 r.p.m. A charging pump is provided to each main centrifugal pump, these charging pumps being erected one at each end of the engine-house, as may be seen in Fig. 4 and Fig. 5.

Prior to installing the gas-driven pumping sets the engine-house contained four sets of steam-driven pumps, and the positions of the centrifugal pumps were determined by the existing delivery pipes, which pass through one side of the chamber and are connected with the open channel or discharge pit. Two of the four original pipes were made use of, and the remaining two were blanked off. The delivery from the centrifugal pumps is coupled with a large sluice valve which has a graduated indicator plate above, showing the exact amount of opening at the sluice valve. The opening and closing of this valve is operated by hydraulic pressure at 500 lbs. per square inch to 750 lbs. per square inch, and controlled by slide valves on the supply pipe from the hydraulic main. The sluice valves are each 44 in. diameter, being of the full-way wedge-gate type, made by Messrs. J. Blakeborough & Sons, Limited, Brighouse.

Referring now in more detail to the main pumping sets, it may be said that these consist of two "Premier" four-cylinder horizontal gas engines, each of 368 brake horse-power at normal load, and connected by a flanged coupling on the engine shaft to a Gwynne Invincible centrifugal pump. The speed is 200

Fig. 3.



SECTIONAL VIEW OF ENGINE

r.p.m. The gas-producing plant comprises three separate units, one of which serves as a stand-by. They were made by the Power Gas Corporation, Limited, of Stockton-on-Tees, and are of the "suction-pressure" type with the usual complement of scrubbing apparatus. The gasplant house is situated about 50 ft. away from the engine-house, their relative positions being shown in Fig. 2. The gas from the producer plant is drawn through the washers and coke scrubbers by an exhauster fan, which also forces the gas, at a pressure of a few inches, through the dry sawdust-scrubbers and into the gas main leading to the engine-house. Starting is by compressed air, and with gas ready at the plant, starting from cold to operation at full speed occupies less than five minutes.

In determining the pump capacity required, it was stipulated in the Port of London Authority's specification that both pumps operating together should be capable of de-watering the Tilbury Western Dry Dock in three hours, or with one set in six hours, when the dock contained 1,825,000 cub. ft. of water. In actual practice the volume of water in the dry dock depends on the height of the water in main dock. The following figures are interesting and show the results of careful tests made in this direction.

Test No. 1.—One centrifugal pump emptied the large dock in four hours 50 min., when containing 1,680,000 cub. ft. of water.

Test No. 2.—Two centrifugal pumps required 2 hours 40 mins. when the dock contained 1,639,000 cub. ft. of water, and working against the highest tide, 12 in. higher than T.H.W.

In the case of Test No. 1 this gives a discharge rate of 5,793 cub. ft. per minute—against a variable head of minus 1 to plus 29 ft. (30 ft. total). Test No. 2 gives 10,244 cub. ft. per minute against a variable head of 5 ft. to 33 ft. (28 ft. total). Fig. 1, annexed, is a reproduction of a pumping diagram showing the pump volumes, static and gauge heads, to which the plant had to conform. The chain-dotted line has been plotted from a large number of tests taken during the runing of the sets and represents the average actual volume of water pumped, with one pump only working.

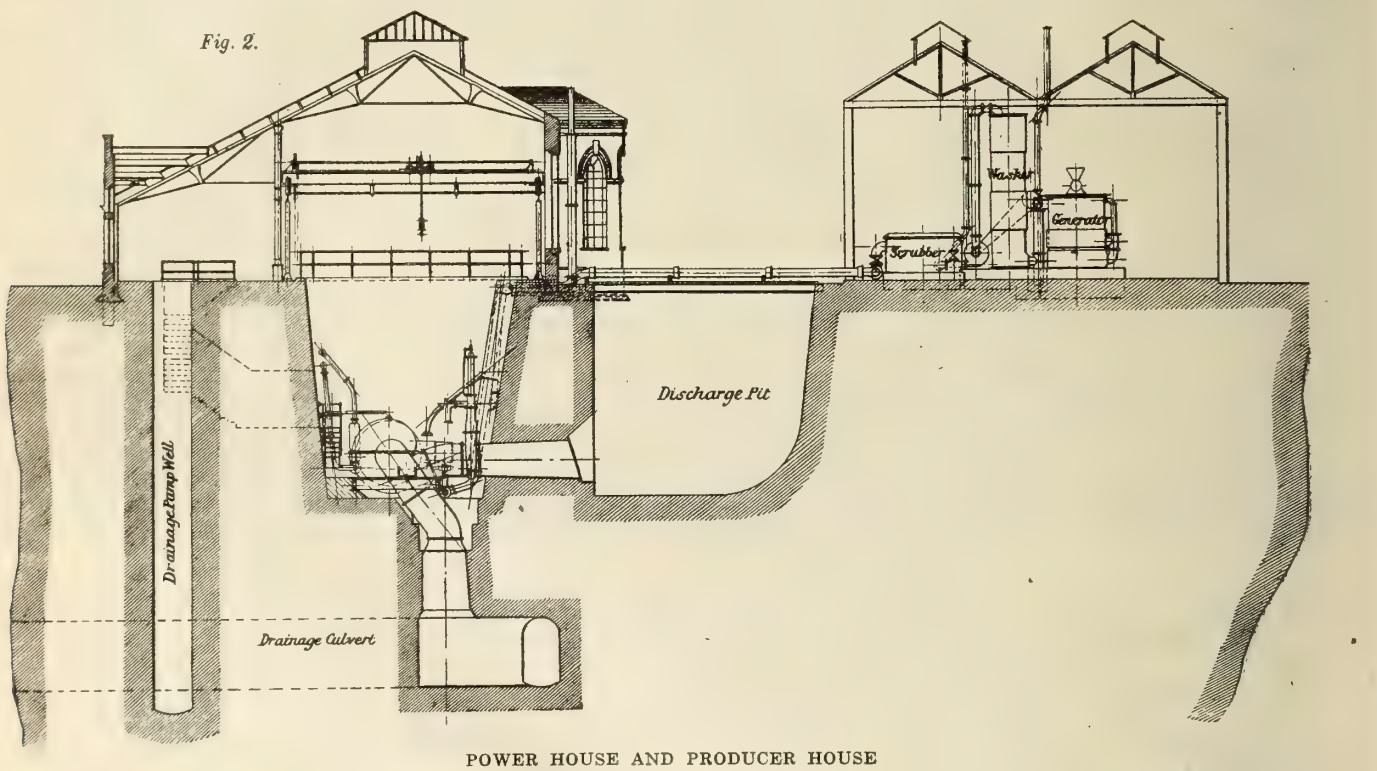
Mention has already been made that compressed air is used for starting the main engines. The air-compressing plant is by Messrs. Reavall & Co., Limited, Ipswich, and of the quadruplex cylinder type, belt - driven (using a jockey pulley) from a 10 h.p. electric motor. The sets are in duplicate, each compressor having a capacity of 36 cub. ft. of free air per minute. The air is delivered at a pressure of 200 lbs. per square inch into a riveted steel reservoir, which, as shown in Fig. 5, is carried on brackets from the engine-house wall. The cooling water circulated through the gas-engine jackets is provided by pumps driven from the end of the main centrifugal pump spindles.

In the "Premier" multi-cylinder gas engine the governor and side-shaft, shown in the foreground in Fig. 4, are on the free side of the engine, i.e., on the side away from the flywheel. The governor is of the enclosed centrifugal spring-loaded type, highly sensitive, and is directly driven by skew gears from the engine shaft. The governor controls the admission of gas by means of a central throttle valve and is actuated from a weigh-shaft and connecting-rod coupled to the governor lever. The gas after passing through the throttle valve enters a gas manifold pipe coupled to each of the four cylinders through the admission-valve cages. Air enters separately, so that the gas and air, forming a mixture, only unite inside each admission-valve cage and immediately behind the point of entry into the cylinder. In the event of an occasional back-fire occurring in any one cylinder, this does not disturb the mixture entering the remaining cylinders, and so the governing is not upset. The gas throttle is specially designed to ensure good control and made easily removable for cleaning purposes. In addition, an air throttle valve is provided to each cylinder, so that, if desired, the strength of the firing mixture can be separately adjusted for each cylinder.

The design and construction of cylinder, combustion-chamber, valves, and cam-operating gear of the engine are clearly shown in Fig. 3. As may be seen, the combustion-chamber is symmetrical in shape and quite free from pockets. The admission valve is large to ensure a full charge entering the cylinder. The exhaust valve, which is placed at the lowest point of the cylinder, is also of liberal proportions to ensure effective discharge of the products of combustion. The shape of the combustion-chamber is such that the clearance volume, when the piston is on the back centre, offers the minimum surface area to the cooling action of the jacket water—thus contributing to the thermal efficiency of the engine. Notwithstanding this, the water passages are ample and give effective cooling where it is most needed.

The design of the cylinder calls for special comment. It will be observed

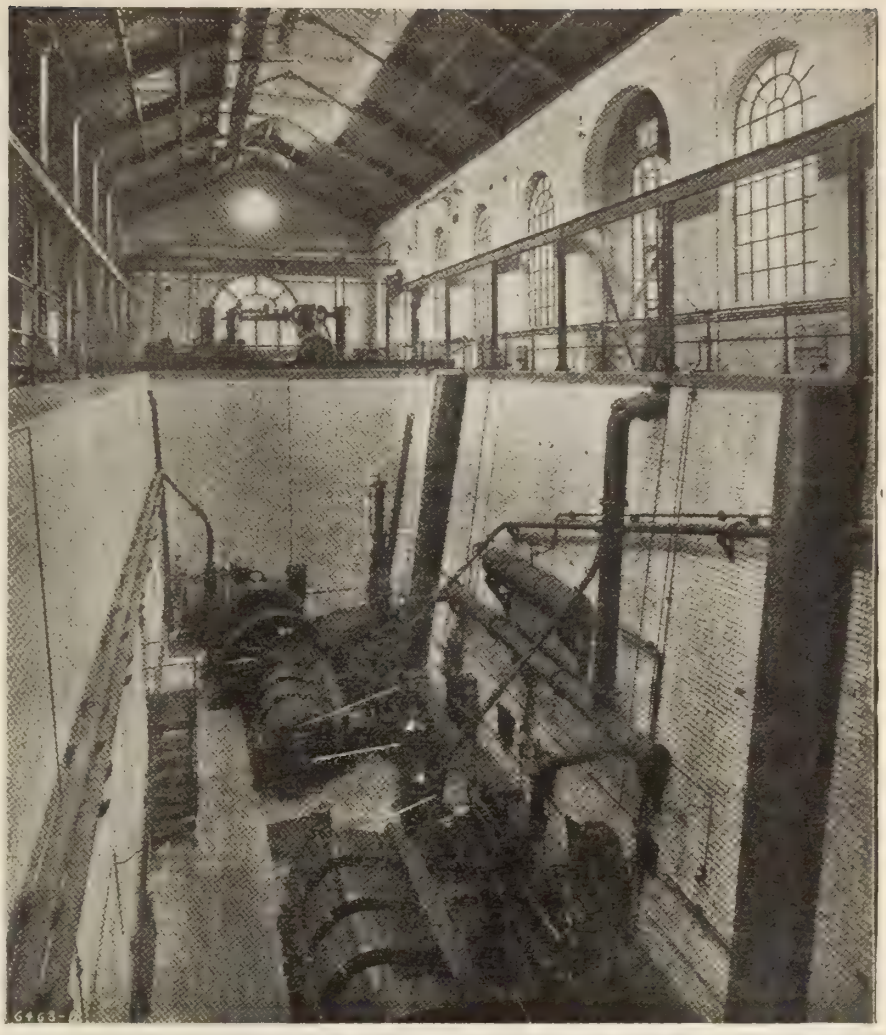
Fig. 2.



POWER HOUSE AND PRODUCER HOUSE

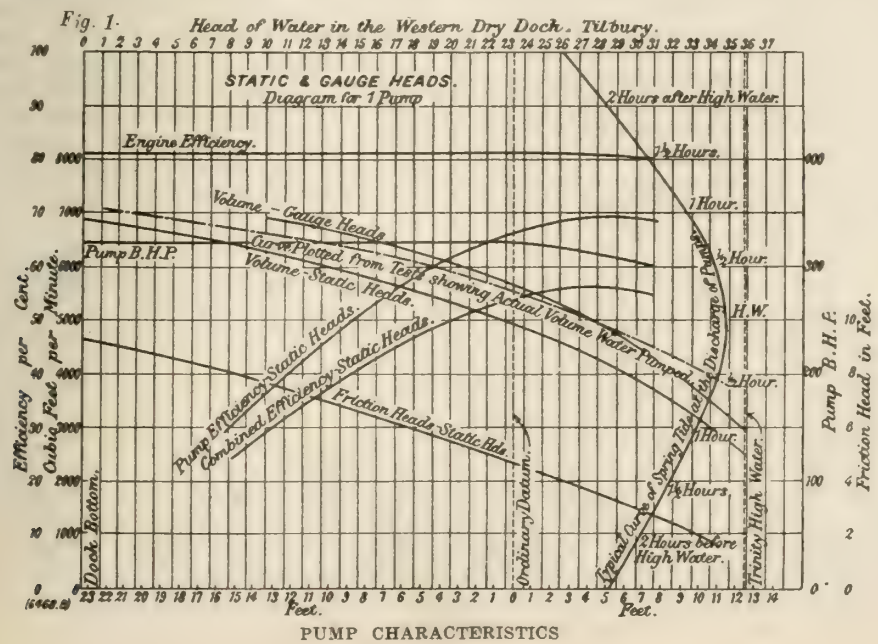
that this engine has no loose liner—such as is generally understood by that term. The cylinder and breech end are cast integral, and form one plain casting, thus dispensing with the liner joint which is by far the most difficult joint to make and keep tight upon a gas engine cylinder. The advantage claimed for a loose liner is that it can be made of specially hard close-grained cast-iron which is easily renewable when worn. Against this may be instanced the large number of worn liners directly caused by a faulty and leaking liner joint. With the "Premier" design as we have said there is no loose liner, but, on the other hand, the cylinder barrel with breech end form so simple a casting that this can also be made from close-grained metal to withstand wear, and be suitable alike for the cylinder-wall surface and exhaust seating. The back of the breech end is cast open, giving perfect access in the first place for the removal of cores and cleaning the casting. A large cover plate as shown is afterwards attached at the back, which allows for the free expansion of the inside walls when working under heat stress. As the result of this method of construction, cracked or broken breech ends are claimed to be an unknown quantity upon the "Premier" gas engines.

All valves are operated from a cam-shaft running in self-oiling bearings, arranged behind the cylinders and placed so that the breech-end cover-plate previously referred to, can be removed without disturbing the cam-shaft. The removal of the cover-plate affords perfect access to the interior of each water-jacket for cleaning away scale or sediment which usually forms around the hottest portion of gas-engine jackets. Each inlet-valve cage is complete with a gas valve and an admission valve, and fits inside a bored opening at the top of the cylinder. The seating is made with a metal-to-metal ground-in joint, so that the complete inlet-valve cage can be removed quickly. The exhaust valve is placed as shown directly below the admission valve, and is also readily removed through the same top opening. This exhaust valve is water-cooled by means of an internal pipe, passing up the hollow valve spindle, through which cold water passes directly to the head of the valve. Ignition is by low-tension magneto operated by eccentrics driven from the cam-shaft, the timing being adjustable whilst the engine is working. The ignition-plug is placed directly above the centre and at the back of the combustion-chamber, this being the best position to ensure perfect firing of the mixture. Immediately below the ignition plug-hole is arranged the opening for the compressed-air starting valve. The gear for starting up the gas engine by compressed air is fully automatic, consisting of a cam-operated distributing valve which admits compressed air to the cylinders at correct intervals. The gears operating both side-shafts and cam-shaft are of the skew type running in oil baths.



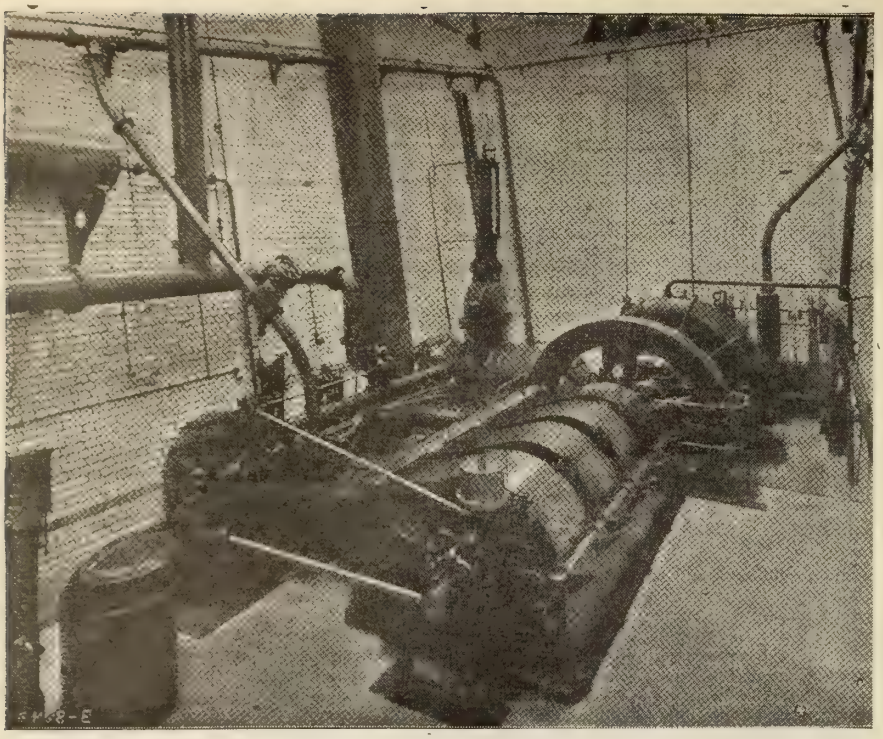
THE PUMPING PIT

Fig. 1.



PUMP CHARACTERISTICS

It has been stated at times that the enclosed type of gas engine arranged with forced lubrication is wasteful in regard to oil consumption. Certainly this does not apply to the "Premier" engine, and the engineer at Tilbury Docks testified as to the moderate quantity of lubricating oil used for all purposes on these engines. The supply is by means of an oscillating valveless pump driven



ONE OF THE UNITS

from the end of the side-shaft, the oil being delivered into boxes placed over each main bearing, and afterwards flowing through by gravity. The quantity of oil delivered into each box can be regulated by hand, and set so that the oil passing to the main and crank-pin bearings is not more than to meet actual requirements. Otherwise, with an enclosed engine there is some possibility of surplus oil lubricating thrown off from the connecting-rod ends, entering the cylinders in excess, and so getting past the pistons into the combustion-chambers, where it is wasted. Tests taken over a period of one month show that only 2-6 gallons of lubricating oil are used per 24 hours. This works out at the rate of 0.0024 of a pint per brake horse-power hour at full load. Part of this oil is recoverable after passing through a filter, and may be used again for shafting lubrication and the like. We are informed that careful tests over long periods show less than 3 cwt. of fuel is used per hour at the producer-gas plant per engine. This is approximately 0.9 lb. per brake horse-power at full load. Calculating the cost of this fuel at 50s. a ton, it works out at 0..24d. per brake horse-power hour.—Engineering.

TRADE GOSSIP

That Collingwood Plant.—The Collingwod Steel plant has caused a lot of worry to Collingwood town council and to many of the citizens as well. It was lately reported that the plant was to be scrapped and on Monday last when it was found that a couple of freight cars had been put on the siding at the plant, it looked as if this were so. The town immediately stepped in and attached the plant for taxes, $64,000, is the amount alleged to be due the town. The seizure was made and thus the movement of the machinery and equipment was staved off for a few days at least. The mayor went to Toronto to consult with the owners, and the result of the interview is not yet known. The plant is a big one and until a few months ago it was owned by Wm. Kennedy and Sons, of Owen Sound. The plant was in commission during the war and turned out a very large amount of steel for the making of munitions.

Better in Hamilton.—Except for the steel mills in Hamilton the coal shortage is causing no great worry there. The majority of the plants are able to get along during the summer without coal, using power to run the plants, says a Hamilton report. And as for the steel plant, officials there state that at present there is no probability of closing through lack of coal. The other plants, using the little they do, report that they are quite prepared for a shortage, and, unless the shortage happens in the winter, will not be seriously affected by it.

Brantford Needs Power.—There is considerable worry on the part of Brantford officials owing to the inability to secure Hydro power. It is pointed out that several new industries have been landed for Brantford, and are nearly ready for production, but the Hydro Commission will accept no more new customers, and power cannot be got. Ald. F. C. Harp, chairman of the Fire and Light Committee, declared that a special meeting of the City Council would be called shortly, and a fight would be initiated to secure a supply of power even if other interests had to suffer for a time.

Bought New Plant.—Messrs. Langslow, Ltd., Canadian branch of Langslow Fowler, Rochester, N.Y., are equipping a factory in Cobourg for the manufacture of all kinds of school furniture. The Canada Machinery Corporation report having secured the order for all of the wood-working machinery required.

Bought Part of Plant.—Part of the equipment used at the Polson Works, Toronto, has been disposed of, a large amount going to the A. R. Williams Machinery Co. They took in drills, slotter, planer, several large lathes, shaper, drills, gear cutters, etc. The plant is in liquidation and there is still more of it to be disposed of.

Starting New Business. — Holden-Morgan Co., Toronto, are remodelling their plant with a view of specializing on the rebuilding of automobiles. It is their intention to take in cars that have been more or less worn, and rebuild the worn parts, any make of car being taken. Some of the surplus machine tools that were used in the shop previously have been disposed of.

Deal Completed. — The change announced some time ago has been completed whereby the Whitman & Barnes plant, one of the oldest and largest industrial concerns in St. Catharines, has been taken over by J. H. Williams & Co., with plants at Buffalo and Brooklyn. The United States plant will serve the U.S. market, and the St. Catharines plant the Canadian and export trade.

Appointed New Officers.—At a meeting of the directors of the Federal Engineering Co., Ltd., November 3, 1920, Col. F. H. Deacon was elected president of the company. J. W. Campbell, who has been president of the company since its inception, resigned, as he has been living in California for some years. The other officers and directors of the company are: R. G. Black, vice-president; Lieut.-Col. H. L. Edmonds, secretary-treasurer; S. C. DeWitt, manager; A. A. Bowman and J. E. Murphy, directors.

PERSONAL

Mr. J. M. Brown has been appointed chairman of the Stationary Engineers' Board of the Province of Ontario, in succession to Mr. W. C. McGhie, deceased. The appointment was made by Hon. Walter Rollo.

The Owen Sound Board of Trade tendered a complimentary banquet to H. B. Smith, vice-president of the British Empire Steel Corporation, who recently removed from Owen Sound to Toronto. During the evening he was presented with an illuminated address from the Board of Trade and City Council.

Electrical Supplies

The PIERCE RENEWABLE FUSE is shown above. This illustration does not in the least exaggerate the simplicity of the Pierce Fuse—A blown Pierce Fuse can be renewed and put into the circuit in 15 seconds. It's a wonderful saver of time and trouble.

SQUARE D. SAFETY SWITCH—an absolute safeguard against shock, fire and accident of any kind. This is a simple knife switch, housed in pressed steel, with the handle on the outside where the current cannot reach it. The Square D. Safety Switch is made in a variety of sizes and types and capacities—for factories, office buildings and homes.

All electrical equipment sponsored by Fairbanks-Morse is of superior quality and design and insures efficiency, safety and durability in service.

Write to us for further information.

The Canadian Fairbanks-Morse Co., Limited

Halifax	Montreal	Hamilton	Fort William	Saskatoon
St. John	Ottawa	St. Catharines	Winnipeg	Calgary
Quebec	Toronto	Windsor	Regina	Edmonton
	Vancouver		Victoria	

FAIRBANKS-MORSE

Engineer Wanted

Applications for the position of Engineer in Charge of the Brandon Water Works Pumping Station will be received by the undersigned until November 27th, 1920. Duties to commence on or about December 1st, 1920.

Applicants must hold a first-class steam engineer's license, Province of Manitoba, and should be familiar with pumping machinery.

A residence with heat and light are provided in addition to salary.

Applicants will state salary asked, give an outline of their experience and name their references.

Further details regarding the position may be had from J. M. Begg, City Engineer, Brandon, or from W. M. Scott, Consulting Engineer, Winnipeg.

(Signed) HARRY BROWN,
City Clerk,
Brandon, Man.

Get Bigger Pay through ELECTRICITY

You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied.

Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

Signature_____
Occupation_____
Employed by_____
Residence_____
Reference_____

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

SITUATIONS VACANT

WANTED — EXPERIENCED BOILER DESIGNER by large manufacturing plant in Ontario. Apply Box 92120, Power House. (p12h)

WANTED—A1 GENERAL BLACKSMITH FAMiliar with mine and mill work; permanent position. Apply, mentioning "Power House," stating experience and wages wanted, to Moose Mountain, Ltd., Sellwood, Ont.

EMPLOYMENT DESIRED

STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers, Corliss and all classes of stationary engines compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St.

RETURNED SOLDIER — EXPERIENCED painter, electrician and elevator operator, or other suitable employment; desires work at once. Apply mentioning "Power House," to Pte. (163466) Ira Charles Winckler, 83 Carlton St., Toronto.

RETURNED SOLDIER WANTS WORK—ANY kind; used to steam heat boilers. Apply, mentioning "Power House," to W. Greenfield (33065), 34 Brock Ave., Toronto.

GREAT BARS

ALL STYLES TO ORDER—PROMPT DELIVery. The E. T. Lansdowne Foundry Co., 37 Niagara St., Toronto. Mention "Power House."

BELTING

4½—4-PLY NEW CANVAS STITCHED BELTing at 30 cents per foot. We carry a complete stock of belting, pulleys and mill supplies. Apply, mentioning "Power House," to N. Smith, 138 York St., Toronto.

LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto.

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont.

EQUIPMENT

BOILERS, SMOKE STACKS, HOISTING ENgines, rock drills, grey iron castings. Apply, mentioning "Power House," to Napanee Iron Works, Limited, Napanee.

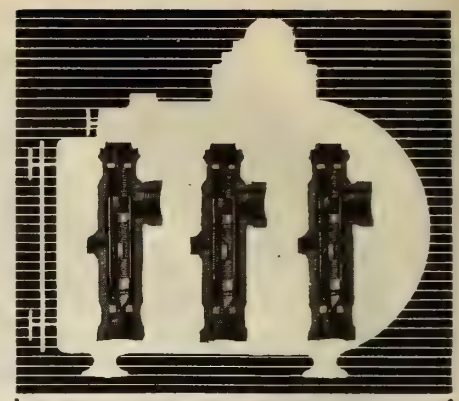
ENGINE PACKING, ENGINEERS' SPECIALties, pipe and boiler coverings, roofing. Apply, mentioning "Power House," to Eureka Asbestos Co., Toronto.

BOILERS AND POWER PLANT EQUIPMENT bought by the Henry Engineering Co. (Henry-Rumgay-McBryde), 71 Bay St., Toronto. Mention "Power House."

ROLLER BEARING FACTORY—DRY KILN, transfer, railroad and steamboat trucks, manufactured by the Corbet Foundry & Machine Co., Ltd., Owen Sound, Ont. Mention "Power House."

THE JOHN INGLIS CO., LTD., ENGINEERS and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention "Power House."

WE BUY IDLE EQUIPMENT OR MACHINery; call or write. Apply, mentioning "Power House," to H. W. Petrie, Ltd., Toronto.



3 Traps for Price of One

If you are willing to pay for mere *bulk,* you will surely get it in the cumbersome float or bucket trap with its impressive array of floats, levers, water gauges, bowls, toggles, packing and other superfluous parts.

But, if you are more interested in *results achieved* by a steam trap than in mere *size* of the apparatus—if you want *real* efficiency unimpaired by trouble-making mechanical contraptions, you will get exactly what you want *at one-third the price in*

STEAM TRAP SARCO

This is a *simple, compact* steam trap with all unnecessary mechanism eliminated. Therefore the Sarco occupies but a fraction of the space required by bucket or float traps. It can be installed at any point on the line without any change of piping. No platform, pit or support needed.

Steam Trap Sarco opens *promptly* to drain off the condensate—and closes just as promptly to prevent the loss of live steam.

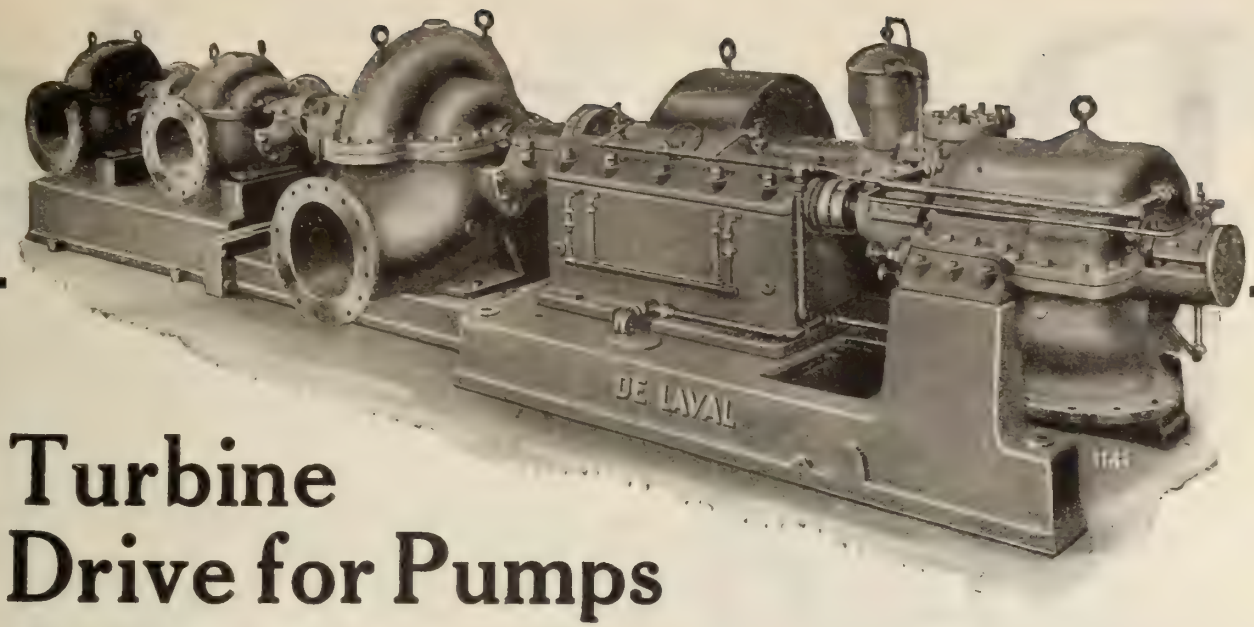
Made in sizes from ⅜" to 3", and is guaranteed for pressures up to 200 lbs.

It *insures* you of greater efficiency, and at the same time permits you to save two-thirds of your steam trap costs.

Send for Booklet J-12 and particulars about the 30-day free trial offer.

SARCO CO., INC.

239 Broadway New York City
Buffalo Cleveland Philadelphia
Chicago Detroit



Turbine Drive for Pumps

The De Laval Geared Steam Turbine has revolutionized pumping practice.

De Laval Geared Turbine-driven Centrifugal Pumps are to-day the most economical for practically all water supply purposes. Recognition of this fact in the municipal water works field has resulted in the installation of a very large number of De Laval pumping units, for all heads and all capacities up to 100 million gallons per day. Because of its (1) high efficiency, (2) comparatively small cost, (3) light weight, and (4) absence of vibration, which eliminates the necessity of heavy foundations, (5) small space requirements, reducing the cost of buildings, and (6) light parts, avoiding the necessity of heavy crane facilities, the De Laval Steam Turbine-driven Pump is able to show the lowest overall cost of handling water.

The same conditions apply to general service pumps, condenser circulating pumps, irrigation pumps, etc. The elimination of packings, valves and rubbing surfaces greatly increases reliability and reduces the expenses for attendance and repairs.

State conditions and recommendations will be made. Ask for catalog 100

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT COMPANY, LIMITED, 73 King St. W., Toronto. THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING COMPANY, LIMITED, Vancouver, B. C.

47

FOR SALE

125 H.P. gas engine
80 H.P. gas engine
2-40 K.W. 110 V. generators
(compound wound)

All in fair condition. Inquire
Erie Beach Amusements, Ltd.,
Morgan Bldg., Buffalo, N.Y.

IF INTERESTED IN WATER HEATERS
BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

H.W.PETRIE
LIMITED
Toronto and Hamilton

New and Used
Power Plant Equipment

Steel Tanks
Steam Engines
Automatic Engines
Vertical Engines

We handle only reliable lines. Through half a century of fair dealing, this fact has become traditional among the trade in Canada. Whether the equipment you purchase from us be new or used, you can be sure of long, reliable, efficient service.

Our tremendous stock of power plant equipment enables us to always fill your requirements. Let us tell you about the equipment in which you are interested.

Dependa

No mechanical stoker can be more dependable than its source of air supply. Both its efficiency and flexibility in carrying high boiler ratings, depend directly upon the ability of its forced draft equipment to deliver the proper amount of air at the right pressure.

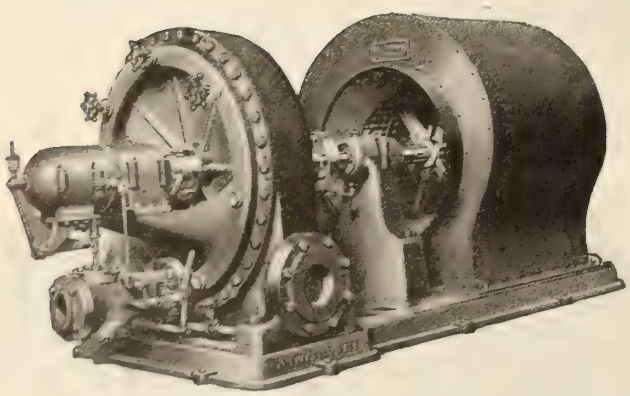
Sturtevant Forced Draft Apparatus

—covers every possible requirement from a small undergrate turbo blower to the most powerful types of forced draft turbine fans.

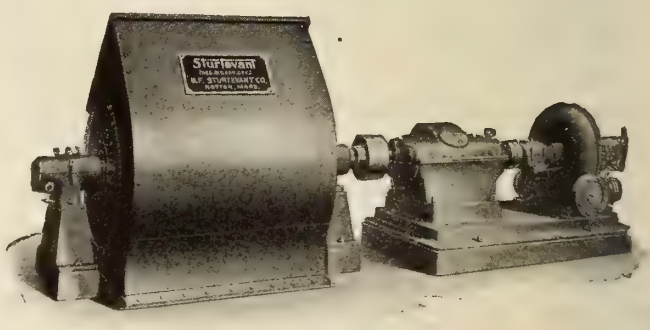
Designed and built by the pioneers in the field and the largest manufacturers of mechanical draft equipment.

Installed in the largest central stations in this country and abroad. Your special draft requirements will receive the consideration of our specially trained fan engineers who will recommend the most economical apparatus for your work.

Sturtevant
PUTS AIR TO WORK

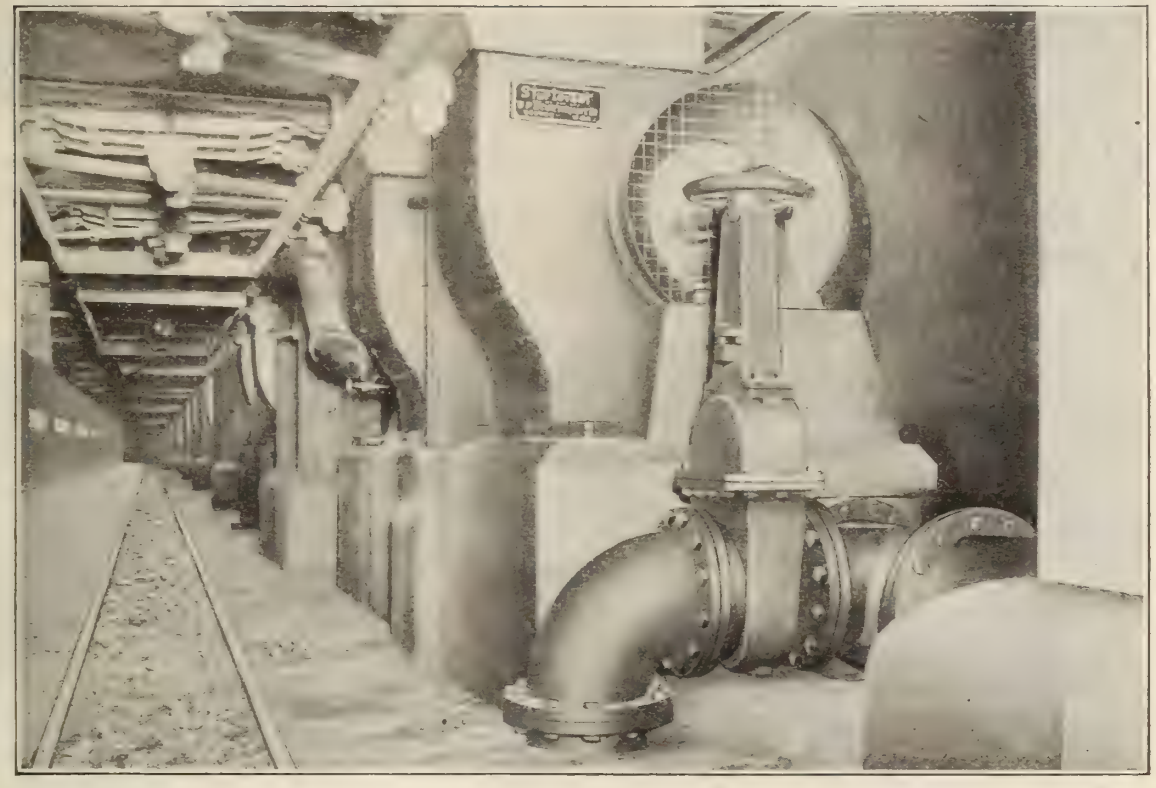


Sturtevant Direct-Connected Turbine Fan.



Sturtevant Turbovane Fan driven by Sturtevant Turbine and Reduction Gears

ble Draft



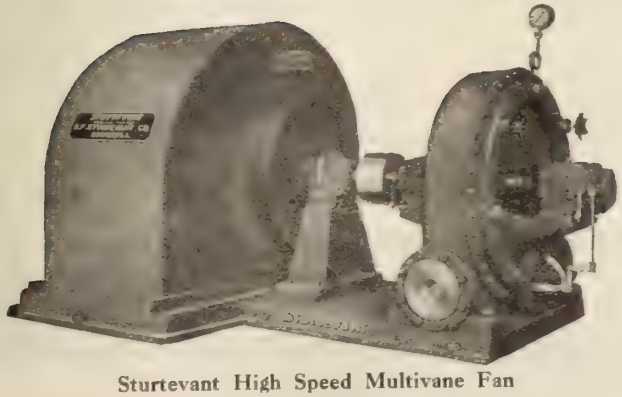
Installation of Sturtevant Turbo Fans at the 59th Street Station of the Interboro Rapid Transit Co., New York City.

Write for Catalog No. 236-P.

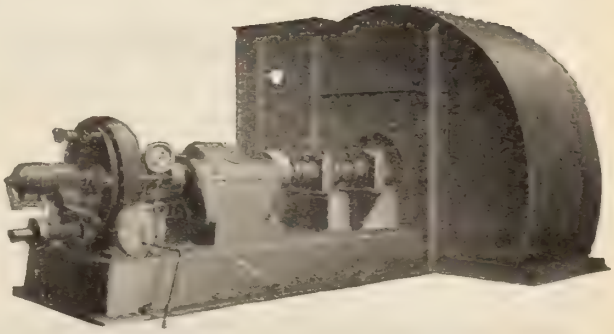
B. F. STURTEVANT COMPANY
OF CANADA, LIMITED

Head Office and Works - Galt, Ontario

Sales Offices : Toronto and Montreal



Sturtevant High Speed Multivane Fan



Sturtevant Induced Draft Fan driven by Sturtevant Turbine and Reduction Gear.

Low Upkeep

NORWALK AIR & GAS COMPRESSORS

Proof of quality in compressor manufacturing lies not only in original efficiency—but equally in the stamina which makes that efficiency permanent.

Wherever air or gas compressors are used the name Norwalk is accepted as a guarantee of long and troublefree service. Under all operating conditions the upkeep of a Norwalk compressor is slight, and its simple design and strength of construction make long life certain.

Write for Bulletins

on Norwalk Compressors for air, oxygen, hydrogen, acetylene and carbonic acid gas, one or all.

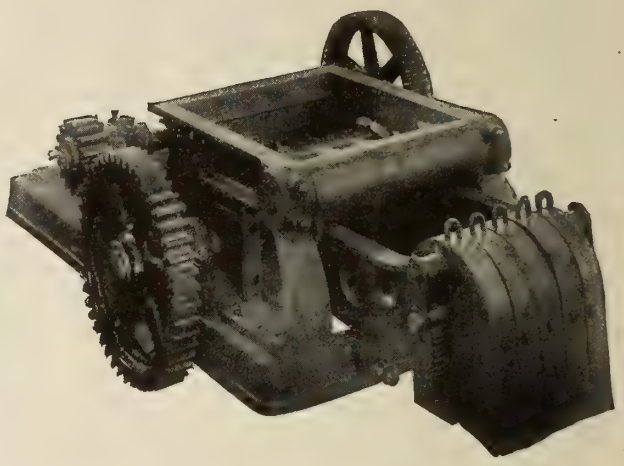
The Norwalk Iron Works Co.
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

A. S. Leitch Company, Toronto
Canadian Sales Representatives

MEAD-MORRISON
CANADIAN MM
Single Roll

COAL CRUSHER

Made in Canada



Capacity Single Roll Crusher, 50 to 70 tons an hour.

Capacity Double Roll Crusher, 100 to 150 tons an hour.

McCASLIN CONVEYORS
GRAB BUCKETS
SKIP HOISTS
COAL HANDLING MACHINERY

Dependable Service

AGENTS:
Harvard Turnbull, Toronto.
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.
Ferguson and Palmer, London, Eng.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Grey Iron Castings

We are ready to give prompt service for Grey Iron Castings, and size up to 15 tons. 35 years of experience and every modern facility to help us.

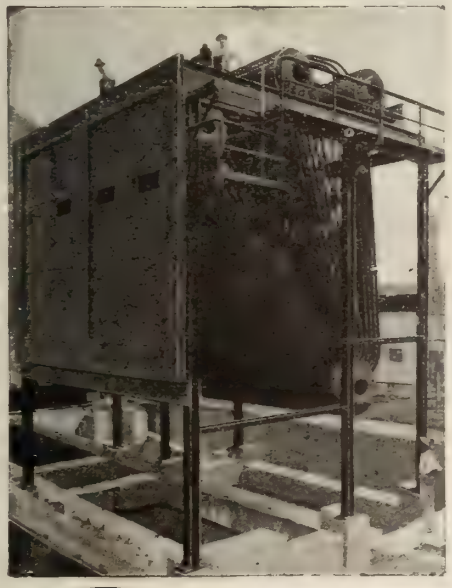
Boiler Sizes Ready

Subject to prior sale of materials we offer shipment of the following (and smaller) sizes—72" x 18', 72" x 16', 66" x 16', 66" x 14'.

Engineering and Machine Works of Canada, Limited

St. Catharines, Ont.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal



Connelly Water Tube Boilers (Patented U.S. & Canada)

are of the 4-drum type: have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no hand-holes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. Leonard & Sons, Ltd. Head Office and Works:
LONDON, CANADA

Branches :

1790 St. James St., Montreal, Que. 62 Water St., St. John, N.B.

86th Year

AGENTS

E. J. Philip & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. John's, Nfld.

LEONARD

HINTS TO BUYERS

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

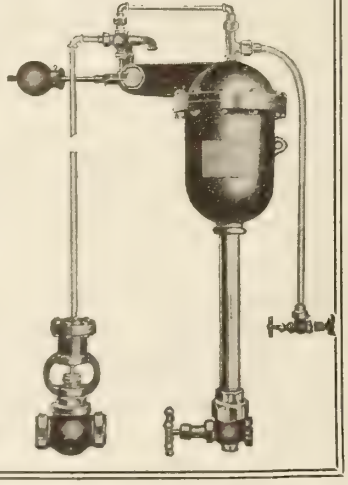
VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

Tuck's Genuine Packings
Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.
Insist Upon Having the TRADE CAOUTCHOUC JHC TRADE MARK Packing Bearing Our MARK
TUCK & COMPANY, LIMITED
London Liverpool Cardiff, Etc.
Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
All Sizes Stocked in Montreal

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE
THE E. S. MANNY Co
27 COTE St MONTREAL, QUE

PROTECT YOUR BOILERS
VIGILANT
Water-Feed Regulators
will absolutely safeguard your boilers. The VIGILANT is the pioneer automatic feed water regulator in this country, and it has remained at the zenith ever since their invention. They ensure dry steam for your engines—prevent accidents to the boilers from low water — prevent flooding of engines—lessen repairs to boilers from leaky tubes — save fuel — insure more uniform operation of feed pumps, heaters, etc.
Write for our latest instructive catalog to-day.
The Chaplin-Fulton Mfg. Co.
28-34 Penn Avenue, Pittsburgh, Penn.
Also Manufacturers of the Fulton Pump Governor



CRANE MALLEABLE FITTINGS
CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver
SALES OFFICES: Haifax, Quebec, Ottawa, Calgary

Largest manufacturers of white metals in the world
Solder
Wire Solder
Ingot Metals
DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings
Lead Wool
Lead Sheets
Lead Traps
and Bends
HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

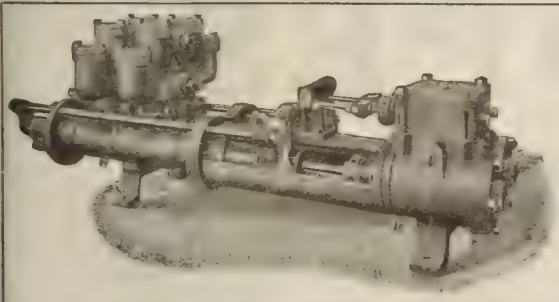
S. & C. BISHOP & CO., St. Helens, Lancashire.

LADD
WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

THE GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN., U.S.A.

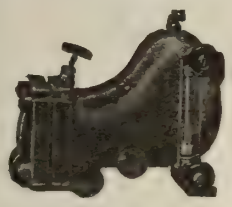


PUMPS
that give
Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

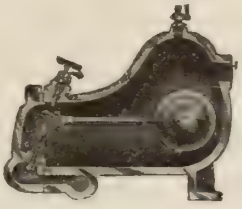
The Simplest and best cleaner on the market is

PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

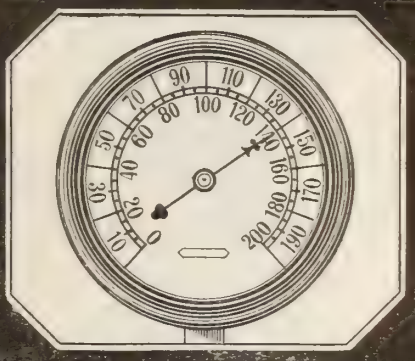


McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



Send for Catalogue
THE GARTH COMPANY
26 Craig Street. MONTREAL, CAN
WATSON & McDANIEL, CO.
No. 146 N. 7th St., PHILADELPHIA. Pa.



Keep Up Steam Pressure by Shutting Out Cold Air

The inleakage of cold air through furnace walls records its effects on the gauge.

BETSON'S PLASTIC FIRE-BRICK prevents this leakage. It forms a monolithic wall, which neither expands nor contracts. Ordinary fire-walls last a few months, but BETSON'S PLASTIC FIRE-BRICK stands for years without cracking, a seal against outside air.

Re-line furnaces; mould one-piece baffles and repair cracks with BETSON'S PLASTIC FIRE-BRICK. Easily applied by anybody. Prompt shipments from warehouses in principal cities.

Write for information pamphlet.

Betson Plastic Fire-Brick Co., Inc.
P.O. Box 386-6, Rome, N.Y.

Canadian Distributors:
INTERNATIONAL CHEMICAL COMPANY
44-6 Lombard St., Toronto, Ontario, Canada

MONCRIEFF'S
"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

Cuts Down Coal Consumption and Improves the Efficiency of Labor

THE COPES
Boiler Feed Regulator

is absolutely safe and reliable. It is the most simple, sturdy and rugged in construction. No ordinary regulator is so direct and positive in action.

As one prominent chief engineer says, "I selected the Copes because it is simple and rugged—everything is on the outside, and our tests substantiated every claim made for the regulator."

A straight tube, a lever, a heavy iron base, a practically frictionless balanced valve—that's all there is to it, as you will see in the illustration.

Designed on correct principles, there are no complicated, sensitive contrivances of uncertain reliabilty, nor weak, delicate parts subject to wear and likely to go wrong at the critical moment.

Once installed, out into service and adjusted by the user, further attention is seldom required by the Copes, and the first cost is usually the only cost, no further outlays or maintenance expense being called for.

Its operation is not affected by steam pressure, drafts, or climatic changes. The rate of feed is varied to insure the highest economy in steam making, where furnace conditions are bound to lag behind extremely irregular and unexpected fluctuations in boiler load.

Copes Boiler Feed Regulators are now made in Canada for Canadian power plants.

Canadian Representatives:

ALLEN GENERAL SUPPLIES, LTD.
205 Yonge St., Toronto, Ont.

H. N. BROWN
P.O. Box 620, New Glasgow, N.S.

MASON REGULATOR & ENGINEERING CO., LTD.
153 Dagenais St. (St. Henry), Montreal, P.Q.

C. C. MOORE & COMPANY, Engineers
618 Mutual Life Bldg., Seattle, Wash.
(Representatives in British Columbia).

Ask for Bulletin D, giving full description, detailed information and technical data.

NORTHERN EQUIPMENT COMPANY

112 West 11th Street ERIE, PA.

World's Largest Manufacturers of Feed Water Regulators

103

WEIR PUMPS

Delivery and Interchangeability

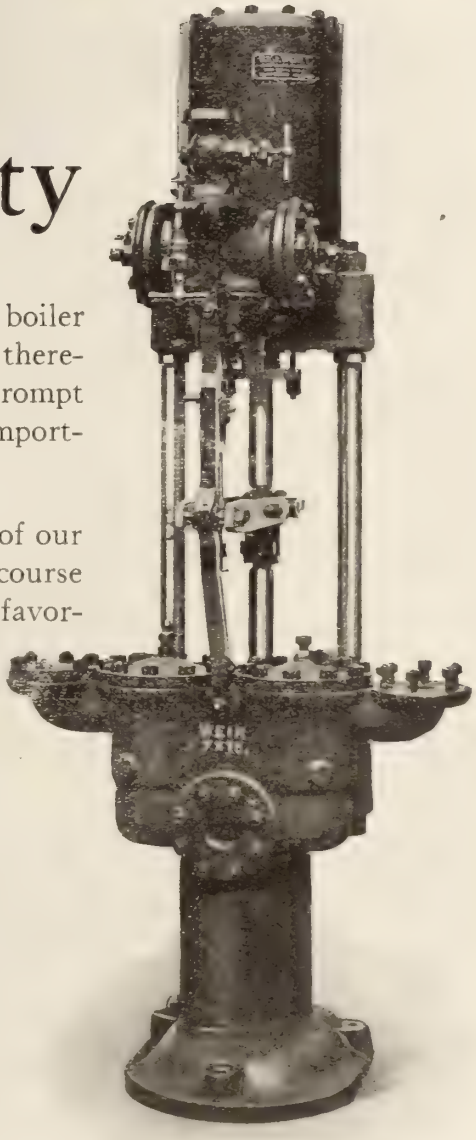
Any possibility of stoppage in the boiler plant is a serious matter. When, therefore, a new feed pump is required, prompt delivery is usually of the greatest importance.

As we always have a large number of our standard pumps in stock and in the course of construction, we are in a specially favorable position to meet demands for urgent delivery.

Overhauling and renewal is greatly facilitated by our system of interchangeable parts and the fact that we keep in stock at all times parts for our standard pumps.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

Prompt and careful shipment is but a single phase of Weir Service. To serve our customers in every way to the best of our ability is our aim.



G. & J. Weir (Canada) Limited

SALES ENGINEERS

Peacock Brothers, Limited, Montreal

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York. N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. General Electric Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto. Can.
Sexton Boiler Setting Co., W. R., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto. Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto. Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto. Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lukenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane, Ltd., Montreal.
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
International Chemical Co., Toronto, Ont.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Northern Equipment Co.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia

CASTINGS, BRASS AND IRON
Bovlig Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England

CHIMNEYS
Arthur S. Leitch Co., Toronto

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

LUNKENHEIMER

OIL AND GREASE CUPS

For Engine AND Transmission Bearings

By their unfailing reliability have won the reputation they enjoy. The engineer specifying "Lunkenheimer," **knows** that bearings thus equipped will get the amount of lubricant for which the feed is set; and that no further attention is necessary other than filling.

They are practical and durable; the feed regulation is simple and easily adjusted, and there is no danger of unsetting the feed when refilling.

The variety of types made embraces **Oil Cups** with Glass or Bronze Body, with or without Sightfeed; and **Grease Cups** of Bronze, Iron and Steel, with Screw or Spring Compression feed,—a type for every service requirement.

Write "Lunkenheimer-equipped" in your engine and transmission specifications, and insist on having the genuine.

Descriptive Booklets Nos. 523 and 524 D.C. will assist you in selecting the proper types. Write for copies.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI
New York Chicago Boston London
23-12-43

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MAKINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk, Con.

Showing ease with which Plibrico is laid in place.

PLIBRICO is Jointless

For a gas-tight, one-piece furnace lining or baffle for boilers use

PLIBRICO

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

Beveridge Paper Co., Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

Trade Mark
Reg. U.S. Pat. Office.

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

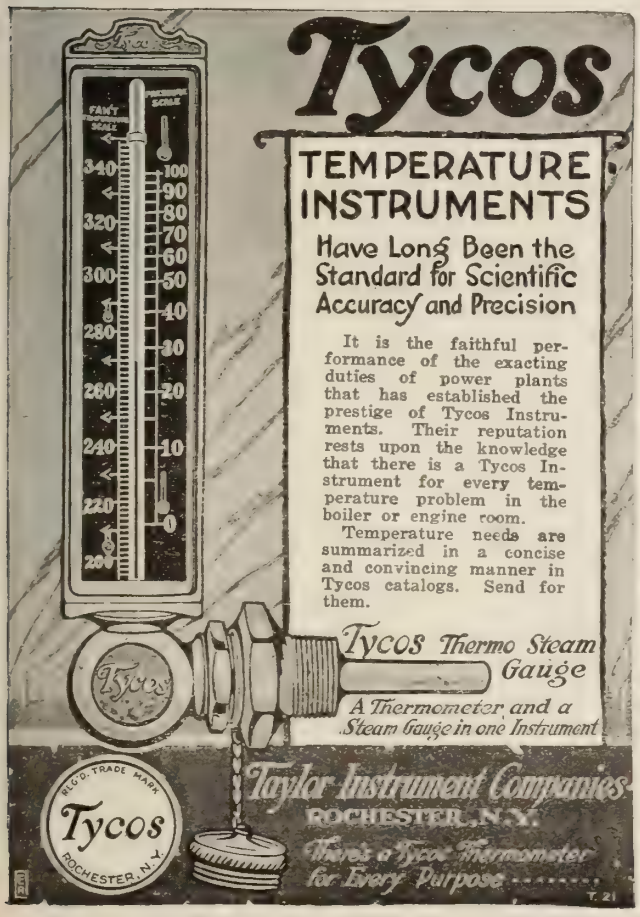
AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.

ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.


Tycos
TEMPERATURE INSTRUMENTS
Have Long Been the Standard for Scientific Accuracy and Precision
It is the faithful performance of the exacting duties of power plants that has established the prestige of Tycos Instruments. Their reputation rests upon the knowledge that there is a Tycos Instrument for every temperature problem in the boiler or engine room.
Temperature needs are summarized in a concise and convincing manner in Tycos catalogs. Send for them.
Tycos Thermo Steam Gauge
A Thermometer and a Steam Gauge in one Instrument
Taylor Instrument Companies
ROCHESTER, N.Y.
There's a Tycos Thermometer for Every Purpose
REG. U.S. TRADE MARK
Tycos
ROCHESTER, N.Y.

Use Starrett Hack Saws
Starrett Service goes with every box of Starrett Blades.
It begins with the fine quality of the saws themselves, and it's yours every minute of the day—any time you need it. Begin using Starrett Service now, and let Starrett Blades, backed by the Starrett Hack Saw Chart, show you why they're called "the blades that cut quicker and last longer."
Write for "Hack Saws and Their Use," the guide-book to more efficient cutting.
THE L. S. STARRETT CO.
ATHOL, MASS. 42-95

GAS, HYDRAULIC, PIPE PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T. & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Boyer Plastic Fire Brick Co., Inc., Rome, N.Y.
International Crushed Co., Toronto, Ont.
Johnlless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox Ltd., Montreal
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Stanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Boyer Plastic Fire Brick Co., Inc., Rome, N.Y.
International Crushed Co., Toronto, Ont.
Johnlless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Dominion Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Empire Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

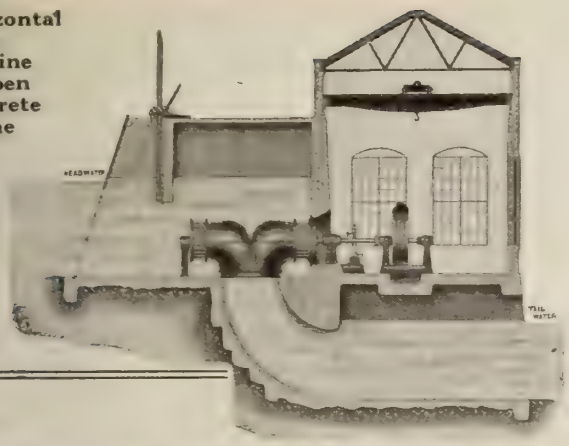
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

Horizontal Twin Turbine in Open Concrete Flume



Water Wheels and Hydraulic Power Plant Equipment

Send for Bulletin No. 54

Hydraulic Turbines
Governors
Head Gate Hoists
Stop Log Winches
Steel Feeder Pipes
Trash Racks
Butterfly Valves
Surge Tanks

William Hamilton Co.,
Limited
PETERBOROUGH, ONT.

HOMESTEAD
Quarter-Turn Valves

A Homestead Was Chosen!

When one of the largest stoker manufacturers ran a competitive test for a valve which would give satisfaction under the severe service encountered in connection with their stokers, a HOMESTEAD was chosen.

This firm has since backed up its experience by standardizing on HOMESTEADS.

There is but one way of convincing yourself, give them a trial.

Homestead Valves are made in straight-way, three-way and four-way patterns.

Our Catalog is Yours for the Asking.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

Mr. Engineer, are you—

one of those wide-awake, up-to-the-minute engineers who is willing to be shown how economies can be effected in the boiler room? Many power plants in Canada and the United States, especially noted for high operating efficiency, consider "Bailey" meters essential to the best operation of either coal or oil-fired furnaces.

Bailey Boiler Meters

"Bailey" Boiler Meters — the **coal savers**—record the true relation between the coal and air supply to the furnace and plainly show the men what adjustments to either are required to maintain high operating efficiency and economy.

CHARTS SHOW PERFORMANCE OF INDIVIDUAL BOILERS

and tell when a boiler requires cleaning or inspection for leaky tubes or broken baffles. You can check the work of the fireman at all times.

Try one "Bailey" Boiler Meter and you will soon order "Bailey" equipment for all of your boilers.

May we send full details? Tell us your requirements.

COAL SAVERS

Bailey Meter Co.
2001 E. 46th St.
CLEVELAND,
OHIO

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
abcock & Wilcox, Ltd., Montreal.
mes Underfeed Stoker Co., Toronto.
urphy Iron Works, Detroit, Mich.
nford Riley Stoker Co., Worcester, Mass.

METERS, AIR
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, GAS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
Republic Flow Meters Co. of Canada, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto,
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co. Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Imperial Oil, Ltd., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd. Toronto Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd. Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.

PIPE, ACID RESISTING
Hart Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.

MADE IN CANADA

An Ideal Attained By
ELESCO SUPERHEATERS

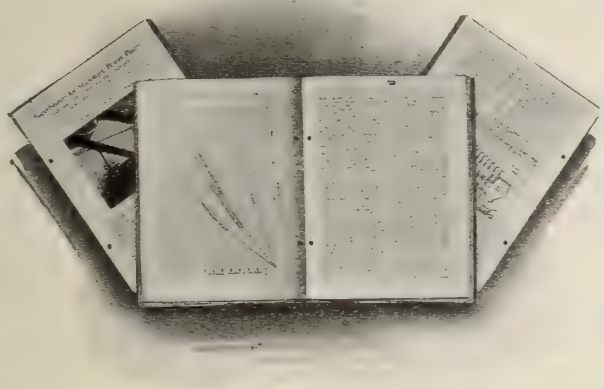
The Correct Application and Use of Superheated Steam

Superheating is too vital a factor in power plant design to be treated in any other way than as an engineering problem.

In the design and installation of Elesco Superheaters 26 different factors are involved. The success of Elesco installations is the result of the correct inter-relation of these factors.

Elesco engineers will study your conditions regardless of the size of your plant, and will co-operate with you in order that you may attain the one ideal toward which all discriminating power plant engineers are working — the economical, practical and reliable generation of power through the correct application and use of superheated steam.

An ideal is reached in plants equipped with Elesco Superheaters because guesswork has been avoided.



The Superheater Company
Limited
Transportation Building
MONTREAL

Works at Sherbrooke, Quebec

Send for Bulletin T-5

Designing engineers and manufacturers of Elesco Steam Superheaters and pipe coils— for all purposes.

Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Nunnwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, FEED WATER
Northern Equipment Co.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SOOT CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co. Inc. New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co. St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

EVERY PAPER DRYER THAT IS DRAINED OF CONDENSATION BY MEANS OF

THE "COLE" RETURN SYSTEM

IS WORKING AT ITS HIGHEST EFFICIENCY

Cole Engineering Service Excels

Cole Products— None Better

This is the Machine That Does the Work

GEO. W. COLE, LIMITED

2002-4 Dundas St. W., Toronto, Canada

Represented in: Montreal, Que.; Winnipeg, Man.; Vancouver, B.C.; New Glasgow, N.S

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall. Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall. Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER REGULATORS, FEED
Northern Equipment Co.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

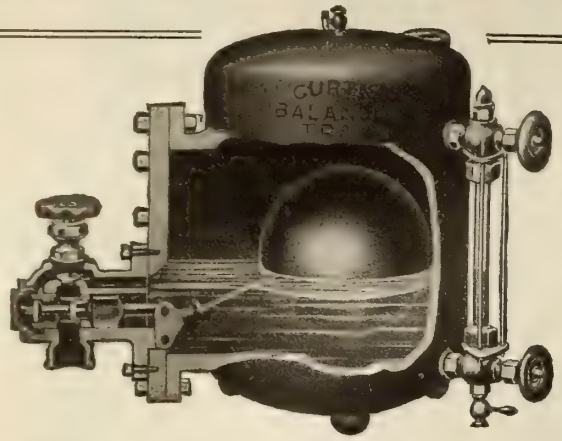
WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE
Williams Machinery Co., A. E., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties.
Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: 83 Barclay St., New York City
174 N. Market St., Chicago, Ill.

FOR REMOVING SCALE

from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★

Frank Gilman

(SOLE MAKER)
9, Westfield Road Birmingham Eng.

INDEX TO ADVERTISERS

Anderson Co., V. D. 12
Audel, Theo. 44

Badger & Sons, E. B. 6
Bailey Meter Co. 59
Betson Plastic Fire Brick Co.. 51
Bishop, S. & C., Co. 51
Brown, Wm. J. 50
Busch, Sulzer Bros. 57
Buyers Directory 54, 56, 58, 60, 62, 63

Canadian Fairbanks-Morse Co.. 43
Can. Link-Belt 8
Can. Mead-Morrison Co., Ltd... 48
Can. Steam Boiler Equipment.
Cole Limited, Geo. W. 63
Chaplin-Fulton Mfg. Co. 50
Coppus Engineering & Equipment Co. .... Inside front cover
Classified Advertising Section.. 44
Crane Limited 50

Darling Bros. 50
Dart Union Co. 15
D'Este Co., Julian 64
De Laval Steam Turbine Co... 45
Dominion Belting Co. 12
Durabla Mfg. Co. 11

Eric Beach Amusement 45
Engineering & Machine Works of Canada, Ltd. 49

Federal Engineering Co. 50

Gates Refractories 4
Garth Co., The 51
Gilman, Frank 64
Goldie & McCulloch 22
Green's Economiser 7

Hamilton, William 59
Holden Co., Limited, The 2
Homestead Valve Mfg. Co. ... 59
Hoyt Metal Co. 50

Imperial Oil, Limited 3
Jeffrey Mfg. Co. 5
Jenkins Bros. 10
Jointless Fire Brick Co. 57

Ladd, G. T., Co. 51
Leitch, The Arthur S. ..... Inside cover
Leonard & Sons, Ltd., E. 49
Lunkenheimer Co. 55
McLaren's, D. K. 14
Manning Co., E. S. 45, 50
Mason Regulator & Engineering Co. 16
Ministry of Munitions 9
Morrison Brass Mfg. Co., Jas. Outside back cover
Moncrieff, Ltd., John 51
Murphy Iron Works 13

Northern Equipment Co. 52
Norwalk Iron Works Co. 48

Page-Hersey Tubes, Ltd. 15
Peacock Bros., Ltd. 53
Petrie, H. W. 45
Pilley Packing & Flue Brush Mfg. Co. 51

Republic Flow Meters 21
Robb Engineering Co. 7

Sarco Co., Inc. 44
Scaife & Sons Co., Wm. B..., 64
Shell Bar Boiler Supply Co... 6
Smart Turner 51
Starrett Co., L. S. 57
Sturtevant, F. B. 46, 47
Steel Mill Packing Co. 6
Sterling Engine Co. 4
Superheater Co., Ltd., The ... 61

Tagliabue, C. J. 13
Taylor Instrument Co., The ... 51

Uehling Instrument Co..Front cover
Under-Feed Stoker Co. of Canada, Ltd. 17-20

Victoria Foundry Co. 50
Wall, H. J. 51
Watson & McDaniel Co. 51
Williams & Co., J. H. 4
Worthington Pump & Machine Co. 1

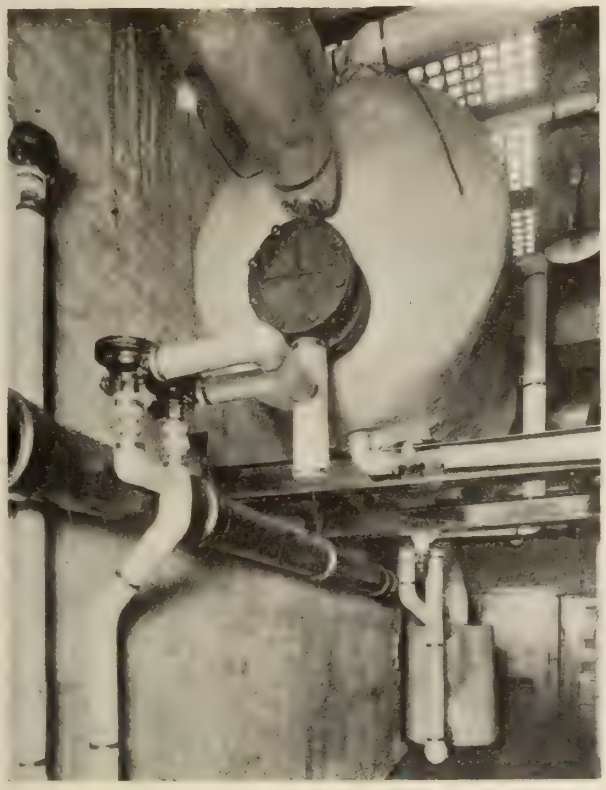
York Mfg. Co. 11

WATER

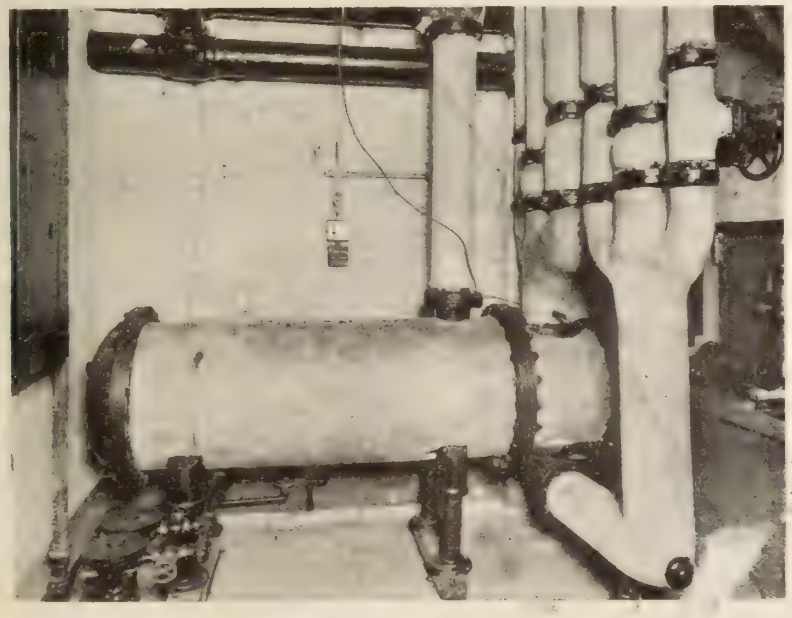
WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

Sims Steam Tube Water Heaters



THERE are advanced features of design embodied in **Sims** heaters which distinguish them from other heaters—and **Sims** heaters are as superior in their service as they are different. **Sims** embodies straight tubes, 1½ in. O. D. Seamless Brass, rolled into a fixed head at one end, and a loose or floating head at the other. The tube structure is thus in no way attached to the heater. This construction admits of expansion and contraction of tubes without strain. Another feature is seen in the manner of grouping the tubes, which promotes the rapid circulation of water and allows for the best results in extracting the heat. **Sims** heaters have several other advantages. It is these advantages that have made **Sims** equipment preferred where large quantities of hot water, with live or exhaust steam as the heating water, are required.



The illustrations show Sims Water Heating Equipment at "Ardwold." Sir John Eaton's residence, Spadina Road, Toronto.

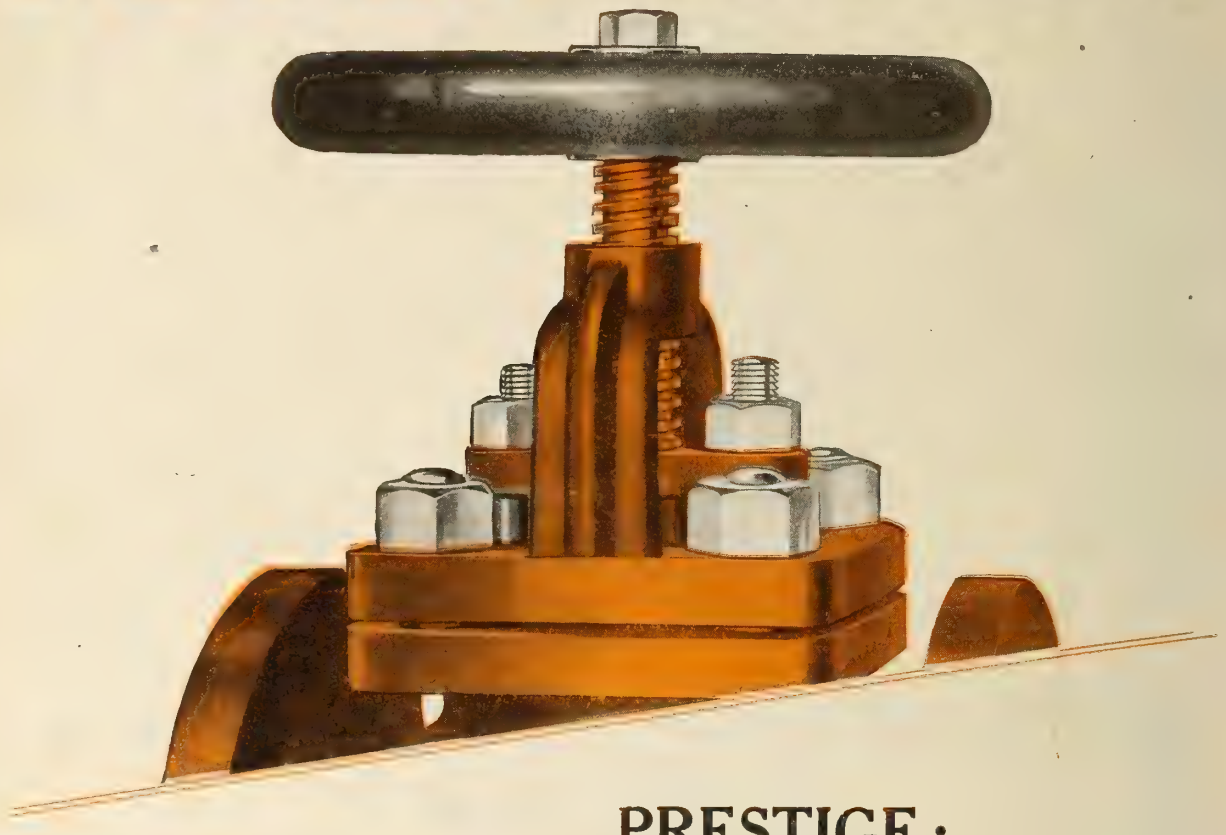
The upper illustration shows a 42 in. x 108 in. Sims No. 6 B.H. Clean E-Z Type Storage Heater for the Domestic Hot Water Supply. The lower illustration shows the Sims Converter, which supplies the swimming pool at "Ardwold."

For full information regarding Sims equipment write to—

THE ARTHUR S. LEITCH CO.

1001-2 KENT BUILDING, TORONTO, ONT.

STEAM MORRISON GOODS



"Every Installation is a Demonstration of Merit"

PRESTIGE:

"Weight or influence derived from past success" *Daniel Webster*

The prestige of the name "Morrison" is built upon over half a century of successful service. When you make sure of the name, you make sure of the quality.

The **James Morrison Brass Mfg. Company Ltd.**

93-97 Adelaide St. W. TORONTO

POWER HOUSE

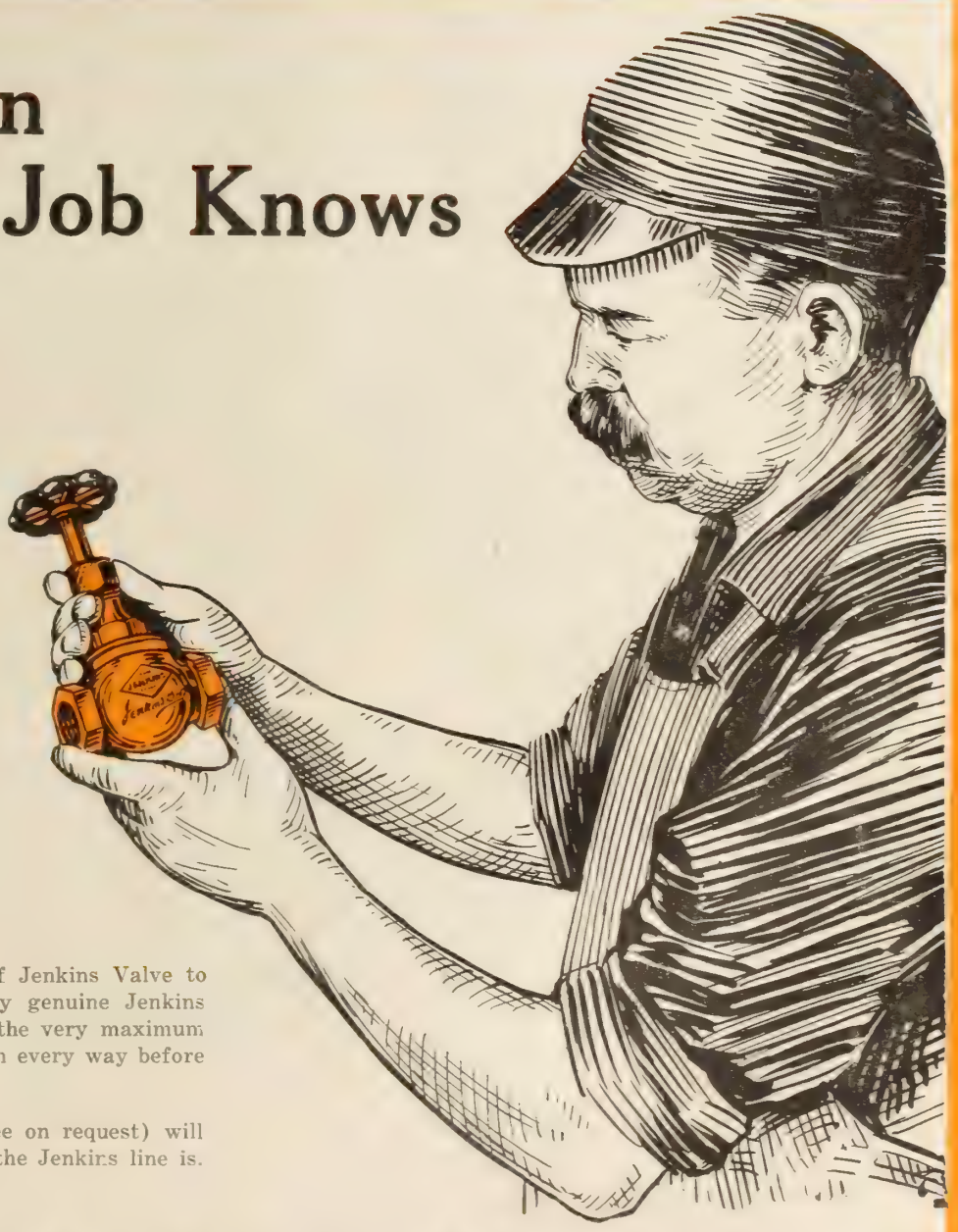
A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 23. Publication Office, Toronto—December 5, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

The Man On the Job Knows



It's his business to know Valves. He knows what they are called upon to do and that to be entirely satisfactory they must be so proportioned as to leave no weakness at any point.

He knows that the "Diamond Trade Mark" cast upon the body is a guarantee of the genuine

JENKINS VALVE

and that Jenkins Valves furnish satisfactory service year in and year out, even where the test of service is most severe.

There is a type and a size of Jenkins Valve to meet all requirements. Every genuine Jenkins Valve is designed to furnish the very maximum of service and is fully tested in every way before leaving the factory.

A copy of Catalog No. 8 (free on request) will show you how very complete the Jenkins line is. Write for it to-day.

Jenkins Bros.

TRADE JENKINS MARK

LIMITED

TRADE JENKINS MARK

Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO European Branch VANCOUVER

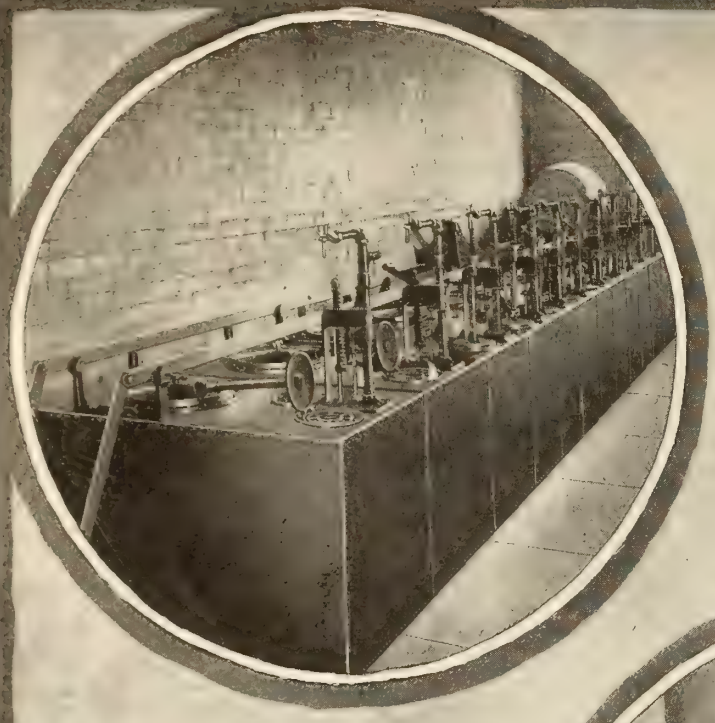
6 Great Queen St., Kingsway, London, W.C.2. Eng.

AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

Jenkins Bros Jenkins Bros

BOWSER

ESTABLISHED 1885



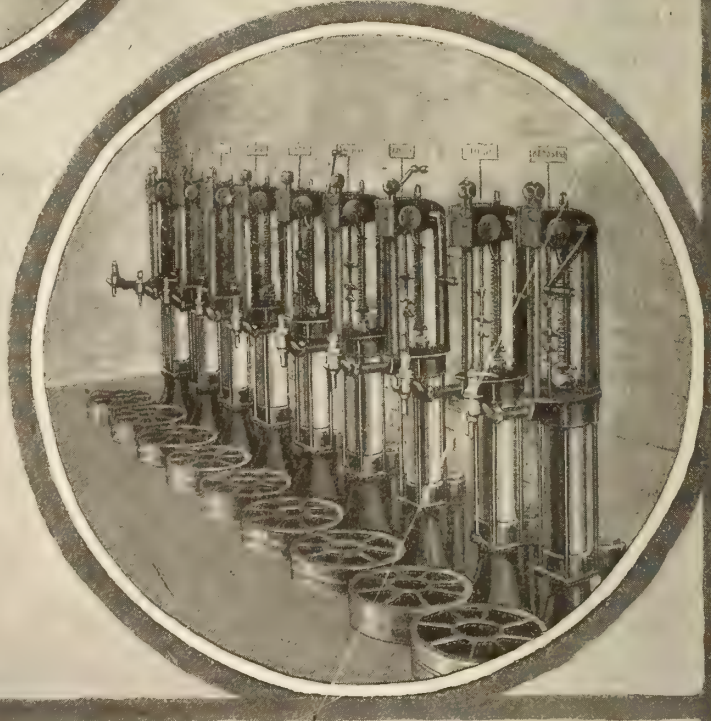
Savings Count Big!

With space at a premium, labor scarce and high, the price of oils way up, a

BOWSER
ESTABLISHED 1885
Oil Storage System

is a necessity that cannot be overlooked. Once its real value is understood, every one concerned in the handling of oils will want a Bowser System.

It saves an immense amount of oil and cuts labor cost. It is clean, safe and systematic.



Illustrations show two installations of Bowser Equipment used by the Lukens Steel Company, Coatesville, Pa.

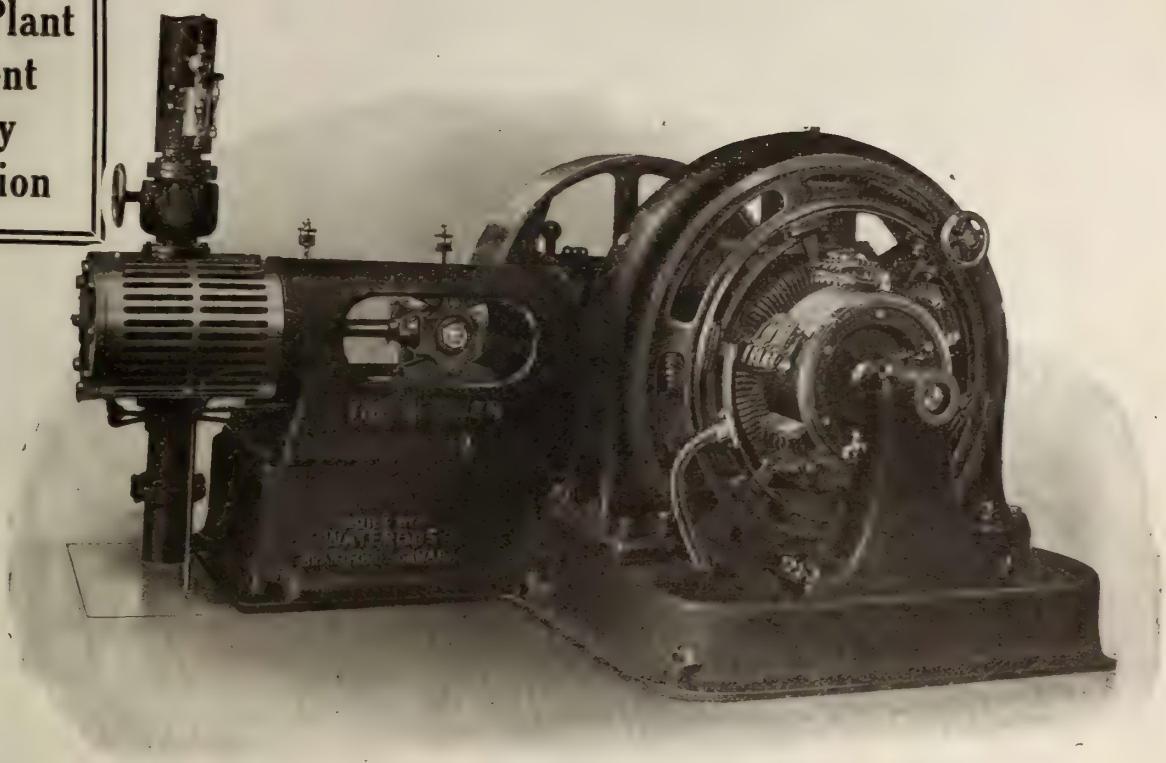
Upper view shows battery of lubricating oil outfits with barrel, track and cradle.

Lower view shows battery of self-measuring pumps for paints and other non-lubricating liquids. These pumps are connected to a battery of tanks in another room.

Interesting literature will be sent on request.

S. F. BOWSER COMPANY, LTD.
66-68 Fraser Avenue
Toronto - - Canada

We Build Complete Power Plant Equipment for Every Installation



McEWEN HIGH-SPEED AUTOMATIC ENGINES

These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

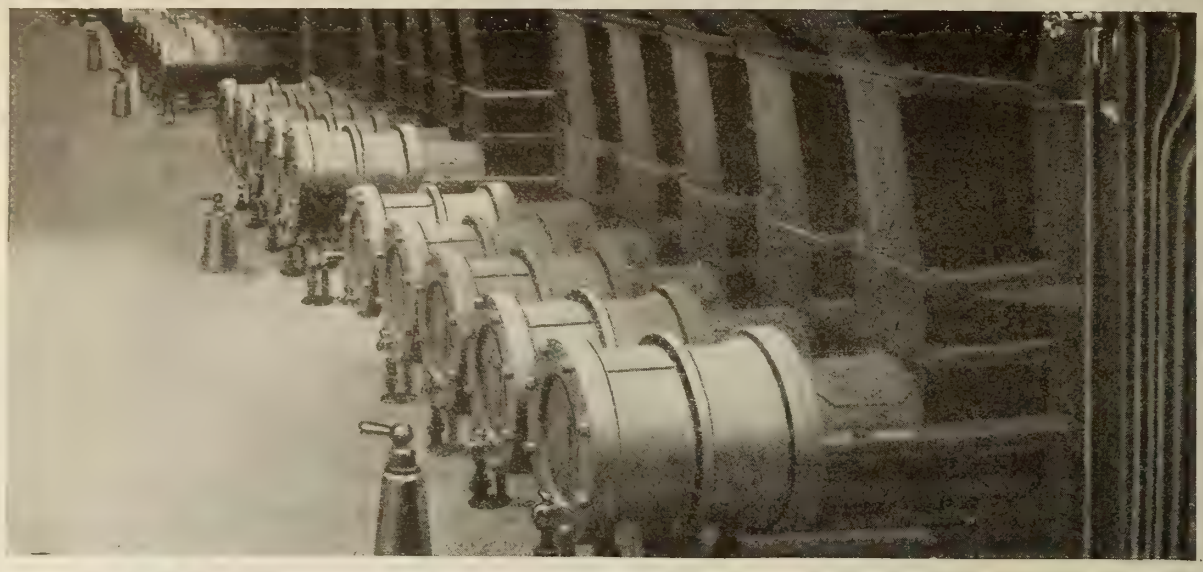
Your careful investigation of their actual service performance record in all parts of the country especially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

Waterous

BRANTFORD, ONTARIO, CANADA

POWER HOUSE, December 5, 1920. Vol. XIII., No. 23. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



High-Duty

—The Short Cut to Low Cost Power

HAVE you a definite conception of just what "high-duty" means as applied to the Jones "A-C" (Automatic-Cleaning) Stoker?

High-Duty Implies first of all, ability to meet any conceivable load condition, whether a steadily maintained overload or a widely fluctuating load where enormous peaks must be met almost momentarily. The automatic-control of fuel and air, and individual control of retorts embodied in the Jones "A-C," makes this a certain result.

High-Duty Means not merely heavy overload capacity, but ability to maintain overloads continuously without shutdowns and with minimum maintenance costs. The automatic-cleaning ("A-C") feature, the absence of clinker on side and bridge walls, and the rugged simplicity, making repairs almost negligible, insures *continuous operation at all loads.*

High-Duty Signifies not alone maintained overload capacity, but ability to fulfill this condition while burning every and any grade of fuel. The underfeed principle (a *Jones* principle) as perfected in the Jones "A-C," adapts this stoker to coals of every firing characteristic.

High-Duty Summarizes the features that have given the Jones "A-C" a wider range of utility recorded in greater return on stoker investment in plants of every size. The new "A-C" catalog goes into detail.

The services of an old-established and newly re-organized and expanded engineering organization — formerly the Jones Under-Feed Stoker Company, Limited, and now the Under-Feed Stoker Co. of Canada, Limited—are at your disposal. Request (without obligating yourself in any way) the new "A-C" catalog.

The Under-Feed Stoker Co. of Canada, Ltd., 81 Victoria St., Toronto

Jones "A-C"

Automatically-Cleaned *Automatically-Controlled*

How to Solve Your Bearing Problems

The cheapest and most reliable form of insurance against interrupted production from worn out bearings is to have on hand in your own shops several bars—in sizes to meet your needs—of

MUELLER
BRONZE BEARING METAL

These bars contain high percentages of copper and tin, giving a tough, close-grained casting to stand high speeds and heavy pressure. We carry a full assortment of Mueller Solid Bars from ½ in. O. D. to 4 in. O. D. in lengths of 12 ins.; in Mueller Cored Bars all sizes from 1 in. O. D. x ½ in. I. D. to 4 in. O. D. x 2¼ in. I. D.; all in lengths of 12 ins. Complete list of sizes and prices will be furnished on request. Mail orders given prompt attention.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products.

Continuous service and low maintenance cost due to the self-cleansing seat

LUNKENHEIMER "DURO" BLOW-OFF VALVES

Remain tight under the most severe operating conditions because the self-cleansing seat feature eliminates the cause of most of the wear to which Blow-off Valves are subjected.

This self-cleansing seat feature,—exclusive in Lunkenhiemer "Duro" Blow-off Valves, functions automatically when the valves close by cutting off the inlet and allowing only a fine spray of water to pass, thereby removing foreign substances which may have lodged on the seat during the blow-off period.

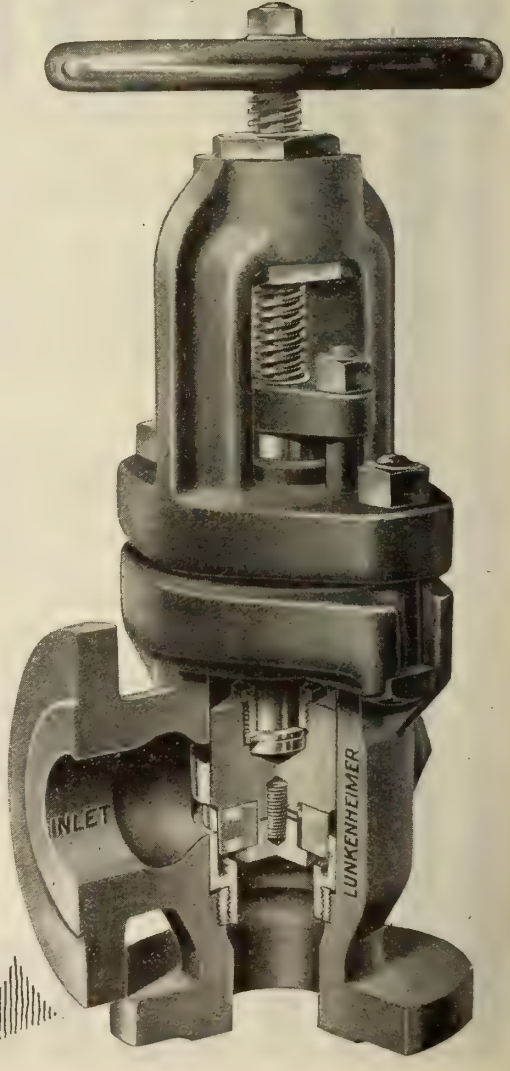
In addition to the self-cleansing seat feature, the disc is reversible and has seat faces made of a durable alloy which readily accomodates itself to any irregularity in the seatring insuring tight though easily operated valves.

To further enhance their durability as a whole, all the parts are renewable.

Lunkenheimer "Duro" Blow-off Valves have proved their merit in service and are specified where boiler mountings of the better grade are desired.

All standard sizes, in material combinations to suit a wide range of pressure and temperature conditions.

Your local dealer can furnish them; if not, write us.
Write for descriptive booklet No. 515-D.



THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI

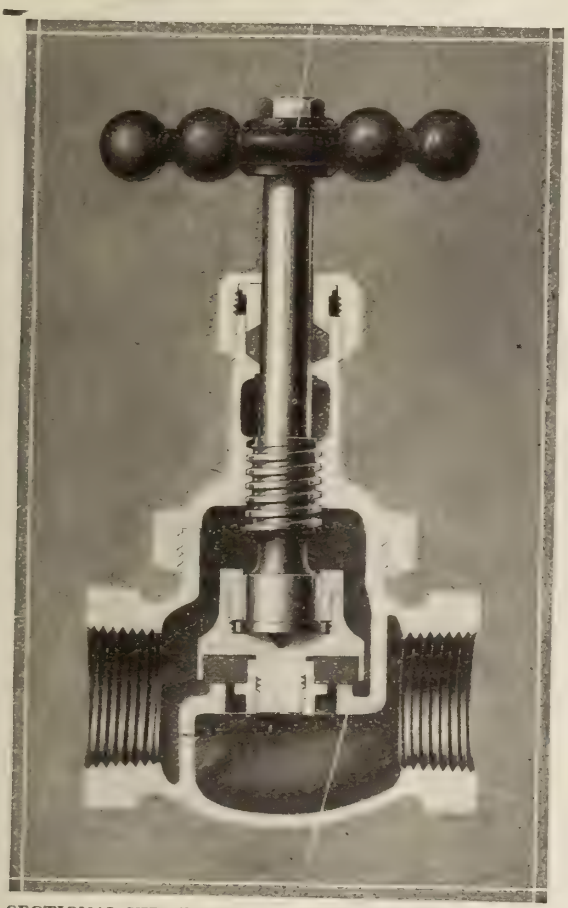
New York Chicago Boston London

10-19-43 Export Dept., 129-135 Lafayette St., New York

AMERICA'S BEST
LUNKENHEIMER
QUALITY
SINCE 1862

TRADE
PENBERTHY
MARK.

BE SURE THIS NAME is on the Valve you buy



SECTIONAL VIEW OF PENBERTHY COMPODISK VALVE
Registered and Approved for 175 lbs. Steam Pressure

Then you get "The valve with the outside bonnet construction."

The first progressive improvement made in brass valve construction in generations.

Think of the advantages! Valve always accessible.

No straining or stripping of threads when assembling or taking apart.

Impossible to spread or enlarge body of valve when screwing down bonnet to place.

No corrosion of threads, for they are on the outside, away from the action of steam and water.

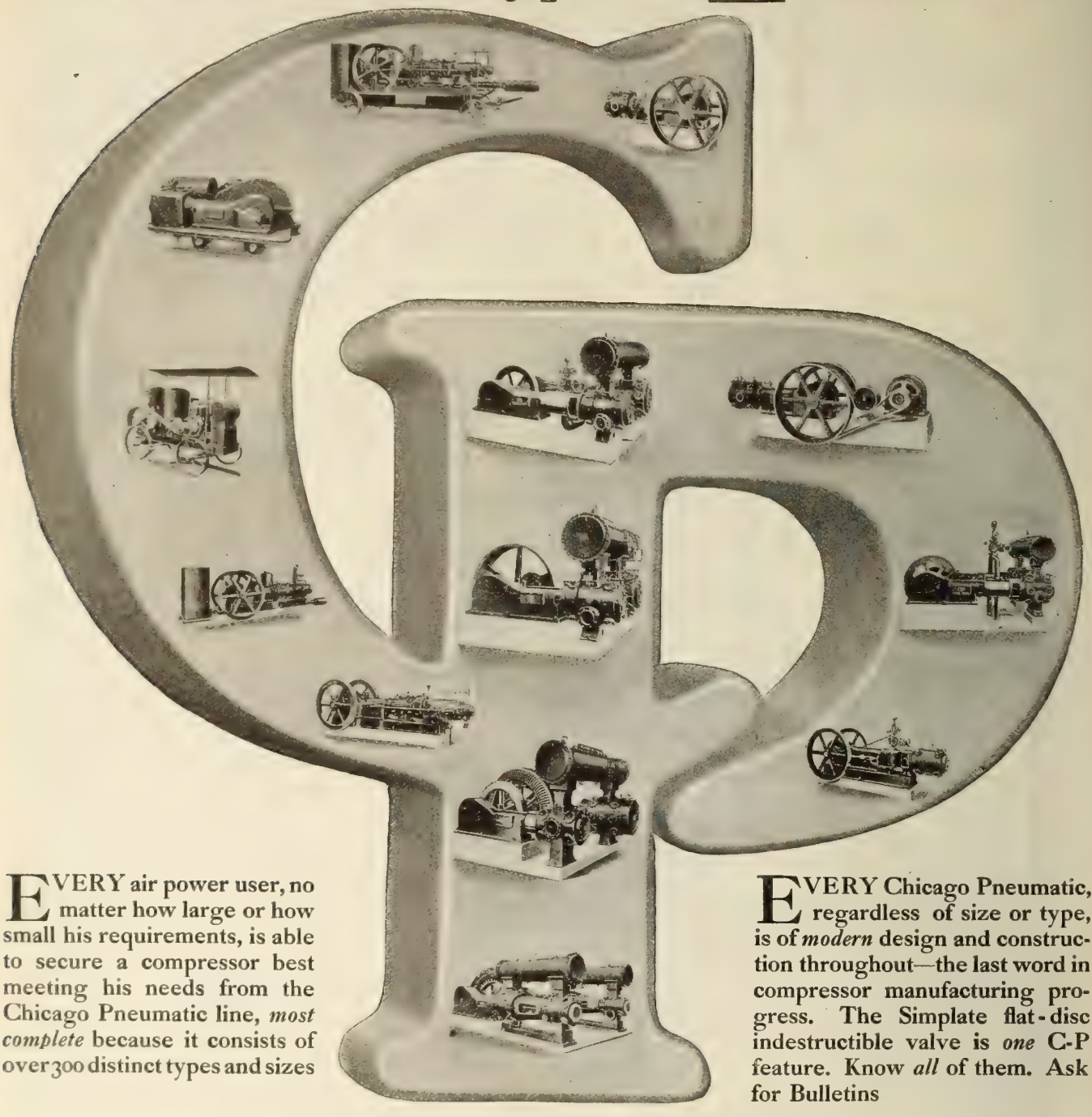
Penberthy Valves Are High-Grade Valves

The fine quality of metal—the excellent workmanship and finish—the up-to-date design with the outside Bonnet Construction—the long wearing, serviceable Composition Discs—the Government approval of 175 lbs. Steam Pressure—all these advantages are yours when you buy the genuine Penberthy Valves. We also make the Regrinding Type approved for 200 lbs. Steam Pressure, as well as Brass Gates, Swing, Horizontal, Vertical and Angle Check Valves.

STOCKED BY LEADING JOBBERS AND MILL SUPPLY HOUSES IN CANADA

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

300 sizes and types—all modern



EVERY air power user, no matter how large or how small his requirements, is able to secure a compressor best meeting his needs from the Chicago Pneumatic line, *most complete* because it consists of over 300 distinct types and sizes

EVERY Chicago Pneumatic, regardless of size or type, is of *modern* design and construction throughout—the last word in compressor manufacturing progress. The Simplate flat-disc indestructible valve is *one* C-P feature. Know *all* of them. Ask for Bulletins

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

C-83 H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

Depend upon *that Name*

The fallacy of too many packings

IF you've been using a certain special packing for this, that or the other job, you've probably a large assortment in the store-room and think of the waste! How much of that packing is good to use, right now? That's part of the price you have to pay for "too many packings."

PERHAPS you wonder how the same sheet can make and keep joints tight against superheated or saturated steam, air, ammonia and most chemical solutions. Yet Service Sheet Packing does this. It's a thin, strong, dense sheet of asbestos fibres, felted and bonded together with heat resisting compounds.

Then we come to rod and outside plunger packing.

Sea Rings, the automatic rod and plunger packing are designed to pack or press against the rod when there's pressure or tendency of leakage through the stuffing box, and release their pressure when the tendency of leakage diminishes. Power ordinarily wasted by excessive friction is saved, and the packing lasts much longer because of the reduced wear. Sea Rings cost more than the ordinary kind—they're worth more than they cost.

Piston Packing

Also there's a Johns-Manville packing that's built in folds—that won't fray out or unravel from constant wiping along cylinder liners like tucks or duck hydraulic. That's Universal Piston Packing—it's best for your pumps.

Kearsage Gaskets for boiler handholes and manholes. Vulcabeston Pump Valves for high or low pressure pumps. Mogul Valve Stem Packing for small rods and valve stems.

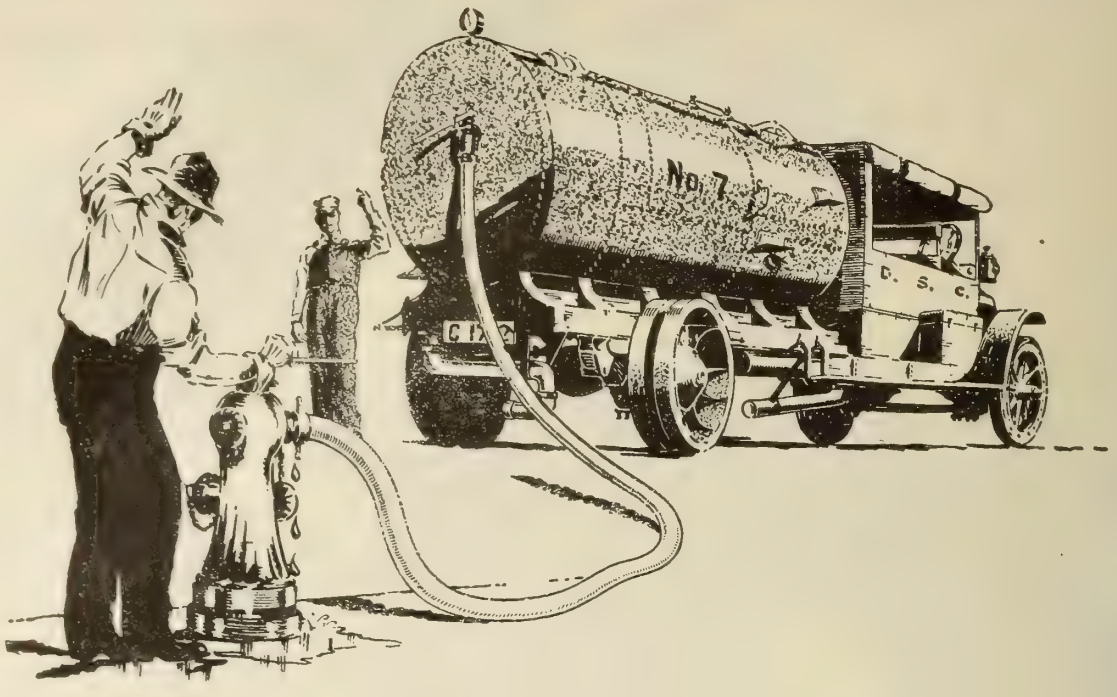
CANADIAN JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa Windsor

Through—
Asbestos
and its allied products
JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS-MANVILLE
POWER PLANT MATERIALS



New Standards of Economy Set by Goodyear Industrial Hose

The outside covering on Water Hose, unless tough and sturdy, quickly disintegrates under the constant dragging over sharp objects, particularly in outside construction work. The hose blisters and bursts.

Goodyear has overcome this with a rubber cover of exceptional toughness and strength, a cover which gives longer life—at a correspondingly low cost. The good inner tube and strong fabric are in keeping with this superior cover.

For every industrial use—Water, Air Drill, Pneumatic Tool, Steam, Fire Hose—Goodyear has designed a *special* type of hose, built only after an exhaustive study of modern conditions in industrial work. Goodyear has broken new trails.

If your business is hampered by the excessive cost and unreliability of old-fashioned hose, get the Goodyear data and the Goodyear hose plan. Let a trained Goodyear man advise with you. No obligation on your part. Phone, wire, or write the nearest branch or Goodyear Mechanical Goods Service Station.

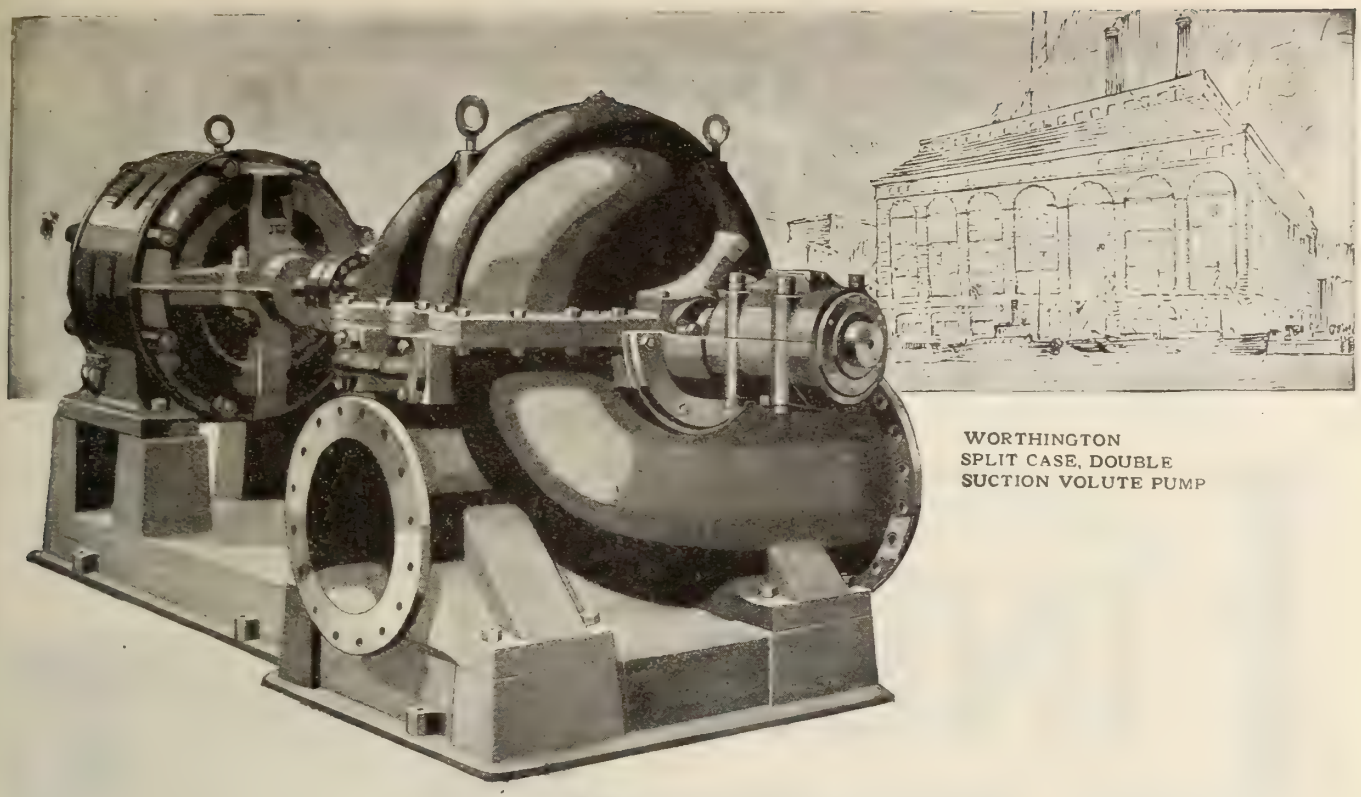
The Goodyear Tire & Rubber Co.
of Canada, Limited

Branches—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver.

GOODYEAR

MADE IN CANADA

INDUSTRIAL HOSE



WORTHINGTON
SPLIT CASE, DOUBLE
SUCTION VOLUTE PUMP

This pump is made specially for you

FOR your opinions and findings have been carefully considered in the designing of Worthington Centrifugal Pumps. Your praises and plaints have been handed to our engineering committee by our men in the field. Constructive criticism has borne fruit.

Worthington Horizontal Double Suction Split Casing Volute Pump is the standard bearer of the Worthington line of centrifugal pumps. Our engineering committee has lavished a wealth of experience, knowledge and skill on this pump. And today it is serving successfully a wide range of industrial uses. For with minor construction changes, the original design becomes a special for special work.

Worthington Double Suction Volute Pumps fitted with special impellers or with other slight changes to suit your needs are guaranteed by Worthington to deliver efficient, economical pumping service.

WORTHINGTON PUMP AND MACHINERY CORPORATION
***Executive Offices:* 115 Broadway, New York City**
Branch Offices in 24 Large Cities

Other Worthington Products

Steam, Power, Centrifugal and Water Works Pumps, Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

W 546.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works
East Cambridge, Mass.
Worthington Works
Harrison, N. J.
Laidlaw Works, *Cincinnati, Ohio.*

Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
Cudahy, Wis.
Snow-Holly Works
Buffalo, N. Y.
Epping-Carpenter, *Pittsburgh, Pa.*

LINDE

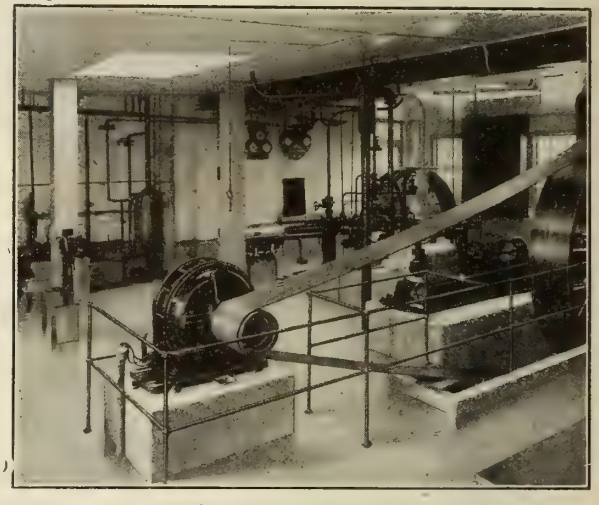
Made-in-Canada

Everything for Refrigerating or Ice Plants, Large or Small

Ice-making and Refrigerating Machinery

Twenty-four years of manufacturing prestige with a constantly increasing volume of business and a record of re-sales to satisfied owners are your guarantee of satisfaction when you adopt Linde equipment.

The new Linde Vertical Enclosed Type Machines embody the most up-to-date design and every modern convenience for small plants from 1 to 30 tons. Then for heavy demands, calling for loads up to 300 tons, our large horizontal frame type is unequalled. Write for full information.



This 100-ton plant was designed and constructed by our engineers. These men are at your service, designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

Ice-making and Refrigerating Machinery

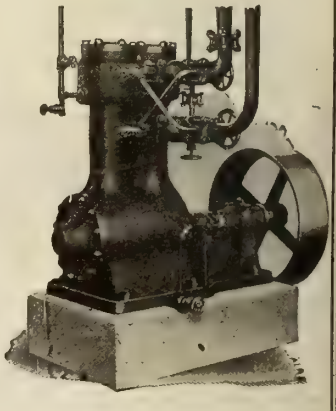
Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

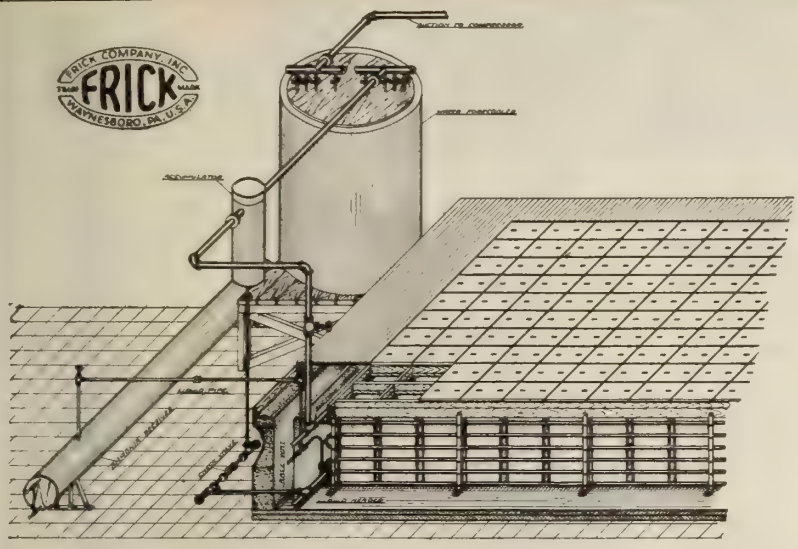
Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES



The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



The FRICK FLOODED SYSTEM

Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

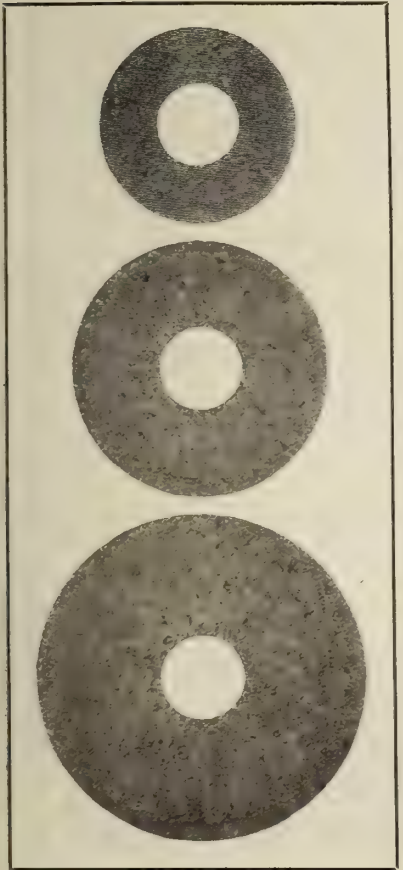
Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

Branches in all Principal Cities.
Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



A Palm Beach Suit in January

is just as consistent as ice water covering on low temperature brine lines. You don't expect chill-room insulation to hold sharp freezer temperatures. Be just as reasonable about your cold pipe covering.

Nonpareil Cork Covering is made in three grades designed for three distinct service conditions:

Ice Water Covering, averaging 1½ inches thick, for refrigerated drinking water, liquid ammonia and other lines where the temperature is above 25° F.;

Standard Brine Covering, from 2 to 3 inches thick, varying with pipe size, for brine and gas suction lines with temperatures between 0° and 25° F.;

Special Thick Brine Covering, from 3 to 4 inches thick, for 0° F. and below, or where lines are exposed to unusually high surrounding temperatures.

Nonpareil Cork Covering, of the correct thickness and properly applied, is the most efficient, durable and economical insulation for cold pipes. For your protection the name, grade and size are stamped on each section.

A 64-page book, "Nonpareil Cork Covering," containing complete detailed information invaluable wherever refrigeration is used, will be mailed on request, free of charge, together with a sample of the covering.

Armstrong Cork & Insulation Company, 504 McGill Bldg., Toronto, Ont., Can.

Also manufacturers of Nonpareil Corkboard Insulation for cold storage and ice storage rooms; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines; and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Cork Covering

For All Cold Lines

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative:

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.
CALGARY: 605 Second Street

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we thing the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

New Truths and Old Fallacies

Fusibility of Alloys—*Continued*

The best bearing metal may come to grief through mechanical defects, which no babbitt could withstand, or by reason of faulty lubrication, as a grease that is too heavy for a light-running bearing, or an oil too thin for a heavy bearing, will invariably cause heating.

A highly fusible alloy rarely, if ever, gives timely warning before running out, whereas a Magnolia-lined bearing heats so slowly that it permits of either shutting down or cooling off the bearing, while running, without injury to shaft or bearing, and we shall recite cases where entire lack of lubrication has done no harm.

Tin is not the only metal that lowers the melting point of an alloy.

It is most natural to suppose that the melting point of a lead-antimony mixture would not be lower than lead, but that the addition of antimony would even make it higher. The eutectic of this series is 87 per cent. lead and 13 per cent. antimony and the melting point is 447° Fahrenheit, or 212° Fahrenheit less than the mean of the two metals.

It is a common practice to guarantee the melting point of babbit metals to be 600° Fahrenheit, and over, and to view this practice from a charitable standpoint, this guarantee is doubtless given because it is taken for granted that such ought to be the melting point. It is quite evident that the guarantors are not hampered by facts and have no definite knowledge upon which to base their assertions, but they run no risk of detection as buyers are just as much in the dark.

We have a Die-Casting Catalogue of recent date in which is given the melting point of their Genuine Babbitt as 810° Fahrenheit. We believe these figures were obtained from a college laboratory, which gives absolution from intentional misrepresentation, as it is highly improbable that such a wonderful alloy exists, but like many other babbitt manufacturers, they don't know any better.

(Continued next month.)

For copy of complete article :
"New Truths and Old Fallacies"
Address our Montreal Office

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.
OF CANADA, LIMITED
Office and Factory:
Montreal : 37-39 Shannon St.

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

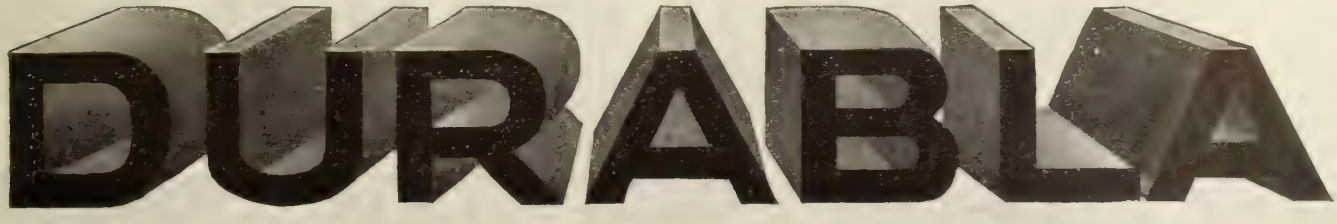
Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited



"I'm astonished to find that such an efficient stoker is so simple!"

That's what an experienced stoker man exclaimed after he had seen the Stowe Stoker in operation.

The Stowe Stoker is really simpler than the chain grate. Alternating tuyeres and chains—that's all there's to it. Drippage falls into a pit provided for that purpose, instead of clogging air passages. There are no air ducts in the firing aisle.

As compared to the chain grate, only *half* the grate surface of the Stowe Stoker actuates; and yet, it provides a graduated air supply for the various stages of combustion, and adapts itself to force draft with no more ado than is involved in the application of forced draft to a hand-fired grate. Furthermore, it positively discharges the refuse at a rate which can be controlled independently of the rate of feeding.

When one considers first, the many striking features and advantages of the Stowe Stoker, and then, the marked simplicity of this mechanism, the realization comes that here is a truly great *achievement* in mechanical equipment design.

We also manufacture the L-C Chain Grate Stoker—the Natural-Draft Type for Higher Volatile Coals—Dominant in this Field Today.

Branch Offices:
Chicago, 1366 Peoples Gas Building
Pittsburgh, 901 Oliver Building
New York, 504 Fifty E. 42nd Street

D136

LACLEDE

A BUSINESS INSTITUTION

THE

STOWE STOKER

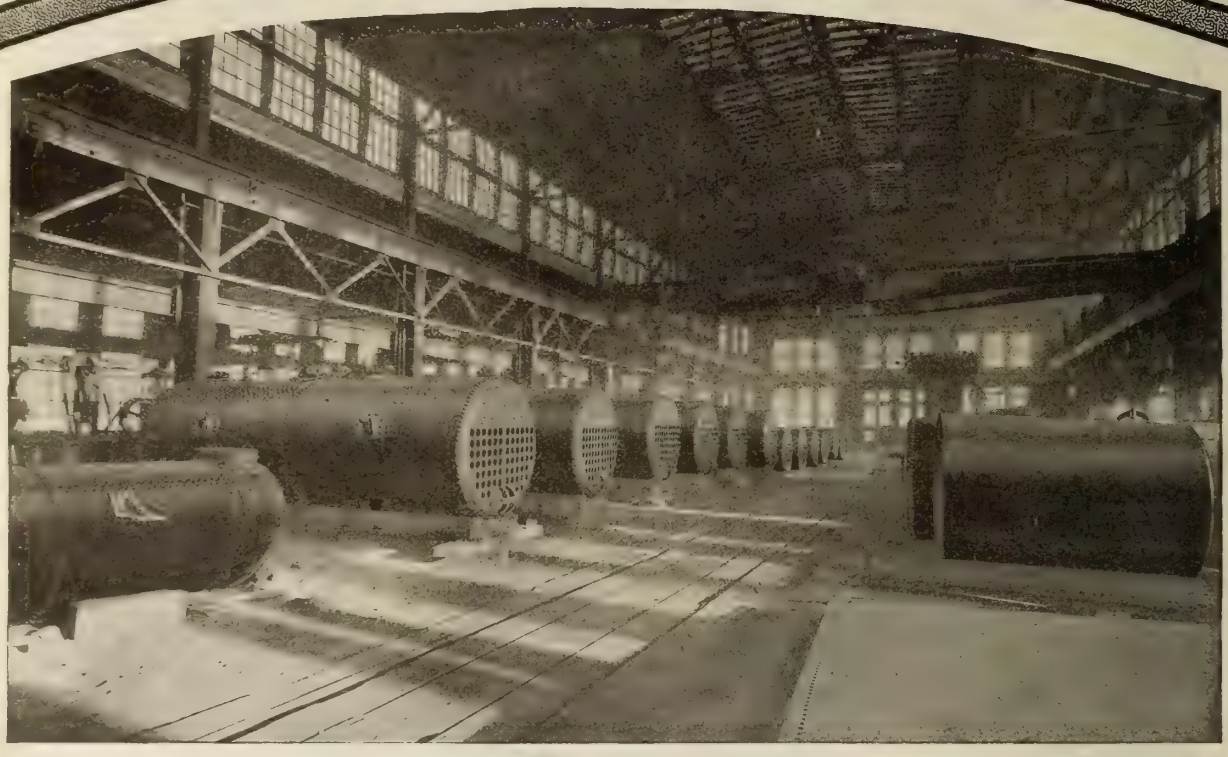
EMPLOYING MECHANICAL DRAFT

Its fundamental principle is a conveyor feed, positive in action from coal-hopper to ash-pit.

CHRISTY

FOUNDED 1844 ST. LOUIS

DEPENDABLE POWER EQUIPMENT



A small corner of our Boiler Shop, showing 12 Boilers under construction on one order

G. & McC.
Horizontal Return Tubular Boilers

Goldie & McCulloch quality in material and skill in workmanship is maintained in every G. & McC. Boiler.

Tube holes are all drilled, never punched. Flanging, riveting, caulking and staying is all done by the most modern methods, and the best material for the purpose is always used. G. & McC. Boilers are designed to conform to the various provincial regulations.

We Build: Steam Engines, Steam Turbines, Return Tubular and Water-Tube Boilers, Heaters, Tanks, Stacks, Pumps and Condensers. Catalogues upon request.

The Goldie & McCulloch Co., Limited

Head Office & Works. **GALT, Ontario, Canada**

Toronto Office
Suite 1101-2 Bank of Hamilton Bldg.

Quebec Agents
Ross & Greig,
400 St. James St., Montreal.

Western Branch
248 McDermott Ave.,
Winnipeg.

British Columbia Agents
Robert Hamilton & Co.,
Bank of Ottawa Bldg.,
Vancouver

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Burning Wet Tan Bark on Mechanical Stokers

Tan Bark, Carrying From 40% to 50% Moisture, is Burned With a Very Small Proportion of Coal—The Boiler Room is a Model of Good Arrangement.

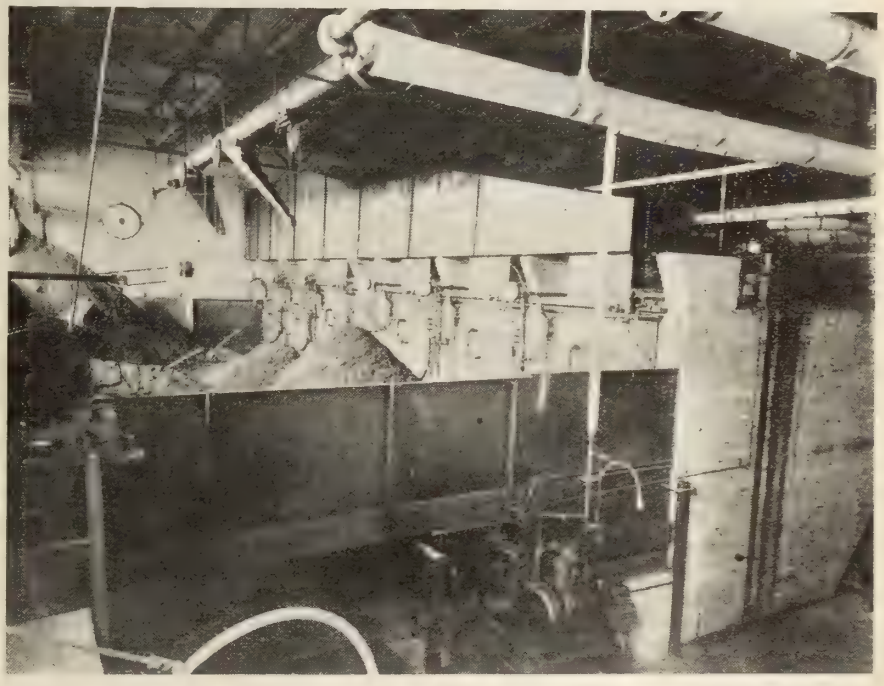
By T. H. FENNER

IT is a fortunate firm these days that can supply itself with power and heat for manufacturing purposes without the need of coal, or at least with a very small proportion of coal. Some special industries, notably those engaged in wood working processes, are able to use the refuse of manufacture to generate steam. The firm we have in mind at present is not in the woodworking business, but in that of tanning hides, and like the first named, have a lot of refuse which can be used for steam generation. This is known as tan bark, and possesses a certain heat value, though this is a very low one.

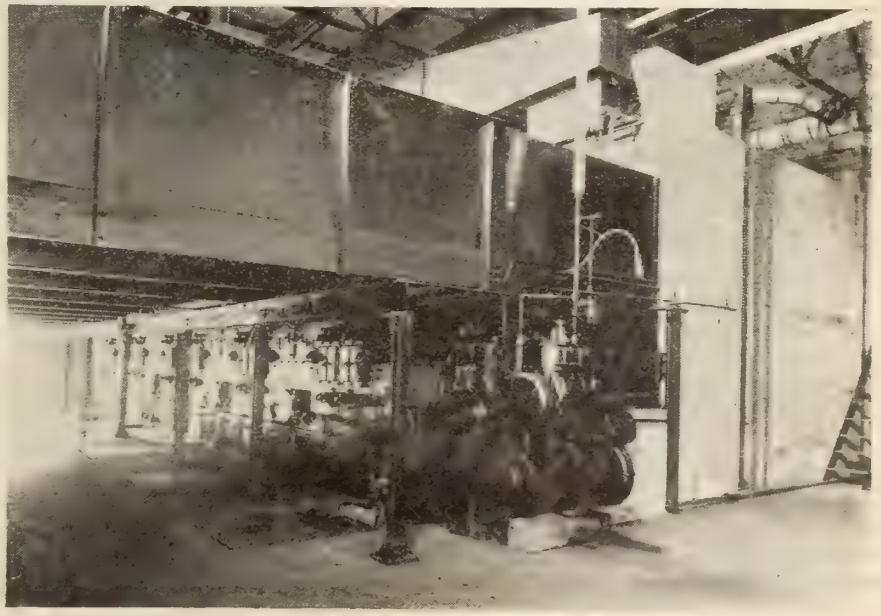
The burning of tan bark under boilers is complicated by the fact that it is very highly impregnated with moisture as it comes from the extractors. In small tanneries it is not unusual to use the bark with hand firing, but in these cases it is usually allowed to dry out. In the plant we are dealing with here, the bark goes to the furnace direct. The firm is the Lang Tanning Co., of Kitchener, Ont.

A Good Layout

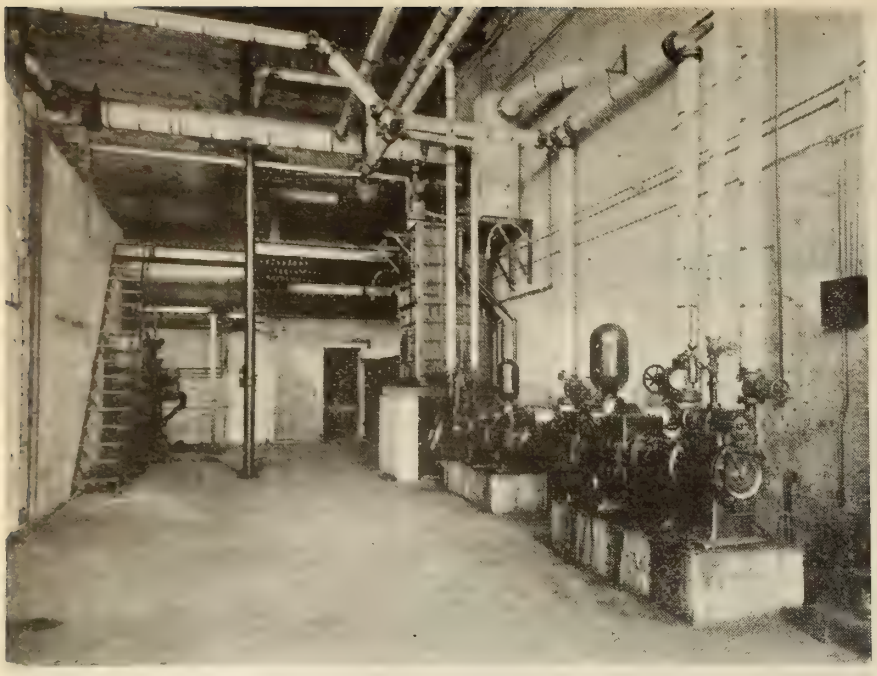
The general design of the boiler room was under the supervision of Mr. August Lang, and reflects a great deal of credit on that gentleman. It is notable for having plenty of space and very convenient arrangement. The boilers are six in number of the horizontal return tubular type, 72 inches diameter by 18 feet in length, built by Goldie & McCulloch Co., of Galt, Ont. They are equipped with mechanical stokers made by the Detroit Stoker Co., of Detroit, Michigan. The power plant consists of a 250 H.P. Corliss engine, made by Goldie & McCulloch, which, by the way, was the first Corliss engine made by this firm. It is sixteen years old, and the writer was informed by Mr. Lang that it had never cost a cent for repairs since its installation. This speaks well for both builders and operators. The feed pumps are of the outside packed horizontal type, by the same makers, and the feed water goes through an open heater before reaching the pumps. This is also made by the Galt firm. The exhaust steam from engines and pumps is used



TOP OF HOPPERS. SHOWING PILE OF TAN BARK. AND CONVEYOR ABOVE.



STOKER FRONTS AND OPERATING MECHANISM. HOPPER ABOVE.



FEED PUMPS AND DISTRIBUTING VALVE PLATFORM.

in the heater and for factory purposes, while a considerable amount of live steam is also used in the factory. The steam piping and feed water piping have been laid out with a view to making things handy for the man on the job. The top of the stokers forms a working platform in front of the boilers, and the boilers are set in two batteries of three each. In the space between is placed an iron stair and platform, leading down to the stoker floor. On the side of the boilers, in the passageway, are placed the feed valves, three on each side for the corresponding boilers. In this way the man in charge can adjust every valve at one time, without the necessity of walking from boiler to boiler. He can see plainly every gauge glass from his position on the platform, and as his eye is level with the glasses, observing the water level is easy. This is perhaps a simple detail, but this arrangement of valves saves an enormous amount of walking about during the day.

The steam pipe is anchored at one end, and connected to each boiler through suitable bends. It is laid on supports, with rollers between the pipe and support, to allow perfect ease of expansion. At the end of the boilers, there is another ladder leading from the ground floor to a platform level with the boiler tops, and over this platform, at a convenient height for a man to reach, are placed the distributing valves to the engine and all the steam lines in the factory. This again is a most convenient arrangement. The space at the back of the boilers for cleaning purposes is ample, and the blow-off pipes from each boiler are connected to a main trench which leads away to the sewer. Each boiler is equipped with a circulating and surface blow-off arrangement.

A certain amount of coal is used in conjunction with the bark, and this is supplied to the stokers from an overhead bunker. The coal storage is outside the building, and the coal is elevated to the bunker by a drag conveyor, whence it flows to the hoppers. The tan bark is brought from the factory to the hoppers by a scraper conveyor, and dumped in a pile as shown in the photo. A certain amount of trimming is necessary, but one man can comfortably look after the whole of the firing, water tending, etc.

The heat value of the tan bark is said to be in the neighborhood of 600 B.T.U. per pound at the amount of moisture carried, which is in the neighborhood of 50 per cent. According to Mr. Lang, who has had many years' experience in this line, great difficulty has always been experienced in burning it successfully. Dutch ovens have been tried with but indifferent results, but the present arrangement is the most successful yet tried. To get the necessary draught a 250-foot chimney is used. The plant has been installed but a short time, and thorough scientific tests have not been made, but we understand that these will be available in the near future. We hope then to be able to present them to our readers.

AN ECONOMISER EXPLOSION

The Board of Trade report on an economiser explosion, which occurred in Huddersfield, emphasises the necessity for handling these valuable adjuncts to boiler plants properly if accidents are to be avoided. The economiser in question was evidently in good condition and quite capable of withstanding ordinary reasonable service, but it exploded one morning and wrecked all the adjacent brickwork. Had the accident happened a few minutes earlier, when the mill hands were passing by on their way to work, there would probably have been many fatalities. As it was, no one was even injured.

The economiser was used to heat the feed water for three Lancashire boilers, and the flues were so arrangd that the gases could be by-passed direct to the chimney. The mill engine, which was supplied by the boilers, was ordinarily run from 7 a.m. to 5.30 p.m., and then shut down for the night, when the fires were banked and left in charge of the night watchman. Feed water for the boilers was supplied by a ram pump belt-driven from the main engine, or by an injector. The ram pump started and stopped with the engine. During the night the watchman occasionally fed a little water into the boilers, through the economiser, and would naturally have to use the injector for the purpose. In the early morning he began to raise a full head of steam, and to get the necessary draught opened the dampers to pass the gases through the economiser. At 7 o'clock the engine was started, and very shortly afterwards the economiser burst.

It is fairly evident that the cause of the accident was a sudden change in the temperature of the economiser tubes. During the hour and a half while the steam pressure was being raised, but no demand made on the boilers, the economiser would get very hot. When the engine was started the feed pump drove the cold feed water into the economiser. The sudden contraction of the tubes, caused by the cooling, cracked them and they blew up under the steam pressure. The proper way to handle the plant would, of course, have been not to pass the hot gases from the fires through the economiser until feed water was needed by the boilers, and it might even be necessary, on account of leaky dampers, to keep down the temperature of the economiser during the night by giving it a little feed water. Added to these considerations, it would be better, for the sake of economy in coal and for the prevention of external corrosion of the economiser tubes, if the feed water were warmed before being led to the economiser in the ordinary course of working.—The Engineer.

Note.—Feed water should never enter an economiser at less than 90°, and preferably higher.—Editor, Power House.

The Worthington Pump and Machinery Corporation have issued a very complete and well illustrated catalogue of their marine pumping equipment. This covers horizontal, vertical and centrifugal pumps for boiler fuel, ballast and circulating purposes. Cross sectional views are given showing the details of construction of some types of pumps. While primarily a marine catalogue, many of the pumps illustrated are equally suitable for stationary purposes.

Regarding the Control of Combustion

By T. A. PEEBLES

THE losses occurring in the generation of steam are usually divided into two groups, one of which is necessary and the other avoidable. In considering the necessary losses it is assumed that a perfect stoker will burn all the fuel with the theoretical air supply, there being no loss due to excess air, incomplete combustion, or combustion in the ash, and the boiler is assumed to be theoretically capable of cooling the gases to the temperature of the water in the boiler.

Necessary Losses

The heat required to raise the temperature of the dry chimney gases from atmospheric temperature to that of the water in the boiler, and the amount expended in evaporating the moisture in the fuel and air, and that formed by the burning of hydrogen, are assumed to be necessary losses.

In the modern central station each boiler is equipped with an economizer and if the steam-generating unit be considered as consisting of stoker, boiler and economizer, this division of the losses is no longer acceptable. If certain difficulties which are encountered when cold water is supplied to the economizer were overcome, water could be pumped from the condenser direct to the economizer and the so-called necessary losses eliminated. Such a unit will absorb 85 per cent. of the total heat of the coal. (Recent tests in Europe have shown test efficiencies of over 88 per cent.)

It will usually be found that a plant which has boiler and stoker equipment capable of giving an overall officiency of 85 per cent. has the very best steam turbines available and they will approach 80 per cent. Rankine cycle efficiency. In the high grade plants, therefore, the boiler room can approach more closely the theoretical maximum than can be done in the turbine room. Smaller plants, having probably somewhat less efficient steam generating equipment will also have less efficient steam consuming equipment and again the economy in the boiler room, under proper conditions, will exceed the economy of the turbine room. The same is true of the small plants using hand-fired H.R.T. boilers and reciprocating engines.

The Why of Boiler Room Improvements

Why is it then that the statement is so often made that improvements in power plant economy must be made in the boiler room? Simply because the performance of a turbine is determined by the design, and being largely independent of the operation, results secured in service closely approximate the best test results, while, unfortunately, a very different situation exists in the boiler plant, where constant attention is necessary to the attainment of results approximating test conditions. This is exactly why the boiler room fails to give satisfactory results in regular operation. The difference cannot be ascribed to dirty heating surfaces, because where surface condensers are used or where the water is properly treated, the inside of the heating surface is kept clean, and with a good installation of soot blowers, properly operated, the outside of the heating surface is also kept practically clean. The loss comes in the improper control of the fuel and air supply and it is here that improvement must be made if test results are to be approximated in daily operation. While certain plants are doing this successfully, it requires an organization such as only a few plants have been able to develop.

Regulation by Automatics

Many attempts have been made to control the fuel and air supply automatically, but they have been only partially successful, largely because this problem has not been given the study which its importance clearly demands. These automatic regulators all work from variation in steam pressure, and before they will respond there must be a change in the one factor which should remain as nearly constant as possible. There is always a lag between a change in steam demand and the resultant drop in pressure, requiring that an over adjustment be made in every case to meet, not only the changed demand, but also to make up for the lowered pressure which must occur to actuate the regulator and bring about the necessary correction. This over adjustment, therefore, causes a variation in steam pressure, the reverse of that which originally produced the adjustment and a tendency to "hunt" is thereby established. A boiler so controlled will always be operating at a higher or lower rating than the actual demand at that particular time. Well managed boiler plants operate with the right number of boilers in service, so that the plant load will be carried with boilers operating it, at or near, their most efficient point. It therefore follows that any operation above or below this particular rating will be at an efficiency below the maximum which can be secured. The regulating apparatus usually employed will not move incrementally with variations in steam pressure, but tends to make a complete movement to either a closed or open position for each increase or decrease in pressure of sufficient amount to operate the regulator. This still further aggravates the tendency of the regulating mechanism to "hunt" and the net result is a period of operation at a minimum rating, for which the fuel and air supply are adjusted, followed by an interval of operation at maximum rating. Such conditions cause wide variations in furnace temperature with the attendant troubles from furnace brickwork and boiler parts which invariably result from such operation.

Where steam engines or turbines are used for driving stokers or forced draft fans, the regulator is employed to operate a balanced valve located in the steam line to such units. These balanced valves have a relatively short travel between minimum and maximum opening, and when operated by a regulator which has a tendency to "hunt," impose very severe service on the steam-driven unit, operating it intermittently, at maximum and minimum rate with sudden changes from one extreme to the other. The same condition exists where the rheostat of a motor-driven unit is controlled by such a regulator.

The fuel bed resistance depends upon the condition of the fire and the rate of combustion, and it is disastrous from the standpoint of economy to double the draft and the fuel feed just because the steam pressure has dropped slightly, or reduce the draft to a minimum for a slight increase in pressure. The maximum and minimum ratings are both points of low efficiency and this condition is aggravated if the draft is varied from one extreme to the other so suddenly that there is no corresponding change in the thickness of the fuel bed.

Going Back to Hand Regulating

The boiler plant superintendents, who have made a careful study of the control of combustion, have usually abandoned this type of automatic in favor of hand regulation, with the assistance of certain indicating and recording instruments. The damper operating levers, and the fan and stoker controlling devices are located at a convenient point with steam flow meters and draft gauges so mounted that the fireman can observe from these instruments the effect of each adjustment made. By observing the flow meter, the fireman is able to determine the demand on the boiler and by means of a large pilot gauge he is informed immediately of any change in steam pressure, and is therefore able to make the necessary adjustments to meet the demand for steam and maintain a practically uniform pressure.

Draft gauges and gas analysis instru-

ments enable him to determine whether or not the relation of air supply to fuel supply is being maintained correctly. With this equipment at his command, the intelligent fireman can secure results which closely approximate test efficiencies, but the difficulty of building up and maintaining an organization capable of doing this is demonstrated by the small number of plants which are actually securing such results in daily operation. It is, therefore, important that automatic apparatus be developed which will actually make the necessary adjustment to maintain correct conditions.

What a Successful Regulator Must Do

Just as the skillful fireman depends, first, on the indications of the flow meter, and, second, on the pilot gauge, a successful automatic regulating mechanism must respond primarily to variations in the rate of flow of steam with secondary control from variations in pressure. The fireman makes adjustment of fuel and air supply in proportion to the change in the flow meter reading or the indication of the pressure gauge, making only slight adjustment for a slight change, and greater adjustments for the wider variations. The automatic regulating apparatus must do exactly the same thing, and must not under any circumstances go from one extreme position to the other extreme, unless a very exceptional condition of load required it. Where stokers or stoker auxiliaries are steam driven, the steam supply must be controlled by means of the automatic regulator, through the medium of a regulating valve, which can be readily adjusted for the correct amount of steam, corresponding to any given demand on the boiler and which will give finely graduated control between the two extreme positions.

Where forced draft is employed, the careful fireman reduces the draft before cleaning fires. The regulator must be so arranged that the draft can be momentarily adjusted without disconnecting the regulator from the dampers or controlled valves which it is operating, and it must remain in the desired position irrespective of changes in steam flow or steam pressure, until the cleaning period has been completed. When the soot blowers are being operated, the boiler damper should be wide open, and the automatic regulator should be so arranged that the boiler dampers can be put in a wide open position and held there, irrespective of changes in steam flow or pressure, until the soot blowing has been completed.

Mechanically, the apparatus must be rugged, and substantial in design and construction. It must be sensitive to slight variations in flow of pressure, and the vital parts must be so protected that the regulator can operate under conditions found in the ordinary boiler plant without frequent overhauling and repair.—Combustion.

Explosion of an Oxygen Tank

THE accompanying engravings show some of the damage done recently by the explosion of an oxygen tank. One man was killed, a considerable number of persons were more or less seriously injured, and the property loss was large.

The tank, which was used for storing electrolytic oxygen, was about ten feet long and four feet in diameter. The shell was made of 7/16-inch plate, laid in two courses, each five feet long, and the longitudinal (or "fore-and-aft") joints were of the triple-riveted lap type, having a calculated efficiency of about 75 per cent. The upper head of the tank was convex, and the lower head was originally concave. (This method of construction is not altogether ideal, but it is reasonably safe for ordinary purposes, when a factor of safety of at least five is used by the designer.) A safety-valve was provided and adjusted to blow off at 100 pounds pressure.

The initial rupture apparently occurred in the solid plate, the line of fracture running parallel to the length of the tank, but keeping well away from the riveted joint. The shell tore away from the head at one end, and the line of rupture also followed the girth joint at the middle of the tank, so that a considerable part of one of the sheets opened out like a leaf in a book or magazine. (See Fig. 1.) In addition to this, the lower head, which was originally concave, was ruptured along one of its diameters, and its curvature was reversed so that it was convex after the accident.

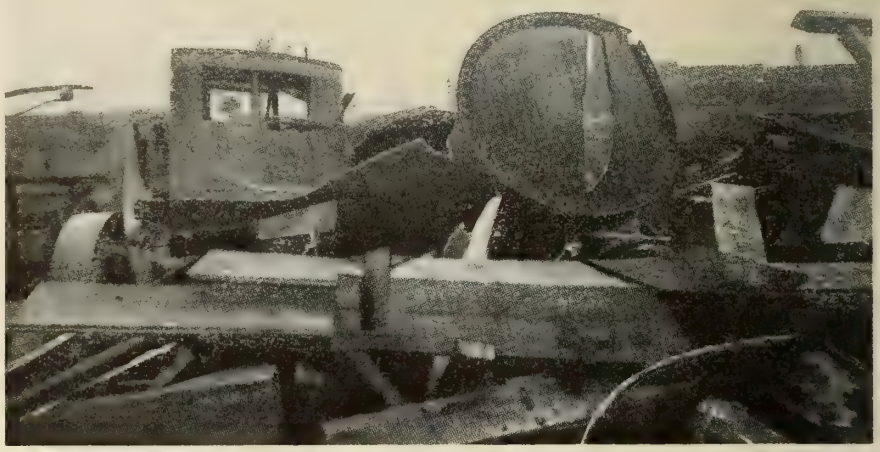


FIG. 1—EXPLODED TANK AND RUPTURED HEAD.

FIG. 2—GENERAL VIEW OF THE RUINS.

The cause of the explosion is not definitely known. In connection with the

FIG. 3—GENERAL VIEW OF RUINS.

production of electrolytic oxygen there is always a possibility of reversal of polarity occurring in the electric generator, and a consequent mixing of oxygen and hydrogen; but it is believed that this did not occur in the present case. It is far more probable, in our opinion, that the accident was due to the presence of lubricating oil in the tank. Pumps used for compressing oxygen are supposed to be lubricated with soap, or merely with water; but it is said that distinct traces of lubricating oil were found on the lower head of this tank after the explosion. The use of any true oil for lubricating purposes in connection with the compression of oxygen is always dangerous, and it appears to be highly probable (as we have already said) that this accident was due to the presence of such oil, and to its spontaneous explosive combustion. It also appears to be more than doubtful if the gas was properly tested for purity.

The exploded tank was supposed to be strong enough to require a pressure of 1,000 pounds per square inch to produce rupture,—assuming that the pressure was applied steadily and with gradually increasing intensity. In accordance with well-known mechanical principles, however, a suddenly-applied pressure of materially less magnitude might produce failure. We have no way of knowing what the actual maximum pressure may have been.

This accident, whatever its cause may have been, illustrates the reality and seriousness of the danger associated with the handling of compressed gases, and demonstrates the need of exercising great care to keep every kind of combustible matter away from compressed oxygen,—whether the combustible material be gaseous, liquid or solid.—Travellers' Standard.

MICA AND ITS USES

Mica is one of the most useful minerals, the production and distribution of which is little known. Of the many varieties, only three are of commercial importance, and of these but two are available in any quantity—the muscovite, or white mica, and the phlogopite, an amber mica. The latter is the most important of Canadian micas.

India is the largest producer of mica, providing over 50 per cent. of the world's supply. Canada produces about 25 per cent., and the United States and other countries the remainder.

In Canada, mica occurs pretty generally. The most productive areas are situated along the lower St. Lawrence below Quebec, north of the Ottawa near Mattawa, and in the townships of Burgess in Leeds county, Lanark in Lanark county, and Loughborough in Frontenac county, also in a few areas in British Columbia. The production of 1919 was valued at $273,305.

Mica mining is attended with many difficulties. For successful exploitation it is essential that the miners be experienced in the mining of this material, and be familiar with the special conditions and problems it presents. Many good mica deposits have been abandoned on account of the lack of experience of the operators.

The general run of mine mica is of a small size. A very small percentage produces sheets of 4 x 6-inch surface, while fully 50 per cent. will cut to 1 x 3 inch sheets only. Fortunately, a process of cementing the small sheets enables the building up of larger surfaces. This product is known as "micanite" or "mica board" and is mostly used in the electrical industry for insulation. Mica is largely used in the manufacture of boiler and steam pipe covering, its insulating properties exceeding by far that of any other known substance. Comparative tests have demonstrated that the loss of heat from bare pipes has been reduced by 90 per cent. when the pipes were enclosed in mica covering.

Owing to its resistance to shock, mica is used for spectacles or goggles worn by workmen in industries where flying chips or sparks endanger the eyes, and in observing processes of melting and fusing in furnaces. The small pieces of mica, formerly wasted, are now used for various purposes. When ground fine in oil, mica forms a valuable lubricant, especially for shafting or journal boxes on locomotives or railway cars. Ground mica, when mixed with a flux, is also used in giving to wallpaper and other substances a silvery effect.

So many uses are being found for mica that what was formerly an industry with a very large proportion of waste is now one in which the material is almost completely utilized.

LONDON LODGE NO. 30 C.A.S.E.

The regular meeting of the C.A.S.E. London No 30, was held on November 19, and took the form of a social evening. A splendid programme of reading and solos was greatly appreciated by all present. After the programme a dainty lunch was served by the Ladies' Auxiliary.

There were about fifty present and a splendid time was enjoyed by all.

Brother Noll, who acted as chairman, made a suggestion that the gentlemen take charge of the next social and provide entertainment and refreshments.

On Thursday December 2, Brother D. F. Campbell will give a lantern slide lecture at the Technical School on steam turbines.

THE MOST POWERFUL GAS ENGINE

This distinction is claimed for an engine made by the Cockerill Society in Liege, Belgium. In August, 1914, it was in process of erection. The Germans after the capture of the city allowed it to be put into operation and, when they were assured of its success, took it from its owners and sent it into Germany, to Duisburg, where it was running at the time of the Armistice. It was then sent back to Liege, where it was installed for the second time, with the addition of some improvements. It develops 8,000 h.p. The cylinders, four in number, are 1.3 m. in diameter, 1.5 m. stroke, 94 r.p.m. The heat of the gases coming from the engine is used to generate steam for a turbine.—La Nature.

High Priced Coal.—Notwithstanding a general decrease in the prices of foodstuffs, Windsor dealers increased the price of anthracite coal to $26 a ton, approximately $10 more than the price being charged in Detroit. The difference in exchange and a shortage of coal are responsible for the step, it was explained.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

THERE has been so much written and spoken on the subject of combustion of late years, that it should be written in letters of gold on the tablets of the engineer's memory. However, this is probably not the case, so we will go over this important subject briefly, not from the view of the theorist, but from a practical standpoint.

Fuel of any kind is merely the reservoir in which nature has stored up heat, some kinds of fuel carrying more heat units to the pound than others. Combustion is the act of liberating these units of heat and by mixing the various constituents of the fuel with a proper proportion of oxygen, ensuring the full benefit of these heat units being secured. It is on this mixture of air that efficiency or lack of efficiency depends and it is for providing the necessary air that we erect tall chimneys, or install fans or blowers.

The constituents of fuel which provide us with heat are carbon and the hydro-carbons. These latter are in the form of volatile gases, or in other words, gases that are distilled from the mass of the fuel, burning with a blue flame, and forming carbon dioxide or carbonic acid gas. When these gases are distilled there is left the fixed carbon, or the solid part of the fuel, in the form of a charcoal or coke. This also disintegrates and burns away, leaving only the incombustible portions, such as ash or clinker.

Constituents of Coal

The principal constituents of coal are easily remembered by their initial letters, which may be written to form two very familiar words, thus NO CASH. The initials stand for nitrogen, oxygen, carbon, ash, sulphur, hydrogen. Of these, it is only the carbon and hydrogen that furnish us with heat. The nitrogen is inert, the oxygen forms, in conjunction with part of the hydrogen, into water, and therefore causes a loss of heat proportional to its weight multiplied by its latent heat. The sulphur has a slight heating value, but it is detrimental in other respects. It is a very small portion of the total weight of coal.

Classification of Fuels

Fuels are classified generally according to the amount of fixed carbon they contain. Coal is broadly divided into two main classes, anthracite and bituminous. The anthracite group contains a very small percentage of volatile matter, being from 90% to 96% carbon, while bituminous contains only 50% to 70% carbon, the balance being volatile matter. This percentage applies only to the combustible material, the ash and clinker being neglected. This, of course, is only for purposes of comparison, the incombustible portion of the fuel being a very important part, as it has to be paid for, although it is of no use.

The ash content of both bituminous and anthracite coals varies very much, being as low as 3% in some kinds of bituminous, and as high as 20% to 22% in some anthracites. The heat value of a pound of coal will vary as the proportion of hydrogen and carbon it contains to the incombustible portions. The oxygen will unite with the hydrogen in the proportion of eight parts of oxygen to one part of hydrogen to form water. From this the well-known formula, known as Dulong's formula, from the name of the deducer, is evolved, and is as follows:

If h=heat C=% of carbon, H=% of hydrogen, and 14600=the heat value of one pound carbon, 62000=the heat value of one pound hydrogen. Then

$$h=14600\ C+62000\ (H-\tfrac{1}{8}O).$$

The constituent parts such as sulphur, ash, nitrogen are neglected in this formula as being of no use in furnishing heat. In analyzing coal for heat value it is usual to furnish a proximate analysis, and an ultimate analysis. The first gives the composition of coal in terms of its moisture, volatile matter, fixed carbon and ash, while the latter gives details of sulphur, hydrogen, carbon, nitrogen and oxygen, and the heat value is given from these. The actual heat value can be determined in the laboratory by experiment, but neither the heat value as determined by the calorimeter, nor the heat value as determined from the analysis, is a guide as to the heat value they will give in the furnace. Chemical analysis is a good guide in purchasing coal, and also as furnishing a standard for the quality, but it must be remembered that the heat value given by analysis and calorimeter test is based upon perfect combustion. That, as we know, is practically never obtained, although it can be closely approximated under favorable conditions. Supposing we have a coal containing 5% hydrogen, 76% carbon, and 9% oxygen, the remaining 10% being ash and nitrogen, then by Dulong's formula, the heat value will be

$$h=14600\times.76+62000\ \left(.05-\frac{.09}{8}\right)$$

$$=11096+2309$$

$$=13495$$

This is a fair sample of Pennsylvania coal of the bituminous variety.

Quantity of Air Required

We have spoken about getting as near as possible to conditions of perfect combustion, and in order to get this we must know exactly how much air is required per pound of coal to give the proper amount of oxygen. Oxygen is the gas that supports combustion and deprived of oxygen, combustion fails. The atmospheric air is the vehicle which carries the oxygen, and therefore we must supply air to the furnace in order that the carbon can receive the requisite amount of oxygen. The other constituent of the air, nitrogen, is of no use to us, and not only that, it has to be heated to the temperature of the other gases, and in doing so extracts heat from the furnace, which it carries up the chimney. Therefore, we must keep the air down to the lowest possible limit. We know that theoretically the amount of air required to burn one pound of coal is about twelve pounds. This is found from the quantity of air required to supply the oxygen to burn one pound of carbon, when they are thoroughly mixed. The oxygen required is 2 2-3 lbs. per pound carbon, and in order to get this quantity of oxygen we are forced to carry 3.32 times that amount of nitrogen, or 8.85 lbs. The sum of the oxygen and nitrogen is then 2.66+8.85=11.52 lbs. Air is composed of 21 parts oxygen to 79 parts nitrogen by volume, and about 23 to 77 by weight.

This theoretical quantity of air must be largely exceeded in practice, owing to the fact that furnace conditions do not allow of the perfect mixture of the oxygen and carbon. It simply means that in order to ensure getting enough oxygen, we have to supply a surplus amount. If it were only oxygen we supplied, it would not be so bad, but we have to bring in the useless nitrogen as well. The amount of excess air actually required is from one and a half to twice the theoretical amount. The quantity can be closely checked in a plant where there are flue gas recording analysers, but in a plant where these useful instruments are not on hand, it is not so easy. It is not within the scope of this course to go very deeply into the CO_2 question, and therefore we will pass over it with a brief description. When carbon is burned with the exact amount of oxygen it requires, then the product of combustion will be carbonic acid gas, or CO_2. If one pound of carbon requires 2.66 lbs. oxygen, and this oxy-

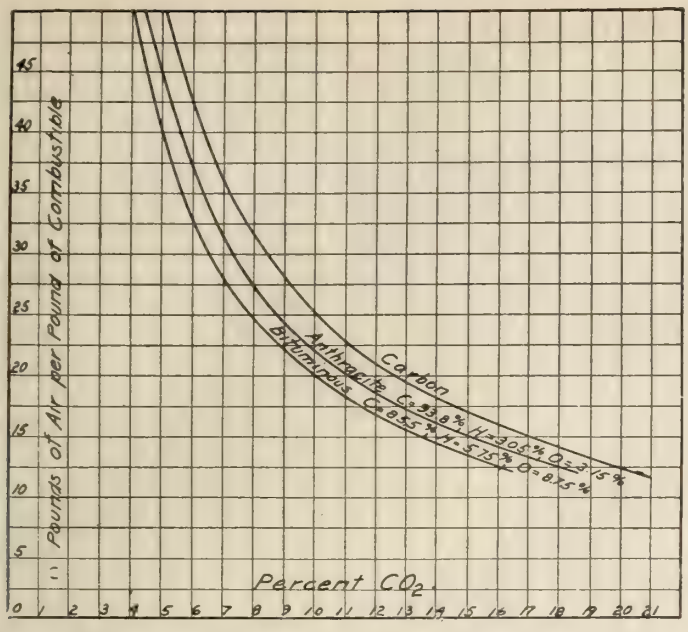


CHART SHOWING POUNDS OF AIR AND PER CENT. CO(2).

gen is supplied through the medium of atmospheric air, the oxygen present will be 21% of the total air, which is 11.52 lbs. Now when the carbon and oxygen unite to form CO_2, they occupy exactly the same space as the oxygen occupied formerly so that the proportion of CO_2 gas to the total amount of flue gases is exactly the same as the proportion of oxygen was to the atmospheric air. Well, then, if instead of the necessary quantity of air we have twice as much the same amount of CO_2 will be formed, but it will only be in one-half of its former proportion. That is, instead of being 21% of the volume, it will only be 10½%. From this we can easily see that the quantity of CO_2 in the flue gases is a direct measure of the excess air. Suppose we find we are getting only 5% CO_2. Then we are only getting 5-21 of the possible, or 23% of the full amount. Then, dividing 100-23 gives us 4.3, which means we are getting 4.3 times the excess air or about 50 lbs. air per pound of coal.

In practice, due to the presence of hydrogen in the fuel, it is not possible to obtain the full 21%, but a mark of 16% should be aimed at. The CO_2 recorder is without question the best means of checking fuel waste we have, and they should be in every plant where fuel consumption is of interest. However, where they are not in evidence, the careful engineer can use other checks.

Draft Gauges, Etc.

We spoke last week of the use of draft gauges, in connection with the efficient working of the boiler. If a flue gas thermometer is available to use in conjunction with them it will be found of great value. By comparing flue gas temperatures with different settings of the damper, and noting whether a change gives lower or higher temperatures, with the same condition of fire, a setting of the damper for all conditions of load can be developed, and marks made to set it to. Draft should never be checked by the ashpit damper, but always by the chimney damper. Further, the chimney damper should never be absolutely shut, but sufficient opening to carry away the gases should be left. There have been disastrous gas explosions through this cause. The damper being closed, there is no escape for the unconsumed gases rising from the coal bed, which is thus turned into a gas producer. This condition lasts for some little time, until there is a good accumulation of rich gas. The fireman then opens the damper wide, admitting a large quantity of air, which supplies the oxygen necessary for complete combustion, and this takes place so rapidly as to cause an explosion, which very often results in the demolition of the brick setting. This is a fairly frequent occurrence in boilers burning wood refuse, as shavings and sawdust, particularly when burnt directly under the boiler, instead of in a Dutch oven.

Intensity of Draught

The intensity of the draught, or the height of the water column, will depend on the resistance of the fuel bed and passages of the furnace. Thus a very small grade of coal which lies close on the bars needs a greater pressure to force the air through it. Burning this kind of coal on the ordinary grate presents a difficulty in that with a thin fire there is a great tendency to blow holes in the bed of coal which provide a short circuit for the air. On the other hand, a thick fire requires a very high draught pressure. It is for this reason that the burning of very small grade anthracite, such as No. 3 and 4 buckwheat and fine, cannot be successful without a suitable mechanical stoker.

With a coal high in volatile matter, which is a coking coal, the best method of hand firing is to keep the green coal towards the front, making the fire a little heavier on the front end. The air rising through the glowing carbon at the back is heated up, and the gases distilled from the green coal thus meet with a strata of high temperature air, which allows them to ignite. A low boiler setting with this kind of coal is especially bad, as it causes the freshly distilled gases to be cooled down by striking the boiler shell before ignition takes place, thus allowing them to pass out unburnt. The object of the refractory arches over most mechanically-fired furnaces is to ensure the ignition of these gases before they strike the heating surfaces. Ample combustion chambers allow of a thorough mixing of the gases with the air, which is a necessity if complete combustion is to take place, and also tends to lower the velocities of the gases.

Temperature of Flue Gases

The temperature of the gases leaving the last pass of a boiler forms a good indication as to the completeness of combustion, if heating surfaces are clean. They should be ideally about 100 deg. higher than the temperature of the steam in the boiler, but in practice are usually more. If furnace conditions appear good and the temperature of the escaping gases is too high, it is an indication of dirty heating surfaces, as the boiler is not capable of extracting the heat from the gases in their passage through the boiler. Low CO_2 will usually be accompanied by low flue gas temperature, owing to the large quantity of air to be heated up. Insufficient air will be indicated by a dull appearance of the fire, and low CO_2.

Many hand gas analysers have bottles for determining percentages of CO and O, which are carbonic oxide and oxygen, but these determinations are not usually necessary to the operating engineer. Generally, if the CO_2 is right, other conditions will be right also, and if the boiler is operating at an average of 12 per cent. CO_2, pretty good results are being obtained.

A device for continuously removing sand from water in hydro-electric works, to prevent the serious wear which is caused by its passage through the turbines, was recently described in "Le Gènie Civil." The apparatus consists of a series of parallel compartments furnished with baffle plates to prevent rapid motion of the water, which enters at one end at the bottom, and after traversing the compartments, escapes at the other end at the top. The sand and gravel fall to the bottom of each compartment, which is funnel-shaped. At the apex of the funnel a hole is provided through whicha small quantity of water constantly escapes, carrying with it the deposits. Thus the compartments are automatically cleared of sand.

A Boiler Room Load Indicator

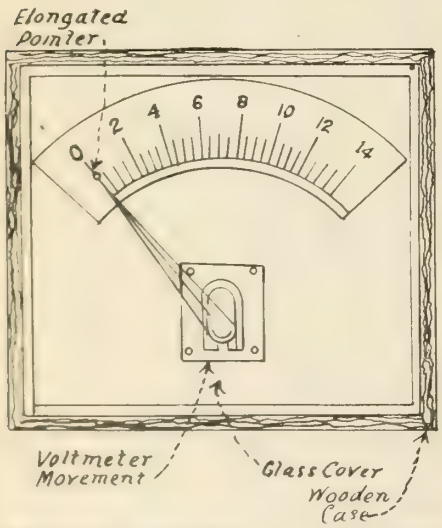
By T. G. CROSSE

(Copyright, All Rights Reserved)

The central station company that operates in one of our larger cities has installed in the boiler rooms of certain of its plants indicators whereby the boiler attendants are advised graphically of the kilowatt load on the station at different periods of the day so that they can handle their fires accordingly. The arrangement comprises merely three voltmeters, one in each boiler room and one at the switchboard operator's desk, all of which are so interconnected with a source of current and a resistance that the switchboard operator can vary the indications of the voltmeters simultaneously and at will. All of the voltmeters have scales which have been altered to read kilowatt load rather than volts. When the operator desires to telegraph the fact that a change in load has occurred, he adjusts the resistance until the pilot instrument in front of him reads the number of kilowatts load then on the station. Then the other two instruments in the boiler rooms will indicate the same reading because of their being interconnected with and having the same calibration as the pilot instrument.

One of the boiler-room indicators is shown in Fig. 1. The circuit showing how the indicators are connected and operated is delineated in Fig. 2.

It is of material assistance to the economical handling of a boiler plant if

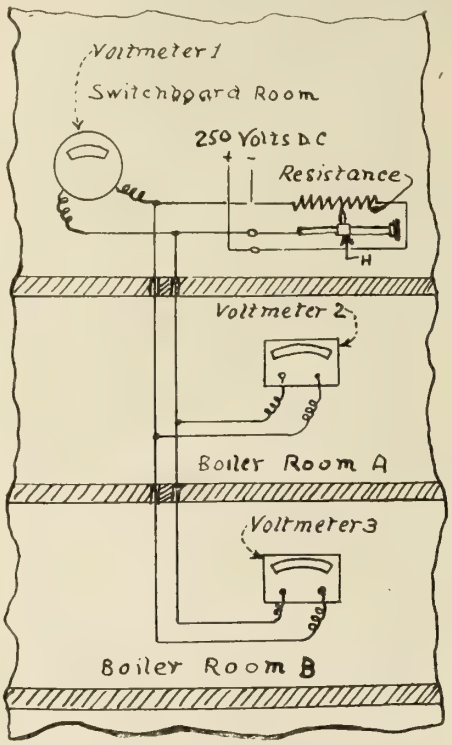


STANDARD VOLTMETER AS BOILER ROOM INDICATOR.

the stokers know the load that the plant is carrying. For example, if the stokers see by the indicator that the load is rapidly increasing, as it sometimes does when a period of darkness, due to a storm, ensues, or when it becomes suddenly dark in the evening, it is obvious that more boilers must be cut into service, or that those that are in service must be pushed to their maximum capacities.

Again, if the fire-room foreman sees from the position of the indicator needle that the load on the plant is decreasing, he immediately knows that he must cease heavy firing, and that possibly some of the boilers should be cut out of service.

The arrangement as used by this company is not automatic but is operated by



SHOWING WIRING OF PILOT METER AND BOILER ROOM INDICATOR.

the switchboard operator. In other words, the system of wiring the electrical instruments is merely an arrangement for transmitting a graphic message from the switchboard operator's gallery to the boiler room. The indicators used in the boiler room (Fig. 1) were made from Weston d.c. station voltmeters, altered into the form shown in the picture. The length of the pointer was increased from the usual 3 inch to 16 inch, so that the narrow end of the pointer would swing over a long scale that would be visible from any portion of the boiler room. This extension to the pointer was constructed somewhat in the form of a truss so that it would have maximum strength with minimum weight. The only portion of the original Weston meter that was retained was the movement, magnet and back board.

The scale of each indicator was divided into seven main divisions, and each one of these main divisions was divided into fourths. Assuming that each main division represents 20,000 kilowatts, the full scale deflection of the instrument would represent a load of 140,000 kilowatts on the station. Each subdivision represents a load of 5,000 kilowatts. The glass-front case enclosing each boiler-room indicator was made 2 ft. 9 in. wide and 2 ft. 6 in. high.

The switchboard operator has in front of him a standard round-type d.c. voltmeter, shown in the circuit of Fig. 2, which has its scale divided from 0 to 140, and has subdivisions, each one of which represents 5,000 kilowatts.

The resistance whereby the current through, or the voltage impressed on, the voltmeters is changed, consists of enameled wire wound on a spool.

A movable contactor is arranged to slide over the convolutions of this wire along a groove where the enamel has been removed. Thereby the contactor makes contact with the resistance wire. Electricity for the operation of the arrangement is furnished by a 250-volt storage battery used in connection with the exciter system.

It is obvious from a study of Fig. 2 that the switchboard operator can, by moving the adjusting handle H backward or forward so regulate the voltage impressed on the three meters 1, 2, and 3, that the three meters can be made to indicate simultaneously any value between 0 and 140,000.

When the load on the station is reasonably steady, the switchboard operator moves the adjusting handle occasionally so that the three indicators will show the load. However, at times when the load is changing rapidly or during the period of peak load, the operator shifts the handle every few minutes so that the fire-room force will always be conversant with the kilowatt load that the station is pulling.

SOME POINTS ON TURBINE MAINTENANCE

When it is considered that the losses in a turbine due to leakage and friction are only about 3 per cent. and 1 per cent. respectively, it is obvious that there is not a very wide field for the practical engineer to improve the efficiency. Reciprocators, on the other hand, usually provide plenty of scope for improvement when they are shut down, and this characteristic difference between the two types of prime movers is apt to result in the turbines being neglected, especially if the engines are troublesome or if the maintenance staff is limited. A thorough overhaul annually when the bearings, governor gears, blades and joints are attended to is generally sufficient to keep a turbine in good order. The rotor bearings will run much longer than the crank-shaft bearings, due to a practically even turning effort and the rotor being in equilibrium, as far as mechanically possible. That is to say, theoretically, the bearings only take the load due to the weight of the rotor and not a reaction load of

developed energy as in the reciprocator. This latter statement depends for its accuracy on the perfect dynamic balance of the rotor.

To secure long life and reduce maintenance charges on the rotor bearings it is most important to keep the rotating element balanced as perfectly as possible. Imperfect balancing causes reaction loads on the bearings, and sets up vibration, which is bad for the turbine, the floors and buildings. A well balanced turbo-generator set may develop an imperfect balance in time, due to either dirt on the rotor blades or slight movement of the generator rotor coils. Vibration will result when the bearings become worn, and allow the shaft to rebound in them. Sometimes it is difficult to distinguish the vibration caused by imperfect balance, or excessive bearing clearance, but when it is the latter the following rules generally apply. The vibration decreases as the speed increases, and when up to speed it further decreases as the load increases. It decreases as the excitation increases, owing to the restraining influence of the magnetic field.

All the bearings of a set do not wear down equally in practice, and it is very necessary to know how much each one wears if the rotors are to be kept in line. There should be a shaft gauge for each journal of every turbo set, so that the wear down to 1/1000 of an inch can be measured. A gauge can be made out of one-eighth in. sheet metal and used in conjunction with feelers. It is necessary to take measurements with the gauge in the same place each time, and keep a log of the figures for reference.

A frequent source of trouble is the electrolytic action which takes place at the bearings, and where a gunmetal worm-wheel is geared to a worm on the turbine shaft to drive the governor. The ends of the bearings and the sides of the gunmetal gear become spongy or pitter. The remedy is to fit a well earthed copper gauge brush to run on the rotor shaft, preferably between the generator and the centre bearing. Most turbine oils decompose to a certain extent with the heat and according to some authorities by electrolytic action. Water also gets into the oil and in time if means are not taken to remove the impurities, the percentage of good oil in the system will be reduced until the normal running temperature of the bearings will be exceeded. It is good practice to draw two or three buckets of oil from the bedplate weekly, filter it, put the clean oil back again, and make up the deficiency with new oil. Another method is to pump a bucketful of oil from the bottom of each compartment in the bedplate with a small pump such as those used in oil cabinets. This is advisable if there are any ribs preventing the flow of the bottom layers of oil to the pump section, and when there is water present.

Turbine casings are made of cast iron, but the annular steam chest at the high-pressure end is usually a steel casting, bolted to the casing circumferentially and split horizontally, so that the top half of the casings and steam chest can be lifted together, thus only breaking one joint. It is not always a simple matter to remake this joint after the turbine has been opened up. Steel expands more than cast iron when heated, and if the casing and steam chest are to make a fair joint at the working temperature, there will be a gap of a few thousandths at the steel joints when cold. Designers endeavour to overcome this difficulty by allowing for increased compression of the cast iron and increased tension on the cast steel, to enable a fair joint to be made cold, but the result is always not satisfactory. Another point which increases the difficulty is the tendency of the casing to warp during its early life; in fact large marine turbines of the Parsons type are steamed and allowed warp before the joints are finally machined. A lead wire joint is not always successful under such conditions, but by warming the steam chest as much as possible with the H. P. gland steam and keeping a good tension of the joint studs during the process, a tight joint may be obtained. The objection to this method is when the turbines are shut down there is excessive stress put on the joint studs, due to the steam chest contracting more than the casing, with the result that they frequently break. Bolts and studs subjected to high temperature as well as tension soon crystallize and become brittle; it is good practice to anneal these at the annual overhaul, and some spare ones should be kept in stock.

THE SAFETY OF LOW-PRESSURE STEAM CHESTS

A steam-heated drying chest in the drug room of a Manchester factory, which appeared on the face of it to be quite safe from explosion, nevertheless blew up in January last and injured the boy in attendance. In view of the large number of such chests in use in the country, we give below some notes taken from the Board of Trade report on the subject, and offer a suggestion for the safety device. The chest in question was 10 ft. long by 5 ft. broad and 3⅛ in. deep inside. It was made of boiler plate, ⅜ in. thick on the top and 7-16 in. thick below. There were three rows of riveted stays ¾ in. diameter, pitched about 9 in. apart. Steam was supplied through a ½ in. pipe fitted with a stop valve, direct from the boilers, which were worked at a pressure of 110 lb. per square inch. At the end of the chest opposite to the steam inlet there was a ¾ in. drain pipe, open at the end. There was no safety valve, reducing valve or pressure gauge on the chest. When the explosion occurred most of the stays fractured or tore out of the plating, the top plate bulged upwards, and split open round the riveted joint.

The only explanation of the mishap is that the drain pipe became choked up with dirt or scale, and that the steam pressure in the chest rose too high for the strength of the chest. The Board of Trade Engineer Surveyor-in-Chief recommends the fitting of a safety valve as a precaution against such accidents, and the chest which has been put in to replace the wrecked one is supplied with steam through a reducing valve, and it is equipped with a pressure gauge and safety valve.

Seeing that the trouble in the case under review, as with many others, was caused by the choking of the drain, which, had it been free, would have provided ample protection to the chest, we suggest that some means of ensuring the periodical clearing of the drain would be a satisfactory safeguard. Such a means might be provided by extending the spindle of the inlet valve so that it reached into the outlet. Then, whenever the steam valve was opened to admit steam the extension of the valve stem would disturb any dirt which might be lodging round the outlet, and ensure the drain being kept free. A U-tube a few feet high and filled with water would form a very effective safety outlet for such low pressure services as those under discussion, and would be very unlikely to get out of order.—The Engineer.

BIG STEEL PLANT SHUTS OFF QUICK

In Response to Demands That Claims of Railroad Men Be Met At Once

Sydney.—When 125 railroad employees of the Dominion Steel Corporation served an ultimatum on the management demanding a settlement of their wage differences before five o'clock the same day the company replied by closing down the various mills at noon and ordering the banking of the blast furnaces. This action automatically threw 4,000 men out of employment, pending the settlement of the dispute with the railroaders. It is estimated that it will require at least a week to get the furnaces in operation again, and it is believed that the big plant will be tied up for that period at least. The company, in the meantime, it is understood, is making application to Ottawa for redress under the provisions of the Industrial Disputes Act. It has been stated that lack of orders has been threatening the operations of steel plants for some weeks past. For the past two years the railroaders employed within the steel plant have been contending for the scale awarded all other railroaders in Canada following the McAdoo award in the United States.

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)

A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED
[illegible] AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, NOVEMBER 20, 1920 No. 22

PRINCIPAL CONTENTS

Burning Wet Tan Bark on Mechanical Stokers	519
Regarding the Control of Combustion	521
Explosion of Oxygen Tank	522
A Course of Instruction	524
A Boiler Room Load Indicator	526
Editorial	528
Our Question Box	529
Development of New Equipment	531

Trying to Slip Through

WE recently received a letter from a correspondent, asking us if we could procure the questions asked by the Board of Examiners for second-class certificates, and furnish them to the correspondent. Needless to say, we neither can nor would if it were possible, accede to any such request.

The writer of that letter evidently misunderstands the purpose of an examination, or the benefit of an examination, or the benefit to be gained by passing it. A candidate for examination should know the subjects in which he is to be examined so thoroughly that any reasonable question should have no terrors for him. If a man presented himself for examination with the answers to a few stock questions committed to memory, he might succeed in passing, and obtain a certificate. There would be but little satisfaction to him in doing so, for he would ever have the fear that someone might come along and show him up for the fakir he really is. We do not think for a moment that we should be doing any man a kindness by trying to help him in that way.

The examinations are conducted by the examiners in a human sort of way, the object being to try and arrive at a reasonable estimate of a man's qualifications. The examiners are not trying to see if it is possible for a man to be rejected, but if it is possible for him to be passed. There is then, no occasion for a man with the requisite experience, and a reasonable amount of fundamental knowledge, to have any fear in presenting himself for examination before the Board. No man, who respects himself and his calling, will try to slip through the back way, but will present himself with confidence in his experience and ability to pass any reasonable test that may be imposed.

A Piece of Good Advice

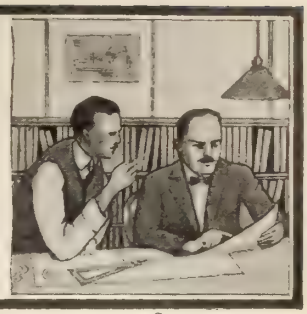
WHEN Mr. Lloyd Harris told the business men of Canada not to depend too much on the Government, he spoke words of wisdom. We do not mean by this the present Government, the past Government, or the future Government in particular, but Government in general as an institution. A government is after all only a collection of ordinary men, who have attained prominence and position sometimes through merit, and sometimes through the fact that having no particular ability, they can be useful to the stronger men in the Government that have. These several men, whatever their abilities, upon attaining place, have their whole outlook on affairs tainted with the view of the office holder, whose primary object is to retain office, and do what he can for the country next. It is obvious that it is vain to look to such an institution for leadership in any vital trade or business development. In fact, any country which depends on its Government to advance its business interests is usually disappointed. It is the enterprise and daring of the individual trader that extends trade, and although a Government can carry out the wishes of the business community to a greater or less extent, it is very rarely that they suggest anything. Generally speaking, Government intervention in matters of business is usually attended with loss and inconvenience to those in the business, as has been abundantly shown in Great Britain by the Government control of shipping. Probably the only exception of note was Germany before the war, but it must be remembered that there they had no representative Government in the sense that we have. Therefore, they had men in the various departments of the Government, who were specialists, and not politicians. The Government holds about the same position in relation to the country that a chief office clerk or office manager does to a big corporation, and should not try to overstep that mark.

KEEP GOING!

"Motor World."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered



HEATING BUILDING

Question: Having been a subscriber to The Power House since its first publication, and having seen many difficult questions discussed and answered therein, I am taking the liberty to ask your assistance in a problem I have facing me. I have shortly to install a heating system in a frame building, 52 x 20, two storeys, 10 ft. ceilings. We have to be not less than 70 deg. I would like a formula for area of pipe coil or radiator surface per 1,000 cu. ft. air space (live steam)., 40 lbs. pressure.

Answer.—In a frame building the loss per square foot per hour runs from .23 B.T.U. to .44 per deg. difference between outside and inside construction. You might take the highest as a safeguard. Your wall area will be

$$52 \times 10 \times 4 = 2080$$
$$20 \times 10 \times 4 = 800$$
$$2888$$

and the roof $52 \times 20 = 1040$, which, added to the wall, gives a total of 3920 square feet. Allow for a difference of 80 deg., that is from 70 deg. to —10 deg. and the total loss per hour will be $3920 \times 44 \times 80 = 137984$ B.t.u.'s. This does not take into acount the ventilating, and if you wish to change the air once an hour, you will have to heat the cubic contents of the room from —10 deg. to 70 deg. In your two rooms you have $52 \times 20 \times 20 = 20800$ cub. ft.

One B.t.u. will heat 1 cubic foot of air about 56 degrees, so you will need approximately 1.5 B.t.u. per cubic foot air to allow for ventilation purposes. That gives 20800×1.5, which is 31200. Adding these two, we get 137984 plus 31200=169184, say 170000 rad. surface per hour.

You can allow 1.5 B.t.u. per hour per square foot surface per degree difference of temperature between coils and room. With steam at 40 lbs. the temperature is 287 degrees and with room at 70 difference is 217 deg. Then $217 \times 1.5 = 325.5$ B.t.u. per square ft. rad. surface per hour.

$$\frac{170000}{325.5} = 522 \text{ square feet rad. surface.}$$

This with 1¼ inch pipe would be about 1200 feet.

If the building is in an exposed position, additions must be made to cover the circumstances. Rooms with northerly exposure usually have an allowance of 10% extra. If building is allowed to cool over week ends, additional coils should be put in to bring it up to temperature quickly. These latter points are a matter for your own judgment.

BOILING UP TANKS

Question

I would like to get your advice on superheating steam for boiling water for dyeing and bleaching purposes.

We have one return tubular boiler working at 125 lbs. pressure. When they open four and sometimes six 1¾" valves at once direct into cold water, which has to be risen up to the boiling point, and boiled for an hour, with a perforated pipe going direct into the water, in these various machines you get nothing but saturated steam, and sometimes pulls the water over from the boiler, which starts priming and adds more water to the various liquors and also making same weak.

I have sent sketch showing proposed way of taking steam from boiler to superheater and from superheater to dye house. Please advise me as to pipes to be used in making up superheater and if it is necessary to have a drip from same. What effect would the flue gases have on the piping?

One reason for coming on to this superheater idea is that when they have got two or three machines on at one time it will pull the steam pressure down to sixty and seventy lbs. per square inch, which is too low for our other machines, and I thought this might help us out a little, and with the higher temperature bring our machines to a boil quicker.

Answer

The arrangement of sketch would not be suitable at all for superheating purposes. Copper pipes or tubes of small diameter would be absolutely necessary. Steam, contrary to water, is a very poor conductor of heat, and in using iron pipes of large diameter there would probably be a film of steam close to the walls of the pipe and relatively little motion. This would cause the pipes to burn out.

It would appear that the question is not one of superheating at all. If four one and a-quarter inch pipes are opened freely the quantity of steam escaping per minute would be roughly 557 lbs. This in one hour is equal to 33,480 lbs., and as one boiler horsepower at the pressure your boiler works at is equal to the evaporation of about 30½ lbs. of water per hour, this means that during the time these 1¼" valves are fully opened the boiler would have to work at 1000 h. p. to supply the steam. It is little wonder that under these conditions your steam drops very rapidly. Superheating would be of no benefit in a case like this, as the opening for the steam to escape would still remain the same. In the horizontal return tube boiler superheating may be of benefit in special cases, but as owing to the construction of the boiler the heat is being taken from the gases before they have fulfilled their work, extra fuel would be used for the superheating. Without knowing the conditions in your plant, it would be difficult to advise you exactly; however, would suggest that the remedy would be found in the application of reducing valves on the steam lines entering the tank, also reduction of area of the discharge pipe.

If the heating of the tank does not require to be performed very rapidly it might be possible to use steam coils instead of the direct mixture of steam and water. It has been my experience that in most cases in dyeing and bleaching industry the area of pipes used is usually altogether too large. The water is brought to the boiling point very rapidly, and no means are taken to regulate the temperature after the boiling point is reached. The result is that a large amount of heat is lost in evaporating water at atmospheric pressure, filling the room with steam for no useful purpose.

REVERSING AUTOMATIC ENGINE

Question.—Will you please explain how I could reverse an engine with a No. 2 Rites fly wheel governor. The engine is running over at present and I require it to run under. Please explain how it can be done in my next Power House.—W. F.

Answer.—With an automatic cut-off engine, it is sometimes possible to reverse the eccentric if the maker has made provision for same. With a Rites governor, the pin on which the arm is suspended would have to be moved to a position on the opposite side of the hub of flywheel. The pin driving the rod would be thus 180 deg. from its former position. The spring would have to be put on the opposite spoke of the flywheel. You would have to see that the

upper guides were strong enough to carry the load, as these are very often made much lighter than the bottom ones. A sketch of the engine would have helped us in answering this question.

SIZE OF CHIMNEY

Question.—Being a subscriber to Power House, I take this oportunity of asking your advice in regard to a problem I have before me. What size chimney will it take for a boiler 12′ x 52″, burning hard nut coal, heating a building 80′ x 45′? What size chimney using soft slack? Is it practical to use hard coal for return tubular boiler without forced draft?

Answer.—The area of the chimney you require should be about 1/9 the grate area, which would be about 2 feet. If it is a round chimney it would mean a diameter of about 24 inches, or if a square chimney 22 inches square. This area will be the same whichever kind of coal you use. It will be necessary in order to get the requisite draft burning small anthracite coal to have a very high chimney, about 160 feet. With soft coal, a chimney of 100 feet in height would be ample. I would suggest that you inquire into the cost of force draft apparatus, as against costs of chimney. Generally speaking, it is more economical to install force draft, as then you can burn a low grade coal and need only a short chimney.

Question.—An engineer holding a third-class certificate went overseas for three years, and continued with this same certificate on his return and worked under it for three years. Is he entitled to second grade certificate? Does war term lapse the certificate?

Answer.—Cases of this kind are decided at the discretion of the examiners, and an application will have to be made to them on special form, and the experience sworn to by affidavit.

SUPERHEATED STEAM IN STATIONARY PLANTS

In these days of the high cost of coal and labor, engineers are turning more and more to look carefully into the economies possible in the use of superheated steam.

When the heating of water in a closed vessel is continued after all the water is evaporated, it will be found that the temperature again begins to rise; and it will continue to rise as long as heat is added to it. Just at the point where evaporation is complete and the final rise in temperature begins, the steam is known as dry saturated steam. At any temperature above this point, we have superheated steam. In other words, when heat is added to saturated steam, it will become superheated; if heat be abstracted from saturated steam, it will condense. If pressure be released from wet steam, more steam will be formed; if the pressure upon it be increased, some will condense.

If saturated steam be withdrawn into another vessel which does not contain water, and further heat be applied, the temperature will increase and the steam will become superheated. It is evident that the temperature of the superheated steam will depend entirely on the amount of heat added.

The main advantage in the use of superheated steam results from the fact that its temperature can be lowered (depending upon the initial degree of superheat) without condensation taking place, resulting in increased economies of power plant operation.

Pioneers in the field of modern engineering realized from the beginning that cylinder condensation was the principal cause of low engine efficiency. Many devices were tried to reduce condensation. Jacketting the cylinder was tried and the engine efficiency was slightly increased. Superheating was also experimented with and great economies were obtained. The drawback was the difficulty of lubrication.

The introduction of compound engines and the use of high pressure steam back in the late '60's and early '70's combined to force the superheater temporarily out of the power plant field.

It was not until about 1895 that interest in superheating was sufficiently aroused to place it where it was a commercially possible power plant adjunct which gave practical economy.

The principal advantage of superheated steam in connection with reciprocating steam engines is in the reduction of the initial cylinder condensation. Initial condensation is seldom less than 20 to 30 per cent. of the total weight of steam entering the cylinder. Cylinder condensation may be reduced by compounding, which results in lower temperature difference between incoming steam and cylinder walls, or it can be done by the use of superheated steam, which allows the steam temperature to be considerably reduced before condensation begins. Even when compounding is resorted to, further reduction in condensation can be obtained by superheating. It is evident, therefore, that the use of superheated steam can very materially increase the economy of engines, whether applied to the simple, compound or triple engines, the amount of saving depending upon the type of engine. For a given amount of superheat the economies may be as high as:

40%—with slow running, full stroke or throttling engines.

20%—with simple non-condensing engines.

10%—with compound Corliss engines.

6%—with triple expansion engines, as compared with the same engines using saturated steam.

These figures are taken on a basis of steam consumption. It is, however, advisable to base results on the heat consumed per horsepower rather than on the steam consumption, since taking steam consumption as a basis, we are apt to receive a false idea of the relative economies. It must also be borne in mind that superheating requires a certain amount of additional fuel. The plant economy is, therefore, not in exact proportion to the increased economy of the engine alone.

In many power plants, the main units are operated on superheated steam, whereas the auxiliaries are operated on saturated steam, but as the latter are necessarily less economical than the main units, there would be much greater percentage gain resulting from the use of superheated steam. While the greatest gain in engines using superheated steam comes from reducing the initial condensation, a further gain will be made with higher degree of superheat, due to the steam being dry throughout the whole period of expansion.

In the case of the steam turbine, the initial condensation is less than in the steam engine, as the temperature difference between the entering steam and the turbine walls is lower, due to the fact that the steam has a continuous course through the turbine, whereas in the engine each end of the cylinder is alternately in contact with high pressure steam and then low pressure, resulting in an average lower temperature of cylinder walls.

In steam turbines, the question of friction or "windage" has a greater bearing on economy than initial condensation. The density of superheated steam is much less than that of saturated steam and hence the reduction in friction where superheated steam is used. Furthermore, there is the mechanical question of erosion of blades due to wet steam. Superheated steam is therefore almost invariably used for the operation of turbines.

Experience has shown that for efficient operation the modern superheater must meet certain requirements which may be summed up, as follows:

1. They must be located in the direct path of the gases without causing an undue amount of frictional resistance to the passage of the gases.

2. The surface should offer the least opportunity for the adhesion of soot or dust.

3. All parts should be readily accessible for inspection or repairs and the design should be such as to allow freedom of expansion without affecting the boiler or the setting.

4. Provision should be made for the protection against overheating when no steam is flowing through the superheater units.

5. It should give the maximum superheating efficiency.

6. It should be designed with careful consideration of steam velocities and steam areas to provide a minimum drop in pressure.

(Continued on page 32)

Progress in New Equipment

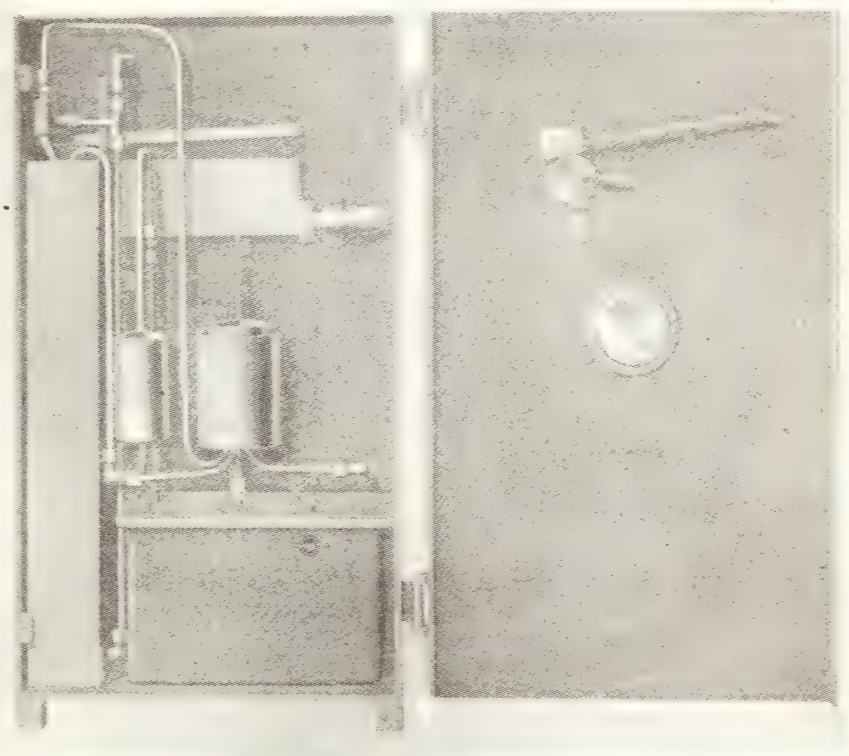
A NEW CO RECORDER

We have recently had the opportunity to inspect the CO_2 recorder, made by the Republic Flow Meter Co., and sold by the Republic Flow Meters Co., of Canada, 145 Wellington St. West, Toronto. The machine is well made, and possesses many points that will appeal to the engineer. It has been designed with a view to the conditions it will have to meet, and is of rugged and simple construction.

A few of the points claimed for the instrument are its simplicity of construction, which eliminates delicate parts and sensitive adjustments. No glass tubing enters into the construction, the necessary piping being of copper. The moving parts are limited to two, as can be seen from the detailed description, and furthermore no valves are used. The flow of gas is continuous, and the provision made for absorbing the CO_2 is ample. The machine weighs 45 lbs. and its appearance can be seen from the cut.

The details of operation are as follows:

When the CO_2 recorder is in operation, the water admitted at tube 1 flows through the loop in the oil seal for the purpose of maintaining constant temperature of the oil. It then passes vertically to the top of the case and follows through the jet 1b and aspirator 3 into the large container 5. The jet 1b forms a partial vacuum in tube 2 which draws the gas from the furnace.



MACHINE WITH CASE OPEN SHOWING RECORDING MECHANISM ON DOOR

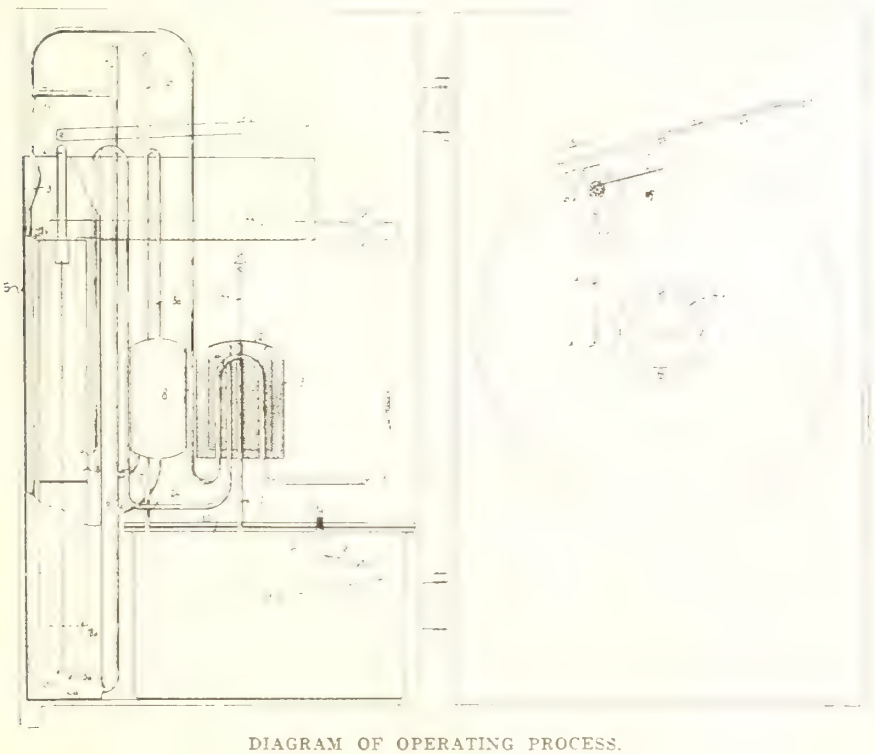


DIAGRAM OF OPERATING PROCESS.

The water rising in the large container also rises in the vertical tubing connected to the container at 5a. When the water reaches the branches 6 and 7, it seals off a definite volume of gas contained in the pipette 8. As the water continues to rise, it fills pipette 8, forcing the contents of the pipette through the tube 8a into tank 10, containing the potash solution. The gas passes through the potash solution under the entire length of the baffle plate in the tank and rises to the surface. This action absorbs all the CO contained in the gas, leaving an amount of residue gas which escapes through outlet 11 and raises float 12 to a height proportional to the amount of residue gas.

As the water continues to rise in reservoir 5, it overflows into float 18, causing the siphon system to sink. When the siphon system sinks, the water is siphoned out through tubes 22, 23 and 23a connecting with waste pipe. As the water level is lowered below point 9, it

releases the seal of the tube leading to the inside of float 12. The float lowers to rest on guide 11 and discharges the contents through the opening 9.

As the receding water reaches point 7, pipette 8 discharges through point 6,

SHOWING CHART.

drawing a charge of gas from tube 2. When the water recedes to point 23, air is admitted and the siphon action stops. The container begins to fill again, repeating the operation.

The recording mechanism is mounted on the door. When the door is closed, arm 14, rigidly connected to recording pen staff, swings into position directly over the rod 12a, and trip 15b mounted at the end of arm 15a is directly over point 21 on the siphon system. The trip is engaged when the siphon system sinks and raises weight 15 so that arm 14 is free to rest on rod 12a. Weight 15 is immediately released and its contact with 16 holds pen in position of the analysis. This exclusive feature of the Republic gives a continuous chart record, and the added feature of an indicating instrument.

THE PETROLEUM SITUATION IN THE CAUCASUS

The scarcity of the petroleum oils and the rising prices of the same in this country give a special interest to a report that has been made on the petroleum situation in the Caucasus by M. Aldebert as published in Le Geine Civil.

Communication with the oil regions of the Caucasus, which was becoming more and more difficult since 1914, was cut off entirely in 1917 because of Bolshevism and the Turco-German occupation. At the present time we are still very poorly informed on the subject. Widely different and contradictory reports are in circulation, and the report of M. Aldebert sets out to classify the situation as it existed on January 1, 1920.

Almost the whole of the Russian oil production comes from the Caucasus. In 1916 this amounted to about one-sixth of the total production of the world, and ranked Russia as next to the United States as a producer of mineral oil.

Although the Caucasus forms a continuous oil-bearing basin, for indications are found upon both the northern and southern slopes of the mountains, M. Aldebert divides the territory into three sections where the principal developments are concentrated:

1. The Maikopp section, which yields about 1.2 per cent. of the Russian output.
2. The Grosny section, which yields 17 per cent.
3. The Baku section, yielding 78 per cent.

In the Maikopp section, which is divided into three groups, there are 138 wells, of which only 38 are worked. These have a daily yield of about 67,000 gallons. The principal group at Maikopp is connected with the refineries at Ekaterinodar by an 8-inch pipe line about 87 miles long. The other two groups are connected by pipe lines to the tanks on the Ekaterinodar and Nova-Rossisk railway. The production of the Maikopp section rose from 503,000 gallons in 1908 to 47,140,000 gallons in 1912, but fell to 10,309,000 gallons in 1916, while in 1919 the output had again risen to 15,400,000 gallons.

These operations have suffered very little from the war, being situated in the centre of the provinces of Couban and Tereck, where the population is Cossack and, from the very outset of the revolution, have resisted the Bolshevik movement and have made up the nucleus of Denikine's army.

At Grosny the section is divided into two parts, that of the Old and New Rayon, located at a distance of about 9 and 3 miles, respectively, from the city. The operations at Old Rayon have not been destroyed, either by the revolution or the uprising of the populace, but at New Rayon the operations have been almost totally destroyed.

In November, 1917, seven flowing wells were fired and burned until February, 1919. Some of these wells had a yield of more than 283,000 gallons a day. An immense layer of lava produced by the burning oil covers the slopes of the hills to a depth of more than a foot. This lava consists of a petroleum coke and is actually used as a fuel under boilers. The wells which were not burned were destroyed with the axe and dynamite.

At New Rayon, out of 122 wells which existed before the revolution, only 5 are now being worked; 7 are being repaired, while the others are idle or have been abandoned.

The operations of the Grosny basin were begun in 1896, and grew continuously, except for a slight fluctuation during the first revolution of 1906, and reached a total yield, in 1917, of 550,300,000 gallons; but it would have reached 786,000,000 gallons had transportation facilities been sufficient.

In addition to tank cars there were 8-inch pipe lines leading from the district to the Caspian and Black Seas which, before the war, had a daily capacity of 10,310,000 gallons, while to-day, after repairing the pipe line destroyed in 1917 and the two pumping stations out of four, the capacity is only 471,000 gallons a day.

At Baku the production of the Akcheron peninsula, which was 258,000,000 gallons in 1882, steadily increased until it reached its maximum of 3,457,000,000 gallons in 1901. The revolution of 1905 cut the production of this section down to 2,106,000,000 gallons, but as matters became settled it rose to 2,467,000,000 gallons in 1916, although the scarcity of repair parts, machinery and material began to make itself felt in consequence of the war and the closing of the Dardanelles. The year 1918 brought in anarchy, and industry was completely paralyzed.

The year 1918, with a production of 630,000,000 gallons, saw the nationalization of the petroleum industry, followed by a Turkish occupation after several days of bombardment with its horrors and massacres. The economic disorganization is complete; there are now neither new operations nor exportations, and output is reduced to a minimum, so that we have to go back to 1889 to parallel it.

At the end of 1918 English and Russian troops occupied Baku anew. It had suffered from bombardment, but the operations were intact.

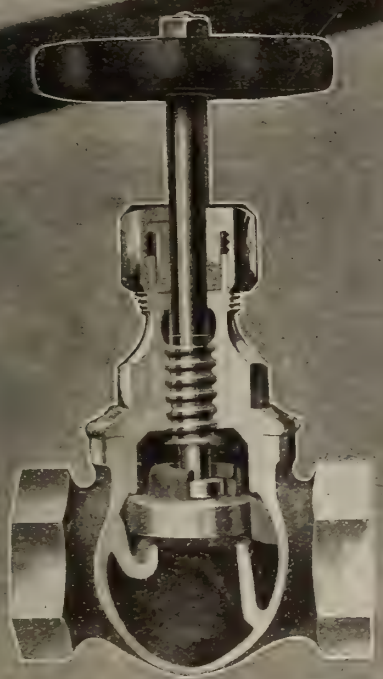
In 1919 a Tartar government was established, which later became the Republic of Azerbeidjan and was actually recognized by France. When order was established in August, 1919, the English evacuated Baku and, contrary to the forecasts, there were no massacres and no disorder.

But oil production was reduced to a minimum because there were almost no exportations, Astrakan being in the hands of the Bolsheviki, and Astrakan, before the war, handled about 75 per cent. of the Baku exportations.

In order to span this crisis the government advanced money to the operators in order to enable them to carry forward new operations, but as the tanks are full the situation is a difficult one. The exportation of oil from Baku is greatly reduced because of the lack of railroad transportation and the difficulty of passing through Georgia. The estimated production for 1919 is 1,257,000,000 gallons.

The average production of wells, which was 4,400 gallons per 24 hours in 1904, was 1,445 gallons in 1917, 1,165 gallons in 1918 and 1,730 gallons in 1919. Since the war the drilling of new wells has shown a constant decrease, falling from an average of 37,720 feet per month in 1913 to 13,120 feet at the end of 1917 and

FAIRBANKS-MORSE



An Achievement in Mechanics

EACH individual department of The Canadian Fairbanks-Morse Company, Limited has given industrial Canada a new conception of achievement in mechanics. Each department has established a 100% quality and service standard. This is what enables Fairbanks valves to stand pre-eminent wherever valves are used.

When an engineer specifies Fairbanks valves, he knows that he has selected not only quality of material but workmanship that guarantees perfect operation.

He is satisfied with the reputation and service of the institution that stands behind them. He acknowledges an achievement in mechanics.

Wherever pipe lines are laid—in Canada's great industrial plants—in her immense water systems—in mines and mills—Fairbanks valves are giving a service that is marked by the 100% seal of quality, the standard of The Canadian Fairbanks-Morse Co. Limited.

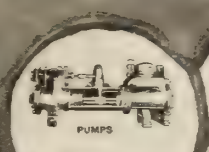
Our nearest branch will give you the benefit of this service, Our experts will help you in selecting valves and everything mechanical that you require. Make our catalogue your buying guide.

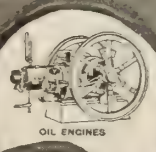
The Canadian Fairbanks-Morse Co.
Limited

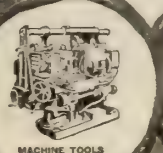
Canada's Departmental House for Mechanical Goods

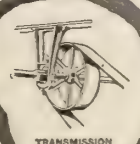
Halifax St. John Quebec Montreal Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

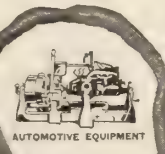
5

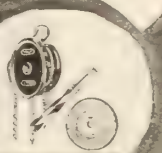












1,400 feet at the end of 1918. For 1919 the average is still lower.

Meanwhile living expenses are very high, materials scarce and high priced; though the government is making every effort to relieve the situation, which is one that affects the industries of the whole world and especially those of the United States by the unprecedented demand the low output of the Russian oilfields causes to be placed upon those of the United States.

LUBRICATION AND THE GERM PROCESS

The following is a synopsis of a paper on "Lubrication and the Germ Process," by Henry M. Wells and James E. Southcombe, M.Sc., read at the British Association meeting:

The authors draw attention that the modern view of lubrication on the physico-chemical side is the existence of a residual valency or affinity between the oil and the solid surfaces of the bearing and journal. The problem has, therefore, to be considered as a kind of intimate relationship between the oil and the metal. This is quite a different view to that held by investigators in the past, who thought that the property of "oiliness" so strongly manifested by fatty oils as compared with mineral oils resided in some particular physical characteristic of the oil itself. The modern point of view has been elaborated recently by a number of students of the subject.

The authors have discovered the reason why the fatty or fixed oils possess superior friction-reducing properties to that of mineral oils. They have shown that this is due essentially to the presence in fatty oils of minute quantities of free fatty acids, which are absent in the majority of mineral oils. In consequence of this discovery they have added small quantities (about 1 per cent.) of fatty mineral or organic acids, which are easily accessible and relatively cheap to hydrocarbon oils. The products so obtained possess remarkably low frictional co-efficients. As an example, the addition of 2 per cent. of common fatty acid to a mineral hydro-carbon oil reduces the coefficient of friction shown by this oil on a friction testing machine from 0.0084 to 0.0052—a diminution of 26 per cent.

By suitably choosing the type of fatty acid to be added to mineral oil, the behaviour of oils in the presence of water and other contaminating substances can be modified at will. It is also shown that the risk of metallic corrosion is even less with these oils than the usual compounded oils, because the latter frequently develops in working notable quantities of free acid.

The principle of making mineral lubricating oils possessing increased frictional properties by adding to mineral oils suitably chosen fatty acids in relatively minute amounts has been patented throughout the world, and has been somewhat fancifully called the "germ process," because the fatty acid is the germ of the idea.

The value of the process lies in that oils possessing friction-reducing properties much superior to mineral oils can be prepared at relatively little extra cost to mineral oils. Secondly, by this means an immense quantity of fatty oil suitable for the manufacture of margarine and other foodstuffs is liberated for the country's needs and substituted by a much smaller amount of commercial fatty acids, which are quite unsuitable for food and are more or less in the nature of a by-product.

Finally, it may enable the lubricating oil manufacturer to produce the highest class of friction-reducing oils from comparatively thin — therefore cheaper — mineral oils, and incidentally this may have the utmost significance to-day, when we are striving to foster and develop the mineral oil production of our own country and the Empire.

INTERESTING CATALOGUES

The Canadian Blower and Forge Co., Ltd., Kitchener, Ont., have issued a new catalogue, No. 19C, dealing with their varied line. This includes forges, blowers, exhausters, fans, drills, punches, shears, binding machines, tire setters.

Combination wood working machines, fan system apparatus for heating, ventilating, drying and mechanical draft, air washers, humidifiers, dehumidifiers, pumps, etc., etc., are also shown. This book contains 186 pages of real, live information to those interested in such lines.

We have received from the Grover Corporation, East Chicago, Ind., their bulletins 501, 502, 507, 509, illustrating water filters and softeners. The filters are of the vertical and horizontal pressure type, the filtering medium being crushed quartz and silica sand. A coagulating tank is supplied when required, the coagulant being fed through a Venturi tube. The bulletins on water softening contain a great amount of useful information on this subject, especially regarding the chemistry of Zeolite water softening.

SUPERHEATED STEAM IN STATIONARY PLANTS

(Continued from page 530)

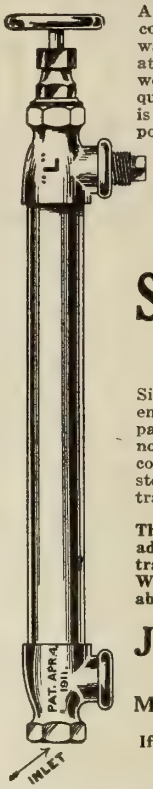
7. It should give uniform superheating and be designed for ease of regulation.

8. There should be a minimum possibility for leaks.

9. Its design should be such that it can be adapted to meet the individual plant conditions.

These considerations are vital to the success of the use of superheated steam. The high economies possible by the use of superheated steam warrant a careful study of conditions for each and every case where it is proposed to use it.

Power House Economy



A Steam Trap that saves coal by abolishing heat-wasting steam leakage, and at the same time does its work efficiently without requiring constant attention, is the trap you want in your power plant.

The Long Patent Steam Trap Fills the Bill

Simple, reliable and efficient. Has but one movable part. Automatic — requires no valves except those which control the admission of steam to apparatus to which trap is attached.

The Long Trap has several advantages over all other traps. Protected by patents. Write and let us tell you all about it.

J. T. LONG
84 ADAM ST.
MONTREAL, CANADA

If your dealer does not sell it, write direct.

6

NON-CORROSIVE CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

GALT FIRM GETS THIS BUSINESS

The Exchange Rate This Time Worked in Favor of the Canadian Firm

Irritation over United States exchange hold-up has been the means of securing for Messrs. Goldie & McCullough Ltd., of Toronto and Galt, a large order for boilers and heavy machinery for the new municipal lighting plant at Murwillumbah, Australia. Several American machinery manufacturers tendered for the business. The order is an important one. Mr. A. McArthur, of the Empire Engineering Supply Company, Sydney, Australia, at present at the Walker House, had the satisfaction of booking this order, and is expected to throw other important trade to Canadian manufacturers.

Mr. McArthur is now in consultation with officials of the Canadian Manufacturers' Association, urging that organization to inspire greater activity among its members to take advantage of present opportunities and lay the foundation for a large volume of the Australian trade. The Antipodean Commonwealth now has a tariff of 40 per cent. against all importations foreign, with a preference in favor of Great Britain and such of her Dominions as are on the same plan as Australia with respect to white labor conditions. Mr. McArthur says that if Canadian manufacturers are prepared to quote reasonable prices in many lines of articles, Australia is in the market with a large volume of orders to be filled.

Trade Gossip

Coal Supply Easier.—With the arrival of colder weather officials of the Railway Commission at Ottawa, who are handling fuel control and distribution, are not apprehensive as to supplies, if the early winter weather proves reasonably good.

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

GOOD INVENTIONS

ENCLOSED LIQUID FUEL COMBUSTION APparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented October 8th, 1918. Can be inspected at and for sale by H. W. Petrie, Limited, 131 Front St. W., Toronto.

EMPLOYMENT DESIRED

STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers, Corliss and all classes of stationary engines compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St.

RETURNED SOLDIER — EXPERIENCED painter, electrician and elevator operator, or other suitable employment; desires work at once. Apply mentioning "Power House," to Pte. (163466) Ira Charles Winckler, 83 Carlton St., Toronto.

RETURNED SOLDIER WANTS WORK—ANY kind; used to steam heat boilers. Apply, mentioning "Power House," to W. Greenfield (33065), 34 Brock Ave., Toronto.

BELTING

4½—4-PLY NEW CANVAS STITCHED BELTing at 30 cents per foot. We carry a complete stock of belting, pulleys and mill supplies. Apply, mentioning "Power House," to N. Smith, 138 York St., Toronto.

LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto.

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont.

SITUATIONS VACANT

WANTED — EXPERIENCED BOILER DEsigner by large manufacturing plant in Ontario. Apply Box 92120, Power House. (p12h)

WANTED—A1 GENERAL BLACKSMITH FAMiliar with mine and mill work; permanent position. Apply, mentioning "Power House," stating experience and wages wanted, to Moose Mountain, Ltd., Sellwood, Ont.

EQUIPMENT

THE JOHN INGLIS CO., LTD., ENGINEERS and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention "Power House."

WE BUY IDLE EQUIPMENT OR MACHINery; call or write. Apply, mentioning "Power House," to H. W. Petrie, Ltd., Toronto.

GRATE BARS

ALL STYLES TO ORDER—PROMPT DELIVery. The E. T. Lansdowne Foundry Co., 37 Niagara St., Toronto. Mention "Power House."

Get Bigger Pay through ELECTRICITY

You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language — complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES

3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination **Hawkins Electrical Guides** (Price $1 each). Ship at once, prepaid, the 10 numbers. If satisfactory, I agree to send you $1 within seven days and to further mail you $1 each month until paid.

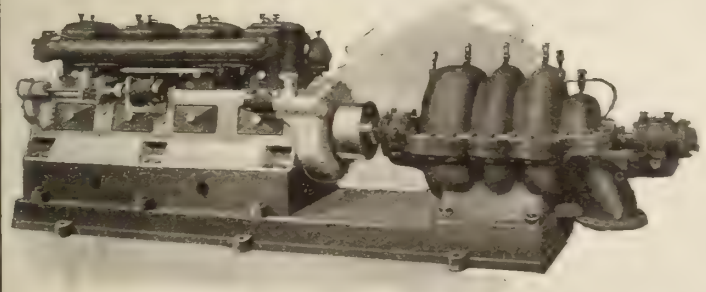
Signature_____

Occupation_____

Employed by_____

Residence_____

Reference_____



If You Can't Get Coal

Use a High Duty Sterling Gasoline Engine to Drive Your Generators or Centrifugal Pumps

Model FC 8-cyl. 200 H.P. Sterling direct connected to Goulds 3-stage centrifugal pump, capacity 1,000 G.P.M. against 280-ft. head. To be installed at Gastonia, N.C.

12 to 300 H.P. for emergency service, fire pumps, etc.

May we send literature?

Sterling Engine Co., Dept. C.-4, Buffalo, N.Y.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$6 50	$7 00
Plates, ¼-in. up	6 00	6 60

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
4½-in. and larger, 10%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse	base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	29½
Palacine	32½
Palacine	27½
Machine oil, per gal.	65
Black oil, per gal.	34
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	19

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	+10
Mach. screws, flt and rd hd, steel	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 50
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 28½
Solder, guaranteed	0 30½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	16 00
Glue, nglish	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl.	4 50
Sandpaper, B. & A. list, plus	43%
Emery cloth list, plus	37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$35 00	$37 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	40 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	43 00	46 00
Copper sheet, planished, 16-oz. base	47 00	50 00
Braziers', in sheets, 6 x 4 base	39 00	42 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white.	20
Dark colored.	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

	Gross Mont.	Toronto
Tin	$45 00	$50 00
Spelter	8 75	10 00
Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

Goodyear Klingtite Belts driving the sugar cane crushers of Cuba, Mexico and Central America

Canadian Success Promotes World-Wide Sale

As a result of the way Goodyear builds and sells belting and industrial hose in Canada, you will find these Goodyear products saving and serving in over 1,000 of Canada's finest industrial plants and mines.

The analysis of conditions, the scientific specification and application of belts, which Goodyear men make in Canadian plants they are now making all over the world.

To meet the requirements of world-wide trade it has been necessary to make some changes in the names of Goodyear Belts.

For example, Goodyear Extra Power is now Goodyear Klingtite Belt.

But the change is a change in name only.

This world-wide use of Goodyear Belting and Industrial Hose, Canadian-made, will multiply many times the fund of data and experience available to Canadian Goodyear users.

The problems overcome and the lessons learned in the factories of Japan and China, in the mills of India, in the workshops of South America, in the mines of South Africa, by the industries of every country, can now be applied by Goodyear men to Canadian industrials.

When the Goodyear belting man comes to talk to you, this information guides him in advising with you. His help is valuable—and costs you nothing. Phone, wire or write nearest branch.

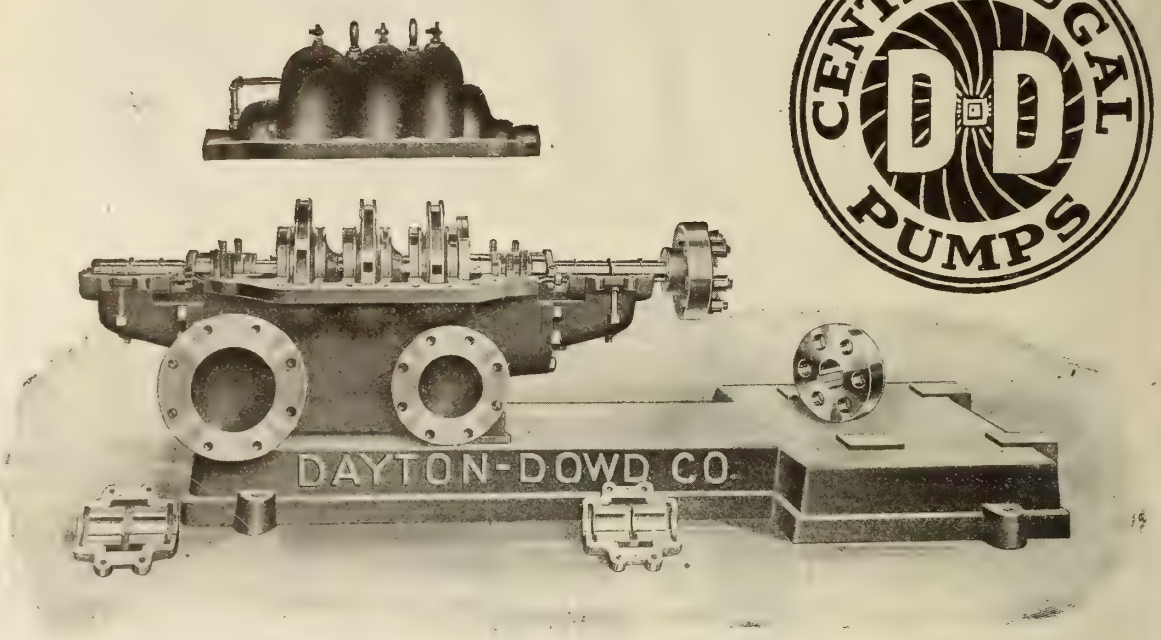
The Goodyear Tire & Rubber Co. of Canada, Limited

Branches: Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in smaller cities.

GOODYEAR BELTS

MADE IN CANADA

KLINGTITE GLIDE BLUE-STREAK



CENTRIFUGAL DD PUMPS

Dayton-Dowd Type CSU Automatically Balanced Three-Stage Centrifugal Pump

Illustration shows upper half of casing lifted. Note ease of access to all working parts. This is but one of the few points of merit of this type of Dayton-Dowd CSU Centrifugal Pump. Simple in design and rugged construction insures reliability in service and durability. Absence of diffusion vanes adds greatly to its life and reduces maintenance expense. Original and advanced in design and absolutely guaranteed to perform the service for which it is sold.

Type CS Single Stage, Double Suction Volute Centrifugal Pump

Non-overloading type, and so designed that the power consumed under any conditions of variation will not exceed the power required under normal operation. This feature protects the motor from being overloaded. This pump contains all the good features of Dayton-Dowd construction.

In Use in Prominent Plants

Parliament Buildings, Ottawa, two 2" type CSU, 2 stage centrifugal pumps.

Toronto Union Station, Toronto, eleven type CS, single stage pumps.

Corporation of New Toronto, two 8" CSU, single stage pumps.

Bridgeburg Water Works, Bridgeburg, two 5" single stage, type CS pumps.

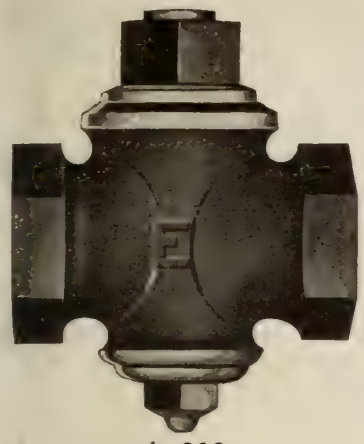
St. Thomas Water Works Pumping Station, St. Thomas, three 8", 2 stage, type CSU pumps, each direct connected to 150 h.p. motors.

Acton Water Works Pumping Station, one 5", 3 stage, type CSU pump, direct connected to 75 h.p. motor.

Send To-day for Free Bulletins

THE ARTHUR S. LEITCH CO.

1001-2 Kent Building, TORONTO, ONTARIO



A-810

Made of Steam Metal

This is a very dependable and durable stop cock. It is made from high-grade steam metal, and is favorably known all over Canada.

Our rigid factory tests and guarantee fully protect engineers who recommend them for use. So, for your own protection and also the customer's satisfaction, you should recommend *EMPIRE STOP COCKS.*

Complete Empire lines are carried in stock by leading jobbers throughout Canada.

"If it's an EMPIRE Product you know it's right"

Empire Brass Mfg. Co. Limited

London and Toronto, Canada

Showing how V-Buckets not only Elevate material but act as Scrapers on the horizontal.

Jeffrey Standardized V-Bucket Elevator-Conveyer

For the Small Power or Industrial Plant

It is designed for coal handling in the plant calling for a run-around conveyer, where the capacity is less than 50 tons per hour, as given by our small pivoted bucket carriers. Especially adapted to the handling of slack and stoker-sized coal.

May be used either as a run-around conveyer or as a combined elevator and scraper, and where conditions will not permit of a vertical elevator being extended sufficiently high to spout the material to points desired.

Upper run of Jeffrey V-Bucket Elevator-Conveyer, showing discharge chutes to Bin Storage in power plant.

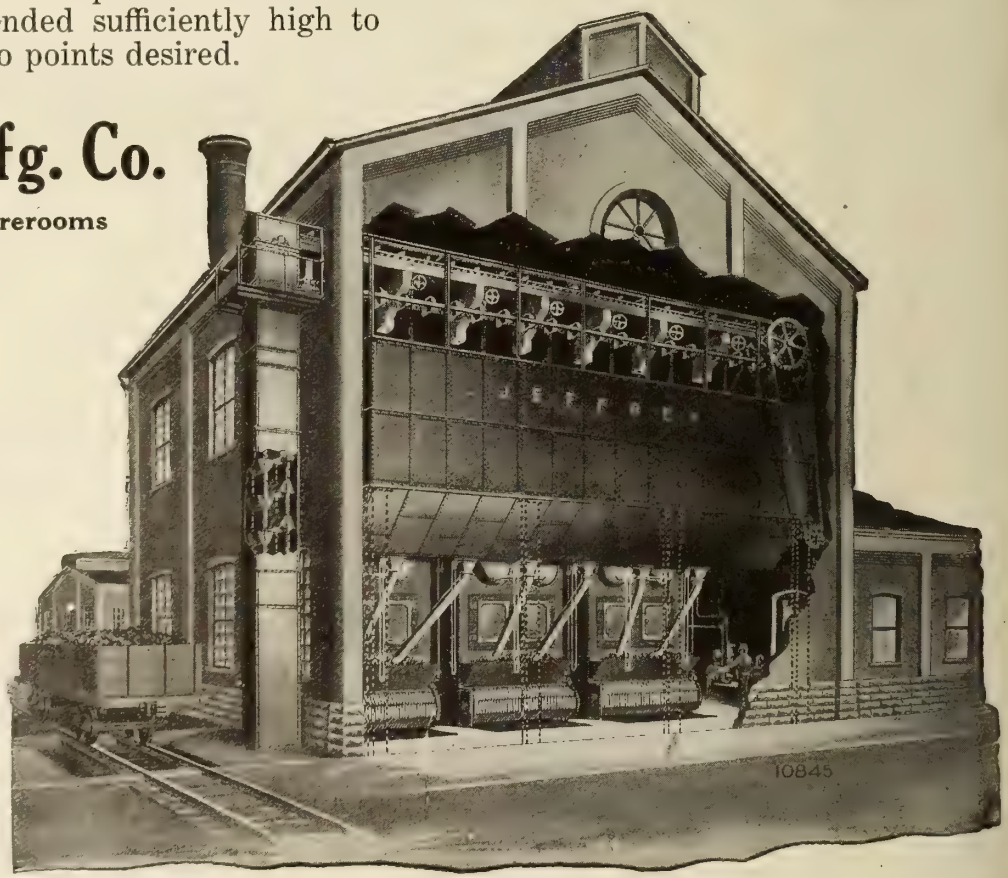
The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

Manufacturers of

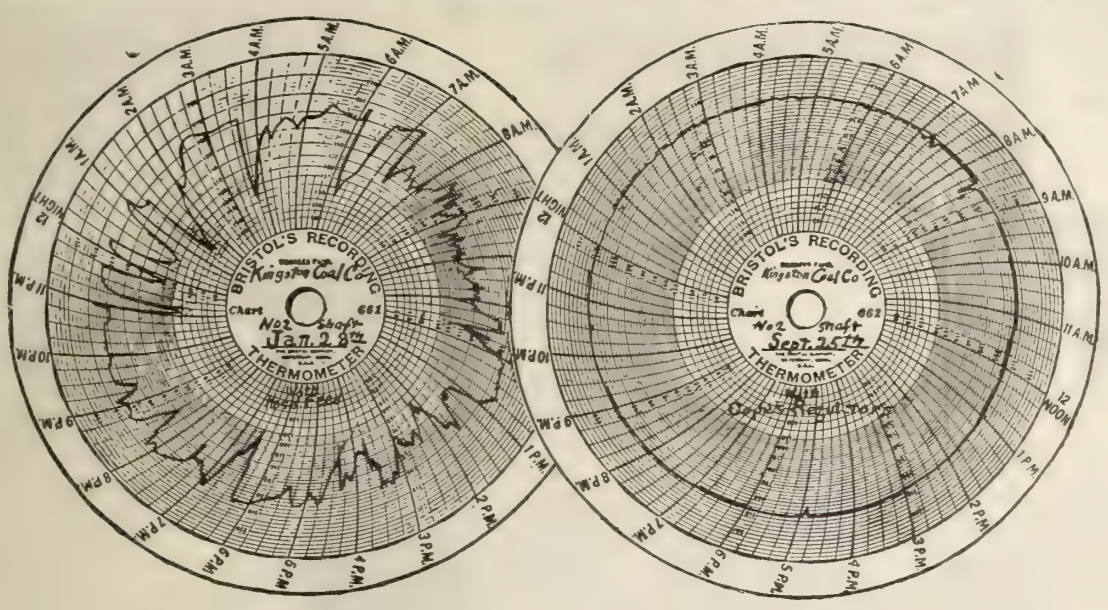
Crushers
Pulverizers
Conveyers
Elevators
Chains and Sprockets
Loaders
Electric Trolley and Storage Battery Locomotives, etc.



Coal being distributed to bunker in boiler house by a Jeffrey V-Bucket Conveyer. Coal passes direct to elevator or first through a Jeffrey Single Roll Crusher and then to Elevator

THE COPES SUCCEEDS

where all ordinary means of Boiler Feed Regulation have failed



BEFORE and AFTER

Records of one Plant where
A Reduction of 3% in Fuel Consumption
Resulted from the Installation of Copes Boiler Feed Regulators

Hand regulation cannot possibly give economical results, because the operator does not know until the gauge glass tells him a long time afterwards what is going on inside the boiler at any given time. **The Copes automatically responds instantly to every fluctuation in the boiler load.** It stores heat when heat should be stored. It utilizes all available heat for steam-making when that is necessary.

The two charts shown above are typical "before and after" records where hand regulation was superseded by Copes regulation. The left hand diagram, a record of hand regulation, shows an average feed water temperature of only 178° F. The right hand diagram, the result of Copes regulation, shows an average feed water temperature of 210° F.

The Copes therefore increased the average feed water temperature 32° F. This is equivalent to a saving of 3% of fuel.

Besides saving fuel and labor, and increasing boiler capacity, the Copes insures constant steam pressure, equalizes boiler load, makes meter charts legible, reduces wear and tear on piping, produces dryer steam, increases superheat, and frequently raises by 30 to 100% the peak load capacity of a boiler plant.

Write for our Bulletin D, giving detailed information and technical data.

NORTHERN EQUIPMENT COMPANY

112 West 11th Street, Erie, Pa.

The World's Largest Manufacturers of Feed Water Regulators

No. 11

Canadian Representatives:

ALLEN GENERAL SUPPLIES, LTD.
205 Yonge St., Toronto, Ont.

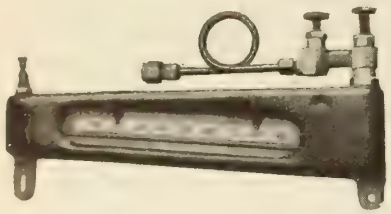
H. N. BROWN
P.O. Box 620, New Glasgow, N.S.

MASON REGULATOR & ENGINEERING CO., LTD.
153 Dagenais St. (St. Henry), Montreal, P.Q.

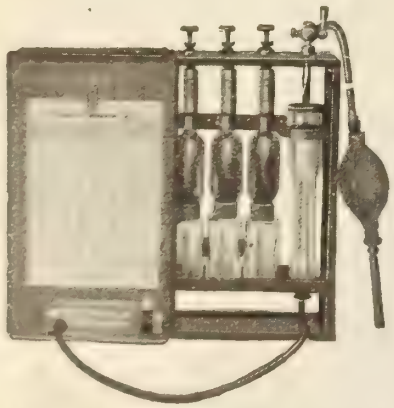
C. C. MOORE & COMPANY, Engineers
618 Mutual Life Bldg., Seattle, Wash.
(Representatives in British Columbia)

When you hold your plant up for inspection

Hays Automatic CO_2 Draft Recorder awarded Certificate of Merit by Franklin Institute.



Hays Draft Gage for the boiler front to guide the firemen in regulating draft.



Hays Improved Gas Analyzer for CO_2, O_2, CO.

Let
HAYS APPARATUS
be the outstanding feature

To be able to actually see the conditions you have as well as the ideal ones to strive for is the best way to put your plant in A-1 class. Economy in the cost of power production at prevailing prices for fuel is essential to business health.

May we tell you more about these unerring guides to combustion efficiency?

The Jos. W. Hays Corporation
Combustion Efficiency Appliances

Michigan City, Indiana, U.S.A.

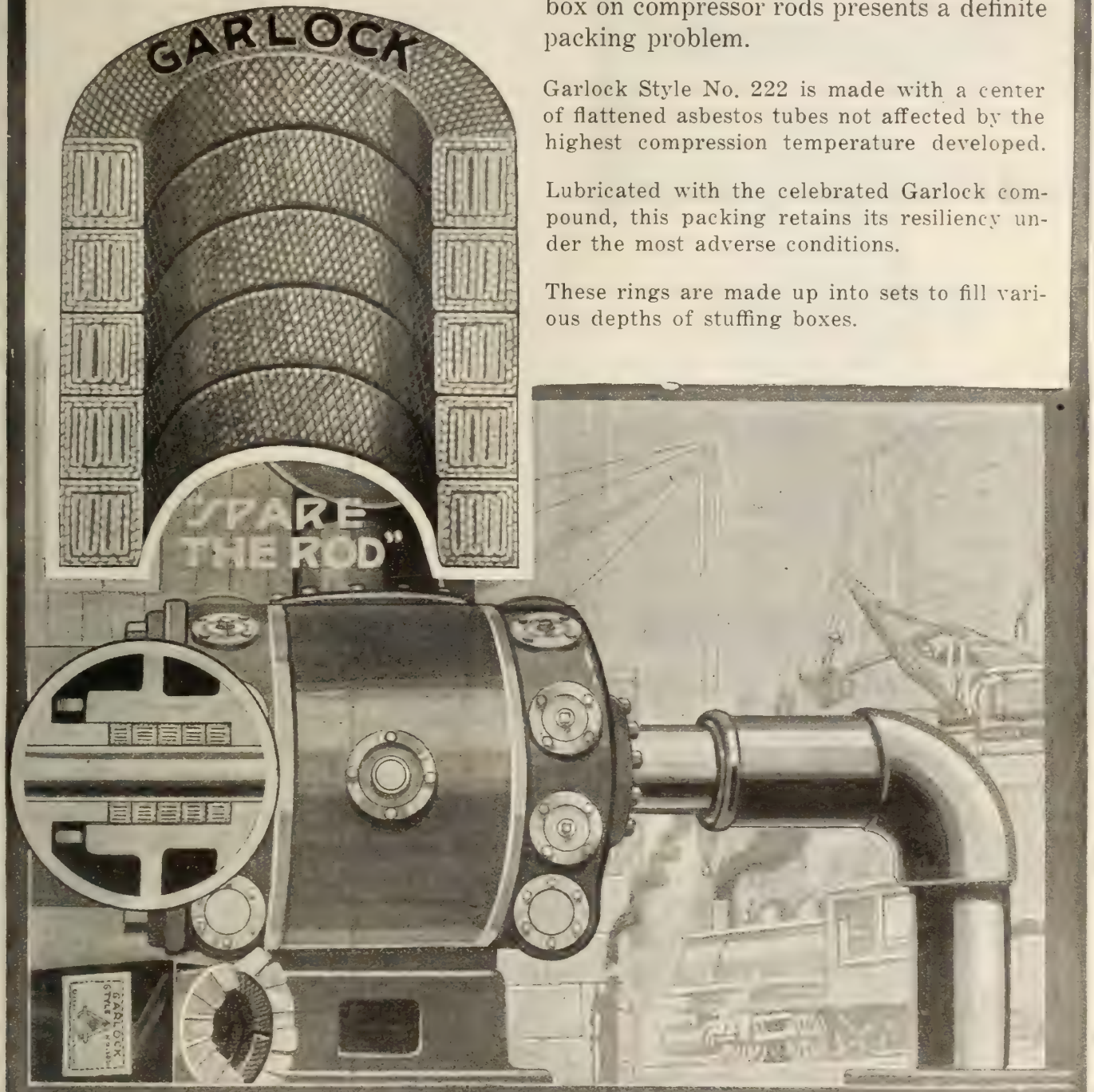
AIR COMPRESSOR PACKING

The maintenance of an air-tight stuffing box on compressor rods presents a definite packing problem.

Garlock Style No. 222 is made with a center of flattened asbestos tubes not affected by the highest compression temperature developed.

Lubricated with the celebrated Garlock compound, this packing retains its resiliency under the most adverse conditions.

These rings are made up into sets to fill various depths of stuffing boxes.

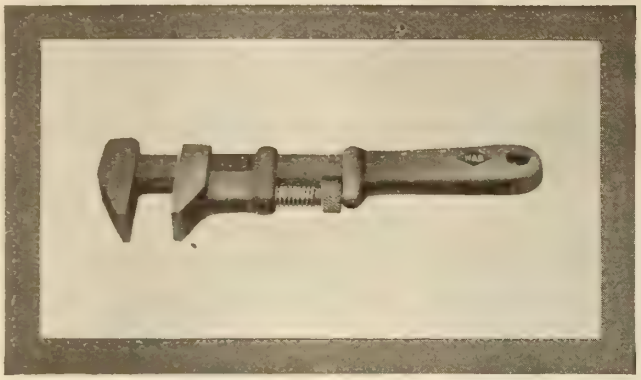


GARLOCK PACKINGS

The Garlock Packing Company
Hamilton, Ontario

Branch Offices:

Montreal, Quebec
Toronto, Ontario
Winnipeg, Manitoba
Calgary, Alberta
St. John, N.B.
Vancouver, B.C.



WILLIAMS' Superior Wrenches

Williams' "W. & B." Railroad Special Wrench is indestructible — under gruelling punishment its ease of action and accuracy of fit are maintained. It is the strongest screw wrench made.

Seven sizes, 6 to 21 inches, with maximum capacity of 3 15-16 inches. Guaranteed. At your dealers'.

Ask for catalog.

J. H. WILLIAMS & CO., Ltd.

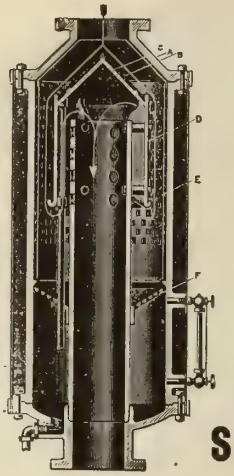
"The Wrench People"

Formerly the Canadian Works of
The Whitman & Barnes Mfg. Co.

St. Catharines - Ontario

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE — Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION — Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

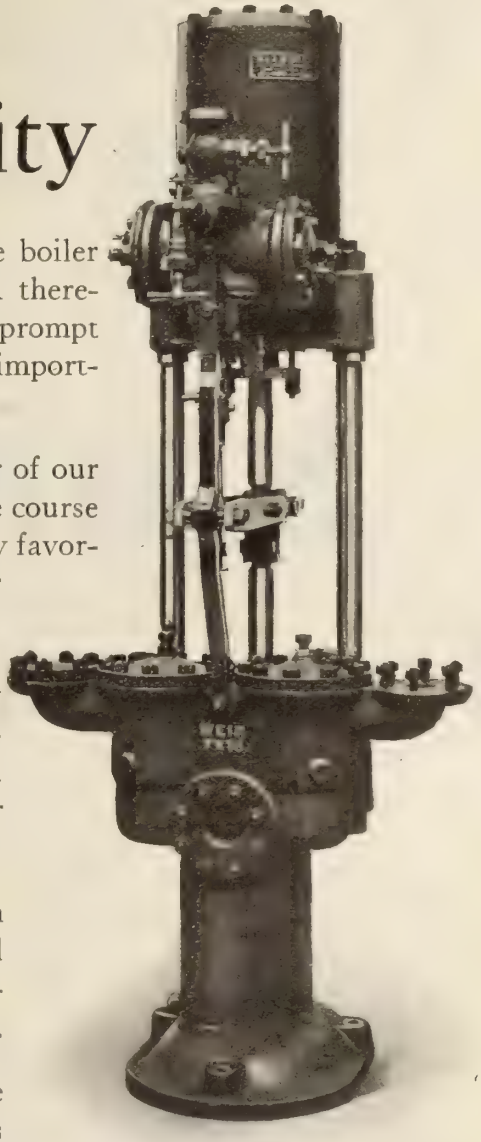
The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

WEIR PUMPS

Delivery and Interchangeability

Any possibility of stoppage in the boiler plant is a serious matter. When therefore a new feed pump is required prompt delivery is usually of the greatest importance.

As we always have a large number of our standard pumps in stock and in the course of construction, we are in a specially favorable position to meet demands for urgent delivery.



Overhauling and renewal is greatly facilitated by our system of interchangeable parts and the fact that we keep in stock at all times parts for our standard pumps.

Special attention is paid to the prompt dispatch of goods and the routing and shipment of all consignments. Special instructions in this regard always receive our most careful attention.

Prompt and careful shipment is but a single phase of Weir Service. To serve our customers in every way to the best of our ability is our aim.

G. & J. Weir (Canada) Limited

SALES ENGINEERS

Peacock Brothers, Limited, Montreal

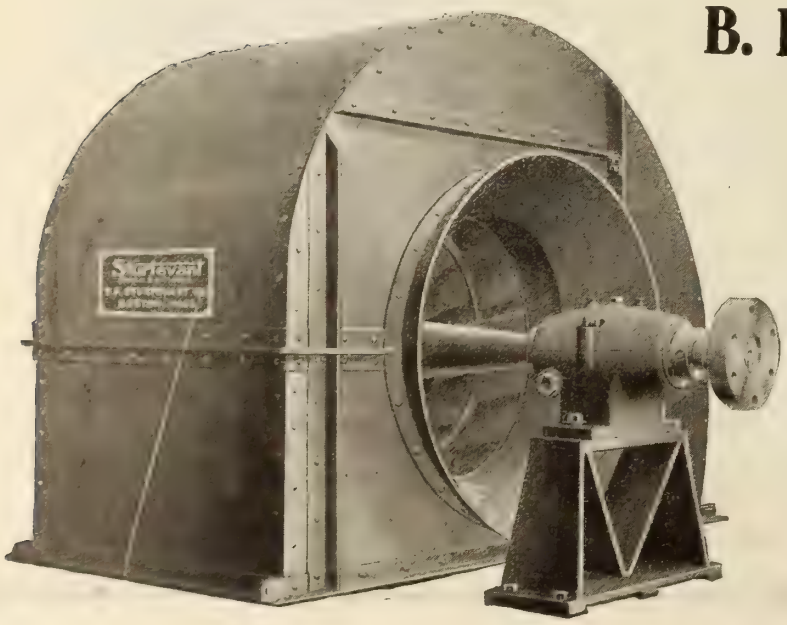
For High Boi

Where overratings up to 250 per cent and even higher are demanded, it is important that an extra heavily constructed fan capable of withstanding the extreme demands for speed and delivered pressure, be selected. Turbovanes are especially designed for direct connected turbine or motor drive.

Sturtevant
(TRADE MARK)

Turbovane Fans

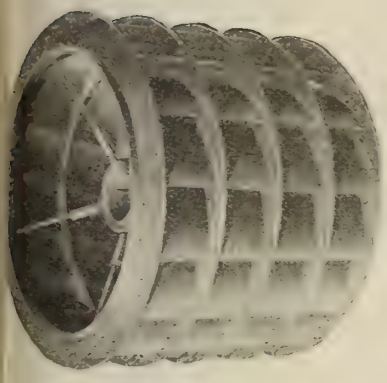
Fitted with conical inlet pieces and long radius cut-off sheets to minimize noise and eddy current losses. The housing is split on horizontal center lines to provide perfect access to the impellers.



B. F. Sturtevant Company
Head Office and Works:
Sales Offices: Toronto

Sturtevant
(TRADE MARK)

ler Ratings



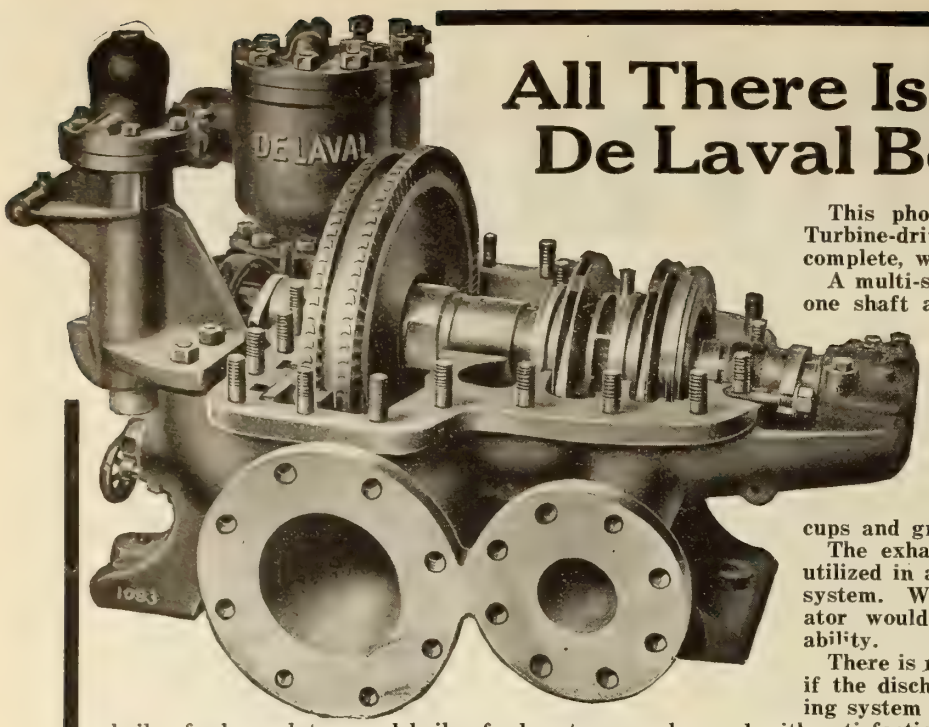
The impellers are of exceptionally strong construction. The blades are made from heavy steel plate to true curvature and are flanged and riveted to the heavy supporting annular rings which are cut from the solid sheet and contain no weld or joint.

he cast hubs are riveted to center-plates and are prop-rly shaped to conform to the natural flow of air.

he impeller and shaft are carried by two high speed edestal type of bearings, which are supported inde-endent of the fan housing.

Consult our engineering department concerning your special forced draft requirements. Their recommendation may lead to important savings in fuel and labor. Write for Catalog No. 236P.

of Canada, Limited
Galt, Ontario
and Montreal



All There Is to a De Laval Boiler Feeder

This photograph shows a De Laval combined Turbine-driven Centrifugal Boiler-Feed Pump complete, with cover lifted.

A multi-stage centrifugal pump is mounted upon one shaft and enclosed within one casing with a steam turbine.

The only packings are two simple packings about the shaft. Contrast this with the numerous packings, including the piston rings, of a reciprocating steam pump.

The only lubrication required is for two ring-oiled bearings. Contrast this with the numerous oil cups and grease cups of a reciprocating pump.

The exhaust steam contains no oil and can be utilized in an open feed water heater or a heating system. With a reciprocating pump an oil separator would be required, with questionable reliability.

There is no pulsation in the pipe line, nor danger if the discharge should be suddenly cut off. Piping system and boiler check valves last longer, and boiler feed regulators and boiler feed meters can be used with satisfaction and to advantage.

The space occupied in comparison with that required by a reciprocating pump is insignificant. The 3000 boiler horsepower pump shown herewith occupies a floor space of only 3 by 2 feet.

As compared with the direct-acting pumps, less steam is used. Provision for regulating the number of nozzles in use make it possible to operate the turbine always at the highest efficiency.

Engineers who have had experience with the simplicity, reliability and reduced wear and tear incidental to De Laval Centrifugal Boiler Feeders, never return to reciprocating units. Ask for Special Publication No. N-100

DE LAVAL STEAM TURBINE CO., TURBINE EQUIPMENT CO., LTD., 73 King St. W., Toronto
THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING CO., LIMITED, Vancouver, B.C. 43

MACGOVERN & COMPANY INCORPORATED POWER MACHINERY

114 Liberty Street - - - New York, N. Y.

WATER TUBE BOILERS

Eight 250 h.p. Stirling Boiler, 160 lb. Pressure

FOR PROMPT SHIPMENT

Complete with Automatic Stokers and all necessary fittings

These boilers have new tubes throughout, making them as good as new.

The above are only a few items from our large stock of Steam and Electrical Equipment, consisting of TURBO UNITS, RECIPROCATING UNITS, ROTARY CONVERTERS, MOTOR-GENERATOR SETS, BOILERS, CONDENSERS, PUMPS, ETC. Complete list will be gladly mailed upon request.
Send for our special lists of INDUCTION MOTORS, new and used, as we have too many to list here.

PITTSBURGH, PA.
498 Union Arcade Building

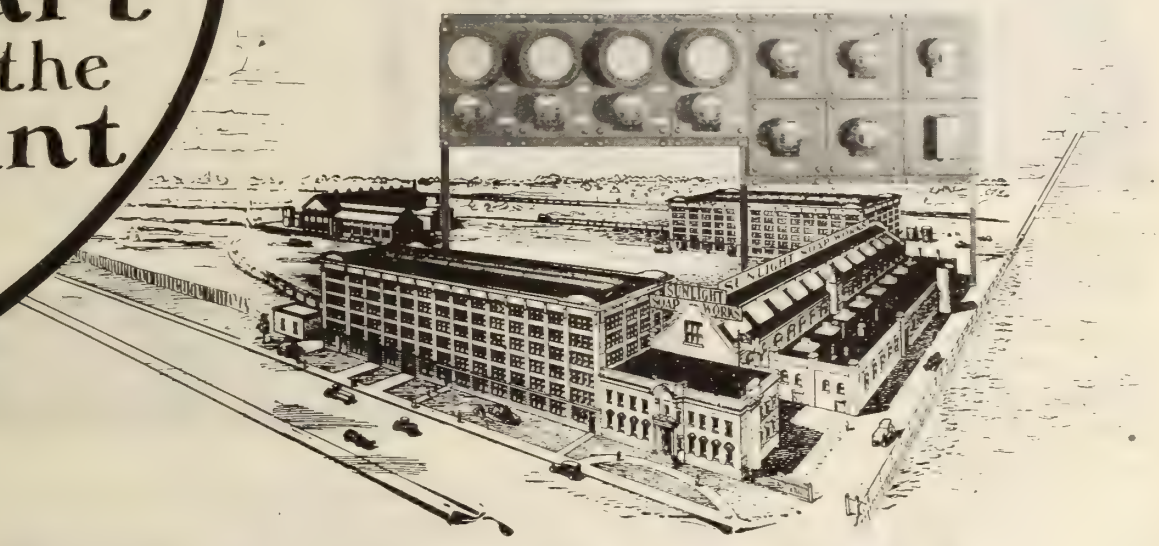
BRANCH OFFICES:
SEATTLE, WASH.
L. C. Smith Building

MONTREAL, QUE.
285 Beaver Hall Hill

Republic

FLOW METERS

The Heart of the Plant



Good Results at Sunlight Soap Works

The great advantages of the Republic principle of electrical operation are well illustrated in the power plant of the Sunlight Soap Company, Limited, Toronto. The superintendent and the engineer should know what Republic Flow Meters have accomplished; read what they have to say:

Less Fuel Consumed

October 12th, 1920.

The Republic Flow Meter Co. of Canada, Limited,
145 Wellington St. West,
Toronto.

Dear Sirs,—We wrote you some time ago, shortly after your Meters were installed, advising that we were getting good results. The installation is now complete and we have many good figures to work with.

We have located leakages of steam which it would have been impossible to discover without the use of your Meters.

Our fuel consumption is being reduced daily and we hope by the end of the year to have yet more complete and lasting results.

The Meters paid for themselves the first week they were in operation.

We would be glad to furnish particulars to any of your customers who may require information.

Yours very truly,
LEVER BROTHERS, LIMITED,
(Signed) James Mess,
Works Superintendent.

One Boiler Less Needed

October 1st, 1920.

The Republic Flow Meter Co. of Canada, Limited,
145 Wellington St. West,
Toronto.

Gentlemen,—In reply to yours of the 29th enquiring as to the results we have had from Republic Flow Meters, I beg to state that since we have had the meters in operation I have been enabled to cut one boiler from use, and also by discovering leaks in lines. I have been able to carry over the week ends with one boiler instead of two as formerly.

We have been able to make great progress with the conservation of fuel by the application of the meters, and I am convinced that a plant without them cannot be economically run.

I shall be glad to show any person you may refer to me the charts, and prove to them the indispensable value of Flow Meters.

Yours truly,
LEVER BROTHERS, LIMITED,
(Signed) Wm. S. Ball,
Power Engineer.

The departmental lines are all metered, making possible a systematic distribution of steam costs. **Flexibility plus accuracy** is briefly the result of electrical operation. It means that Republic Flow Meters will conform to your plant conditions—it means that you can rely on the indications of the reading instruments. **Write for complete information of the benefits of the Republic Flow Meters in your plant.**

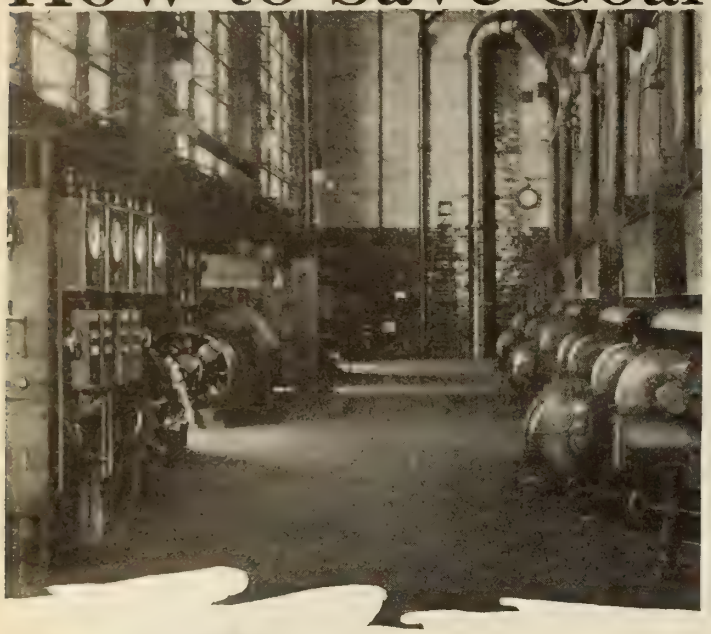
Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

Republic System

145 Wellington Street West
TORONTO

How to Save Coal



Tried on one Boiler—
Soon used on *all*

Many large Canadian plants are reaping a good profit from the savings effected by

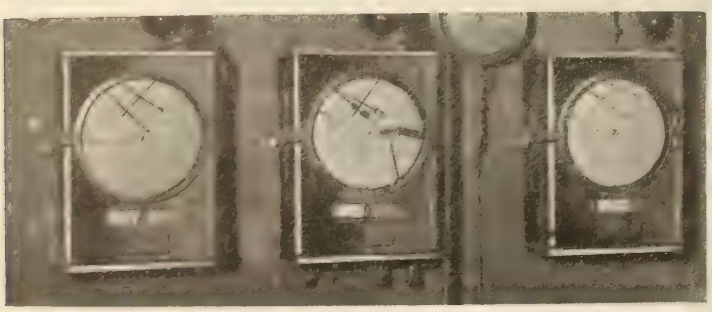
BAILEY
BOILER METERS

The "Bailey" is a watchdog of the coal pile. It prevents steam waste in the plant.

"Bailey" boiler meters show the true performance of each individual boiler, enabling you to determine which boilers are lagging and the number of boilers that should be cut into the line to carry the existing load at the highest overall economy. They show when a boiler needs cleaning or repairing and will serve as a check on the attention paid by the men to their firing and feed regulation.

May we consult with you regarding their application to your plant conditions? Ask for bulletins.

Bailey Meter Company
2001 E. 46th Street, Cleveland, O.



A MALLET, A TROWEL AND A BARREL OF
Betson's Plastic Fire-Brick

That's all you need to build substantial, crack-proof, airtight boiler arches, as well as line your furnaces better than you could ever hope to do with masonry.

Your handy man does the work and after a few hours' hardening your boiler is all ready for use. Our pamphlet describes this easy method and its many advantages. Send for it now, while you think of it.

BETSON PLASTIC FIRE-BRICK CO., INC.
P.O. BOX 386-6, ROME, N.Y.

Canadian Distributor:
International Chemical Company
44-6 Lombard St.,
Toronto, Ont., Canada.

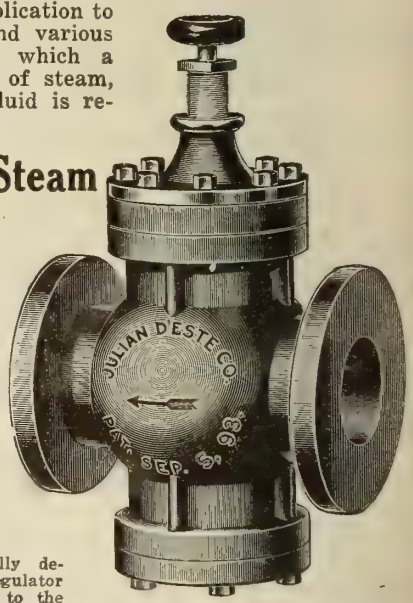
BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the

Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip for leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

Canadian funds are accepted at par at Montreal.

MANUFACTURED BY THE
JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.
Agencies: 83 BARCLAY ST., NEW YORK CITY
174 N. MARKET ST., CHICAGO, ILL.

Solve Your Transmission Problems

with a

P.M.S. BELT

Years of study of belting conditions have enabled us to produce a belt that resists heat or moisture. Exceptionally adapted to all difficult transmission conditions. Submit your problem to our belting experts. They will be glad to help you.

Gutta Percha & Rubber, Limited

Head Offices and Factory— TORONTO

Branches in all Leading Canadian Cities

Let Riley Stokers Reduce Your Costs

Riley Stokers are always on the job—you can rely on them to be at work every day. They are tireless—working all hours of the day and night—without complaint.

Industrial plants can cut their operating costs to a minimum by using Riley Underfeed Stokers. Consider the following facts:—

EFFICIENCY—Boiler tests on Riley Stokers have shown over-all efficiencies of 80 per cent. and higher.

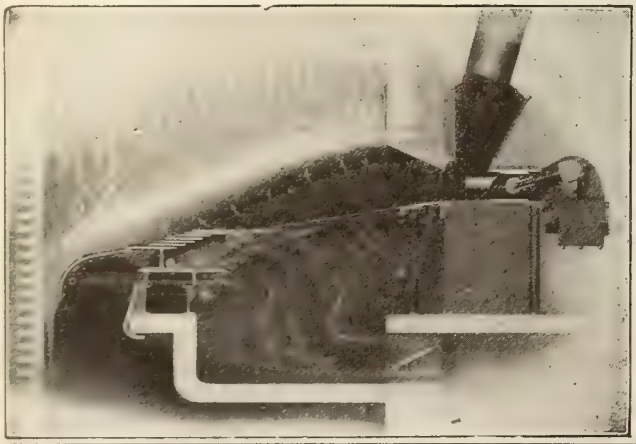
LABOR SAVING—One or two men can replace ten or twelve required for hand firing. Continuous, automatic discharge of ashes means elimination of drudgery in fire cleaning. Labor for ash handling in a well-laid-out plant is negligible.

COMPLETE COMBUSTION—The underfeed method and moving grates intimately mix the proper amount of air and coal, giving perfect combustion.

Catalog HR-12 sent on request.

For information on the Murphy Automatic Furnace for small plants, see last month's advertisement, or send for Murphy's catalog HM-12.

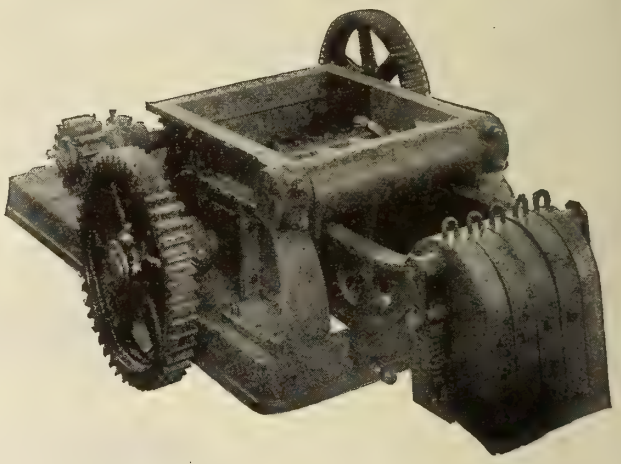
Sanford Riley Stoker Company
Worcester, Mass.



"MEAD-MORRISON"
CANADIAN MM ©
CANADIAN MM ©
Single Roll

COAL CRUSHER

Made in Canada



Capacity Single Roll Crusher, 50 to 70 tons an hour.

Capacity Double Roll Crusher, 100 to 150 tons an hour.

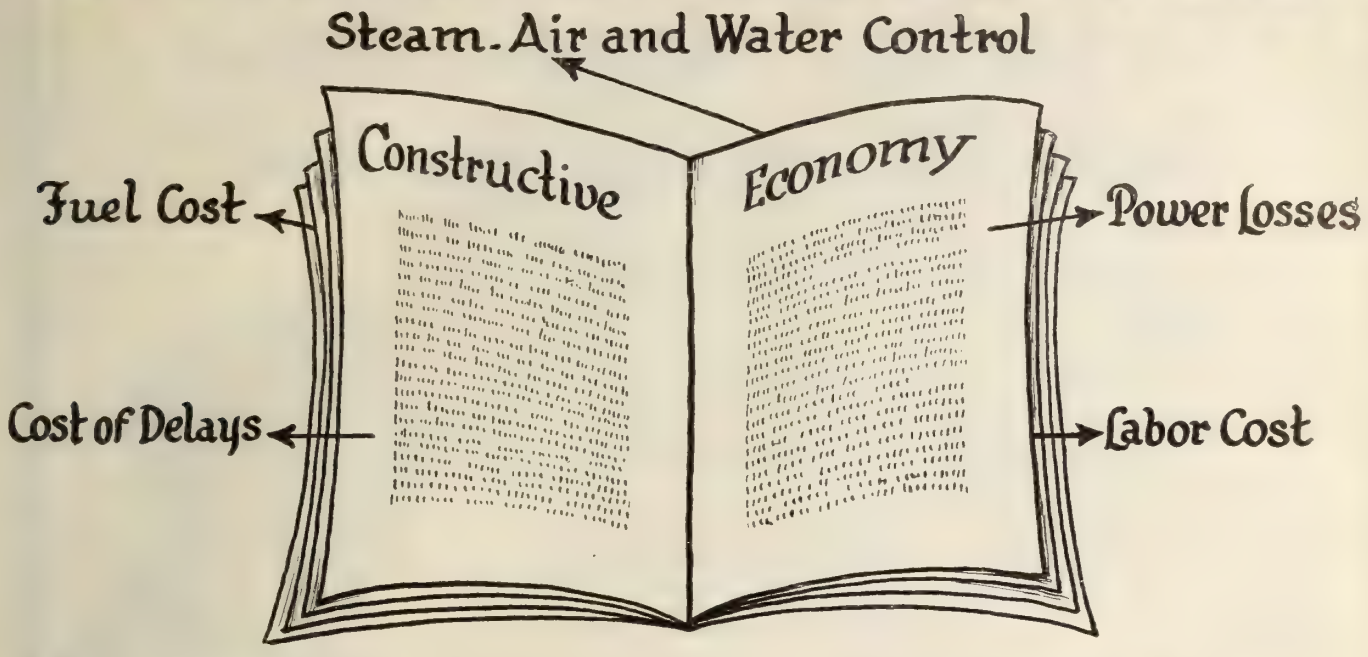
McCASLIN CONVEYORS
GRAB BUCKETS
SKIP HOISTS
COAL HANDLING MACHINERY

Dependable Service

AGENTS:
Harvard Turnbull, Toronto.
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.
Ferguson and Palmer, London, Eng.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

LOOK FOR THE NAME ON THE NUT



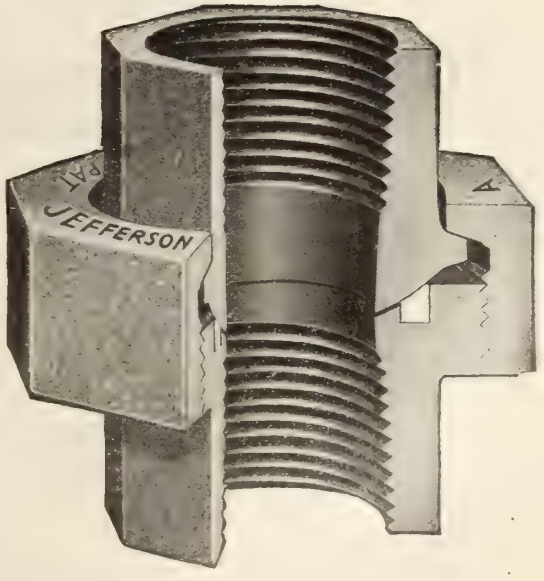
Are there any Leaks in your Policy of Constructive Economy?

JEFFERSON UNIONS will help you tighten up. Every connecting link in production must be capable of meeting the straining demands of the times if the present power plant slogan, "Economy and Efficiency," is to be other than a meaningless one.

From the most expensive machine down to the seemingly insignificant piping details **dependability** must be the embodiment of every individual factor. Each succeeding step from the source of power to the output must hold steadfast in its functioning, for weakness in any one of the connecting units may nullify the good results of the whole system.

The little union in the pipe line is an important big thing.

When the unions are JEFFERSONS, **dependability** is added to importance, for they assure absolutely tight joints in the pipe lines.



The Jefferson Union provides joints that will not corrode, loosen, dislodge or leak. It is made of the best high-grade air-refined iron, well proportioned and unusually strong. It has a ground ball brass to iron joint, a drawn brass tubing seat and perfect machined-like threads.

Ask your dealer about Jeffersons—the full line of ELBOWS, TEES and FLANGES. Our Catalog sent on request.

The Jefferson Union Co., Lexington, Mass., U.S.A.

Special Types for Every Purpose-Ask your Dealer

JEFFERSON UNIONS

Do You Get Real Lasting Service From The Packing You Use?

Or are you using one of those packings that are made to effect frequent sales?

There are packings and packings, many of which are sold only on price and require renewing so often as to be really expensive in the end, especially the labor cost of renewing the packing, which is the largest item of expense.

The engineer who uses a packing that gives long service under the peculiar conditions of his plant not only saves money for the owners, but avoids a lot of hard, unnecessary labor for himself.

Our claim for

TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

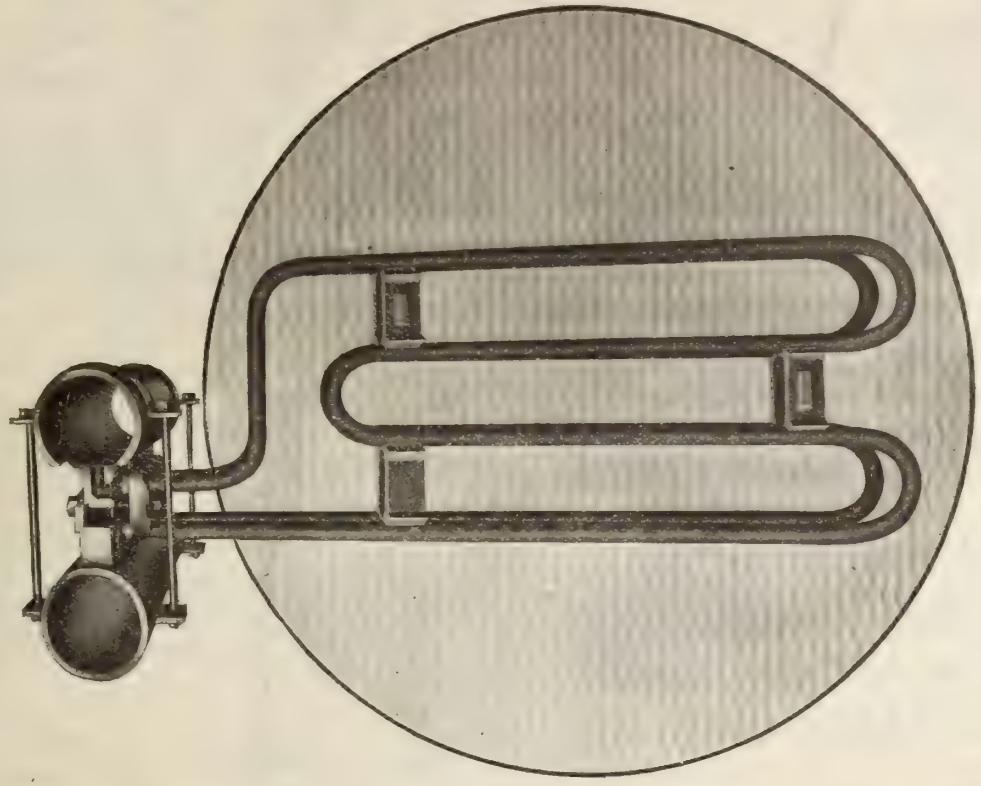
is that it is a packing with only one object in view — LONG SERVICE.

We can prove to you that "PALMETTO" will outlast the packing you are using if you will let us send you—without charge —working samples to test under your own conditions in your own way.

Write us at once, stating the size you wish.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St. New York

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver



Cleanliness Easily Maintained in ELESCO SUPERHEATERS

The long life of Elesco Superheater units is due to the prevention of scale and the maintenance of clean surfaces. This cleanliness is obtained by providing for high steam velocities which prevent the accumulation of scale-forming material in the superheater.

Cleanliness is further obtained in Elesco Superheaters because the units present smooth, easily cleaned gas touched surfaces.

THE SUPERHEATER COMPANY, LIMITED

TRANSPORTATION BUILDING
MONTREAL

WORKS AT SHERBROOKE, QUEBEC

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes.

Use This Coupon

The Superheater Company, Limited
Transportation Building, Montreal

Please send your Bulletins T-1, T-2, T-5 and T-6.

Name..... Position .....

Company ..... Address .....

MADE IN CANADA

P.H. 12-5

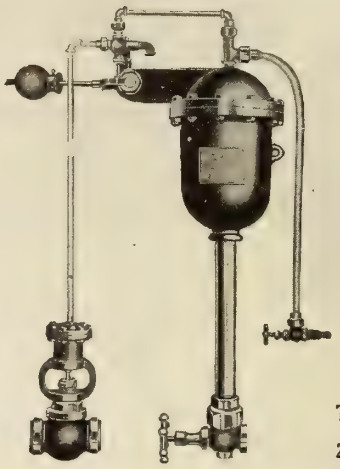
HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal



Insure Constant Level

The most economic way to operate boilers is with constant water level and uniform constant inflow. With the level held constant at middle gage, the greatest amount of heating surface is presented to the hot gases and the maximum amount of steam space is available.

Vigilant Feed Water Regulators

meet these conditions in a very satisfactory way.

They are easily adjusted to maintain an absolutely constant water level at any arbitrarily determined height in boilers, and they feed continuously with perfect uniformity.

Write For Full Particulars

The Chaplin-Fulton Mfg. Co.

28-34 Penn Ave., Pittsburgh, Penn.

Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Trial Orders Solicited—Our Packings Do the Rest

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED

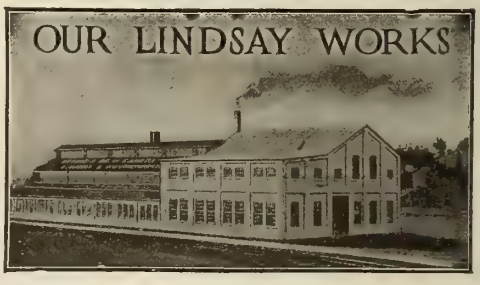
London Liverpool Cardiff, Etc.

Canadian Representative:

Wm. J. Brown, 117 Youville Square - - - Montreal, Que.

Stocks carried in all sizes TEL. No. MAIN 2387

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited

Lindsay, Ontario

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

DARLING BROTHERS, LIMITED

Engineers, Manufacturers and Founders

120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

Largest manufacturers of white metals in the world

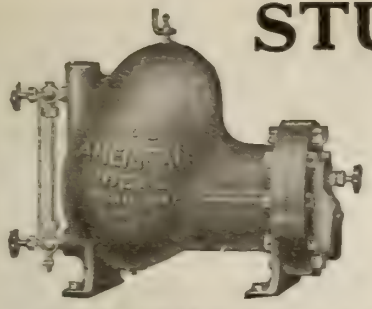
Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY

MONTREAL TORONTO WINNIPEG



STUDY TRAP CAPACITIES

Select your Traps on a Guaranteed Capacity Basis.

SAVE SPACE— SAVE MONEY

Send for our New Trap Booklet

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York Chicago BOSTON Atlanta Pittsburgh

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

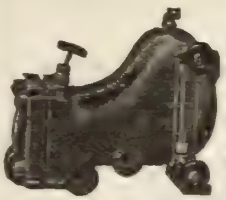
For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.



McDaniel Improved

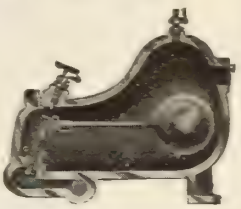
STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



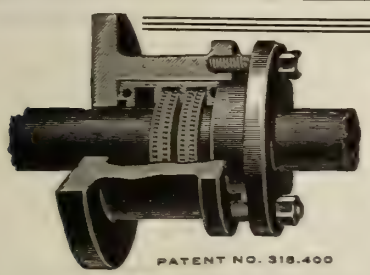
Send for Catalogue

THE GARTH COMPANY

26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.

No. 146 N. 7th St., PHILADELPHIA, Pa.



PATENT NO. 318,400

PAT. NO.	530,899	PAT. NO.	829,116
" "	544,104	" "	830,530
" "	600,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	705,368	" "	895,791
" "	774,490	" "	898,066
" "	776,193	" "	906,108
" "	776,194	" "	934,629
" "	791,300	" "	979,206
" "	805,669	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES'

Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,

Wilkes-Barre, Pa.

Incorporated 1897

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

A British Made Glass that stands in a class by itself for Quality

The British Navy uses Moncrieff's "Unific" Water Gauge Glasses, which have the quality that withstands the test of unusually hard service.

Why not get acquainted through a trial order? Ask for our catalogue.

JOHN MONCRIEFF, Ltd., Perth, Scotland

Canadian Representative:

W. J. WALL, 134-136 Bleury St., Montreal

Tycos

TEMPERATURE INSTRUMENTS

INDICATING · RECORDING · CONTROLLING

In hundreds of power plants Tycos instruments meet the ultimate test—unusual service. The strength and the mechanical worth of the instruments — the skilled advice given in their application all mean the satisfactory solution of extraordinary as well as ordinary temperature problems.

Angle and Straight Stem Thermometers
Indicating and Recording Thermometers
Hydrometers Hygrometers
Engraved Stem Thermometers
Temperature and Pressure Regulators Pyrometers
Vacuum, Pressure and U Gauges.

Let Tycos catalogs and Tycos engineers be your guides in temperature needs. Request literature and specific advice—no obligation.

Canadian Branch:

110-112 CHURCH STREET

TORONTO, ONT.

REG. U.S. PAT. OFF. Tycos ROCHESTER, N.Y.

Taylor Instrument Companies

ROCHESTER, N.Y.

There's a Tycos or Taylor Thermometer for Every Purpose

STATIONARY
120 TO 3300 B.H.P.

MARINE
600 TO 3000 SHAFT H.P.

BUSCH-SULZER
DIESEL

AMERICAN
DESIGNERS & BUILDERS
OF
DIESEL ENGINES
SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

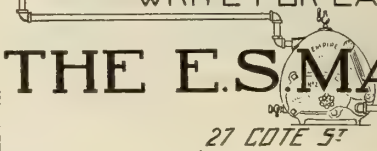
CRANE FITTINGS

CRANE
LIMITED

HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL

Branches: Toronto, Winnipeg, Vancouver.
Sales Offices: Halifax, Quebec, Ottawa, Calgary.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE



THE E.S.MANNY Co
27 COTE St MONTREAL, QUE

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

HOMESTEAD
Quarter-Turn Valves

Users Know

Experience is a great teacher. That is why almost every engineer has used Homestead Valves — why almost invariably they will tell you that Homestead Valves are the best of all for water, air and steam lines.
Simple in construction, easy to operate, and designed and built to stand up under the heaviest duty. Made in straightway, threeway and fourway patterns.
There's a Homestead Valve for every purpose. Catalog upon request.

Homestead Valve Mfg. Company
Homestead, Pa.

Quality H. W. PETRIE LIMITED TORONTO Service

New and Used
POWER PLANT
EQUIPMENT

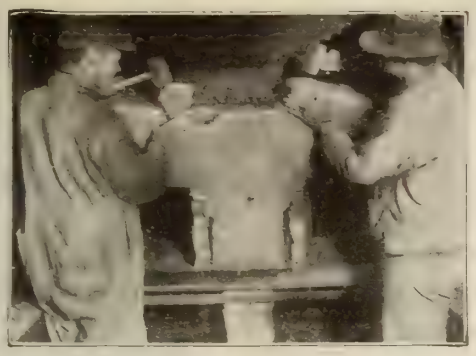
Steel Tanks
Any Capacity, Any Purpose

Steam Engines
Slide Valve, High and Low Speed Types

Automatic Engines
Up o 450 H.P.

Vertical Engines

H. W. Petrie, Ltd.
Toronto and Hamilton



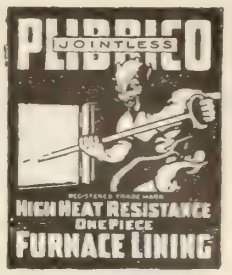
Plibrico is molded into place; needs no forms and H requires minimum time and labor.

PLIBRICO Makes Air Tight Furnace Linings

Air leaks in furnace lining joints, boiler settings and baffles are the greatest preventable losses in a boiler plant. No argument should be necessary to establish the fact that **an Air Tight Furnace Lining** is a great fuel economizer.

Shipped in steel containers only. Warehouse stock carried in principal cities for immediate delivery.

Send for book on furnace building.



JOINTLESS FIRE BRICK CO.

Offices and Factory, 1130-1150 Clay St., Chicago, Ill.

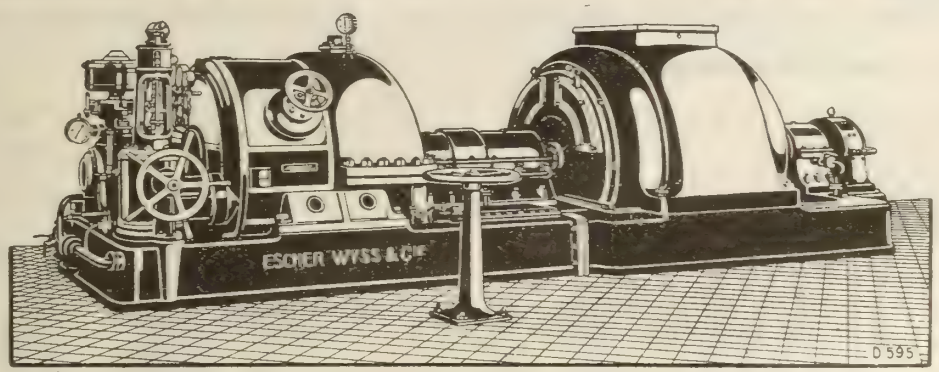
Beveridge Paper Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.

Trade Mark
Reg. U.S. Pat. Office.

Escher Wyss & Co., S.A. ZURICH (Switzerland)

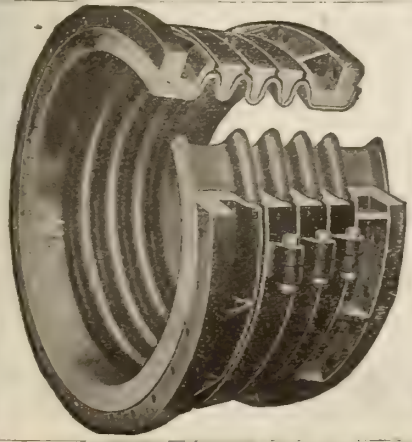
Montreal Office: 112 Coristine Building

Zoelly-Steam-Turbines



Zoelly-Rotary-Compressors

9 '20



BADGER
SELF-EQUALIZING EXPANSION JOINTS

Prevent leaks in all pipe lines

E.B. Badger & Sons Co.

101 PARK AVE NEW YORK | 75 PITTS ST. BOSTON | 616 S. MICHIGAN AVE. CHICAGO

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

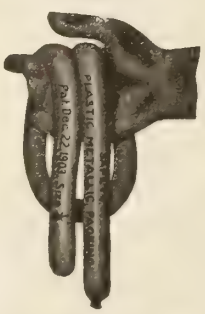
Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.



In Cotton Tubes

--If all your Valves were one BIG Valve

A small valve here and there is too insignificant to worry about. But if all your valves were one big valve, you would nurse it along very carefully, because, when it wore out, the loss would loom up in proportion.

Learn to look on the constant loss and repair of a **number of small valves** as equivalent to the loss of **one big valve** and you will realize the economy of

PRATT & CADY Renewable Valves

Valves of this type do not have to be scrapped prematurely. New seat rings, or a new disc, inserted quickly without removing the valve from the line, makes your old valve practically new. Made in both Globe and Gate Valves for every condition.

Write for booklet.

Pratt & Cady Co., Inc., Hartford, Conn., U.S.A.

The Canadian Fairbanks-Morse Co., Ltd., Halifax, St. John, Quebec, Montreal, Ottawa, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Better Belting with Efficiency "Built In"

Efficiency is a result—in our belting it is the culmination of thousands of experiments and tests over a period of fifty years.

The outstanding factor in creating transmission efficiency in our Dominion Friction Surface Belting is our special friction rubber compound which gives our belts a pulley-gripping quality that prevents practically all wastage of power through slippage.

Dominion Friction Surface Belting

will transmit all the power that any belt can be made to transmit because every ounce of material is carefully tested by our experts to make sure that it is up to our high standard.

This "Built-in Efficiency" is backed by the service of our belting engineers, who are ready to demonstrate its value without charge or obligation.

'Phone or wire our nearest service branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the same high standard as Dominion Friction Surface Belting.

Dominion Rubber System Service Branches

Halifax	Toronto	Fort William	Edmonton
St. John	Hamilton	Winnipeg	Calgary
Quebec	London	Brandon	Lethbridge
Montreal	Kitchener	Regina	Vancouver
Ottawa	North Bay	Saskatoon	Victoria

BELTING

Transmission: "Dominion," "Keewatin," "Para."
Conveyor: "Rockproof," "Canadian," "Hiheat."
Elevator: "Dominion," "Rockproof," "Endurance."
Agricultural: "Lumber King," "Star." "Western."
Grain Elevator: "Metcalf Standard," "St. Lawrence," "Grain King."

HOSE

Air: "Kushion Kover," "Para," "4810 Airtite."
Steam: "Indestructible," "Rockproof," "Para."
Water: "Indestructible," "Kushion Kover," "Para."
Suction: "Para," "Star," "Trade."
Garden: "Canadian," "Dominion," "Star."

PACKINGS

Sheet: "Join-Tite," "Star," "Importers."

Rod: "Cabestos," "Valve-Bestos," "Canadian."

Valves: "Montreal," "Commercial," "Canadian."

MISCELLANEOUS

Mats, Matting and Flooring, Plumbers' Specialties, Rubber Covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rubbers, Moulded Goods.

No Ashes! No Clinkers! No Waste!

You can burn even the low grades of commercial fuel—screenings, etc.—and secure maximum results with Cyclone Shaking and Dumping Grates. No ashes—no clinkers—no waste!

The furnaces get 60% air space and 90% underdraught by the scientific construction of Cyclone Grates. Why not test their efficiency? We will install them on a 30-day trial basis.

Ask for full particulars of our new pin-hole grate bars for burning hard coal screenings.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street **Phone G. 3660** **Toronto, Ontario**

AGENTS:

ST. JOHN, N.B.: F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator Co., Ltd. HAMILTON: Robt. Fitzsimmons, 8 Grove St. WINNIPEG: Vulcan Iron Works. OTTAWA: Campbell Steel & Iron Works, 855 Carling Ave.

DART UNIONS

Dart Union Construction means a saving of time for you and satisfactory service to customers

It is surprisingly easy to make connections with Dart Unions. The Ball-Shaped Seat enables you to make a perfect joint without the slightest bother, regardless of the alignment of the pipe.

TRY THEM. ORDER FROM YOUR JOBBER.

Bronze to Bronze at the Joint
No deterioration, no loosening up

DART UNION CO., LIMITED
TORONTO - ONTARIO

Lubricating Oil Specifications and the De Laval Oil Purifier

Thousands of dollars are spent each year for experiments and tests which determine the most satisfactory and economical lubricant for various power units.

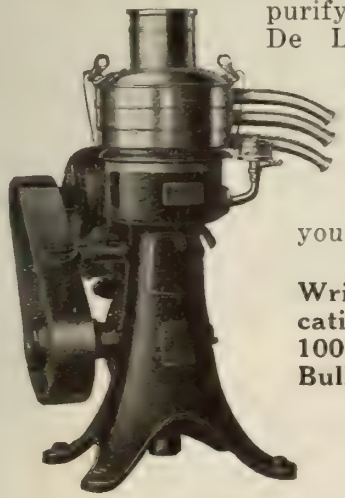
In some cases the time and money so spent is practically wasted by continuing the use of the oil after it has become foul.

Dirt, grit, water and particles of metal are at times present in every lubricating system—sometimes to such an extent as to cause the oil to act as an abrasive rather than a lubricant.

The De Laval Oil Purifier removes these impurities from used oil and maintains its original lubricating qualities.

The useful life of the oil is prolonged with a consequent saving in oil bills; the danger of burned-out bearings is largely eliminated, and the oiling system is less likely to become clogged.

Many of the largest power plants have replaced older and less efficient methods of purifying used oil with De Laval Centrifugal Purifiers. The experience of the De Laval engineers who designed these installations is yours for the asking.



Write for Oil Purification Bulletin No. 100; also Crank Case Bulletin No. 102.

The De Laval Separator Co.

New York **Chicago**

Turbine Equipment Company
Toronto, Ont.

The De Laval Company, Limited
Peterboro, Ont.

You can again obtain Genuine "Resisto" Gauge Glasses with the Red Line—

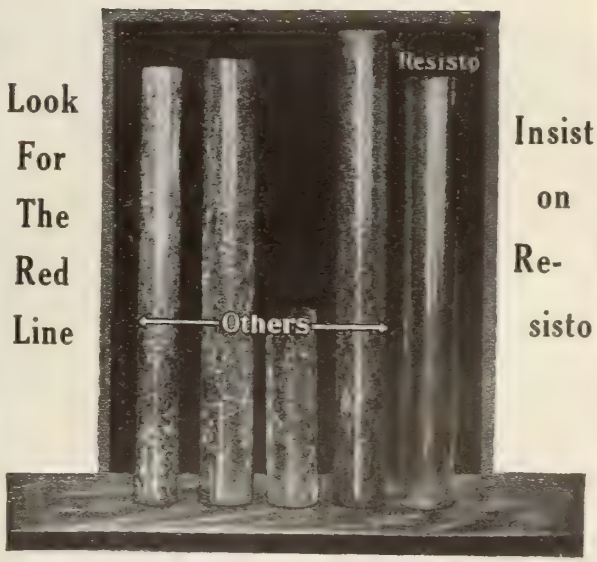
You'll be glad to know this. No more dangerous experimenting with inferior glasses. You can depend upon the "Resisto"---its reputation is your assurance of perfect service.

Get your order in at once.

Note below the result of a very severe test in which the "Resisto" was tested with several well-known brands of glasses.

THE SCHAEFFER & BUDENBERG MFG. CO. RESISTO HIGH PRESSURE GAUGE GLASS

Look For The Red Line



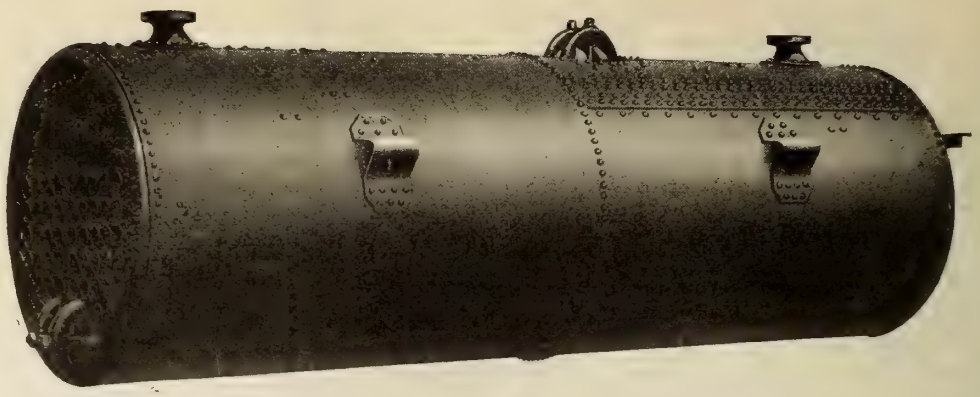
Insist on Resisto

THE
SCHAEFFER & BUDENBERG MFG. CO.

338 Berry St.
BROOKLYN, N.Y.

Toronto—A. G. Milton, 32 Front St. West

Now is the Time!



Buy your Boilers here and now

Prompt deliveries of Boilers of the workmanship and quality we embody is an item of importance. If you happen to need boilers in sizes 66 in. x 14 ft., 66 in. x 16 ft., 72 in. x 16 ft., 72 in. x 18 ft., we have the materials here ready, subject to prior sale, and your enquiry will be promptly answered.

Engineering and Machine Works of Canada, Limited

St. Catharines, Ont.

Eastern Sales Offices: **Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal**

Use Starrett Hack Saws

Starrett Service goes with every box of Starrett Blades. It begins with the fine quality of the saws themselves, and it's yours every minute of the day—any time you need it. Begin using Starrett Service *now*, and let Starrett Blades, backed by the Starrett Hack Saw Chart, show you why they're called "the blades that cut quicker and last longer."

Write for "Hack Saws and Their Use," the guide-book to more efficient cutting.

THE L. S. STARRETT CO.

ATHOL, MASS. 42-95

UEHLING CO_2 Recording Equipment

CO_2 Recorder for office of Chief Engineer. Can be placed any distance from the boilers and it will trace continuous records of the changes in CO_2 exactly as they occur during every second of boiler operation

is SAVING FUEL for

	Number of Uehling CO_2 Recorders
Brown Corp.	19
Canadian Pacific Railway	8
Corn Products Refining Co.	54
Detroit Edison Co.	53
Dominion Iron & Steel Co.	14
E. I. du Pont de Nemours & Co.	16
Thos. A. Edison Laboratories	9
Ford Motor Co.	17
Standard Oil Co.	51

If it can save fuel for these and scores of other leading companies, it can save fuel for you.

The New Uehling CO_2 Equipment reduces waste of fuel up the chimney by insuring correct air supply. It guides the fireman at the boiler in burning any kind of fuel, while simultaneously recording results in the chief engineer's office. It usually pays for itself in a few months, or even weeks, by savings effected.

Send for Bulletin 111

CO_2 Indicator is as important to combustion economy as the water gauge glass is to safety. Mounted on the boiler front, it guides the fireman by showing the percentage of CO_2 and giving warning when improper furnace conditions prevail

UEHLING
Instrument Company
COMBUSTION ENGINEERS
098 Empire Bldg. New York

We Design and Construct Power Plant Equipment

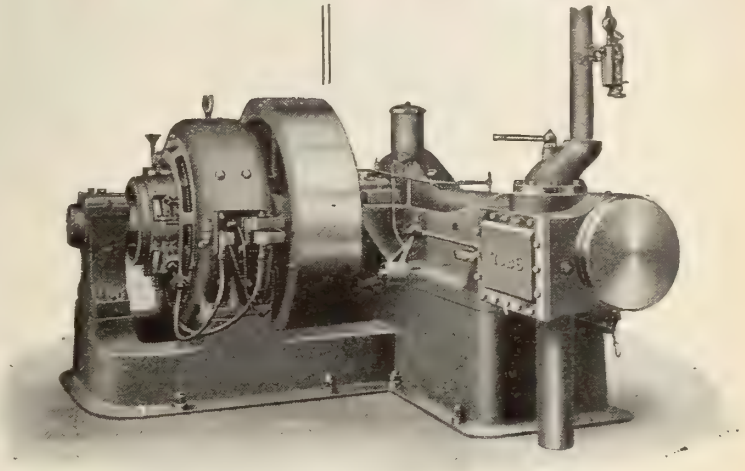
WE specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water Tube, Return Tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market —remember it will pay you to purchase equipment that has won the confidence of leading engineers.

ROBB

Power Plants



Robb Engineering Works Co., Ltd.

Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

P&H WROUGHT PIPE BENDS AND FLANGED PIPE JOINTS

ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office: 100 CHURCH STREET, TORONTO, ONT.

Besides the

Dunham Radiator Trap

there are the following

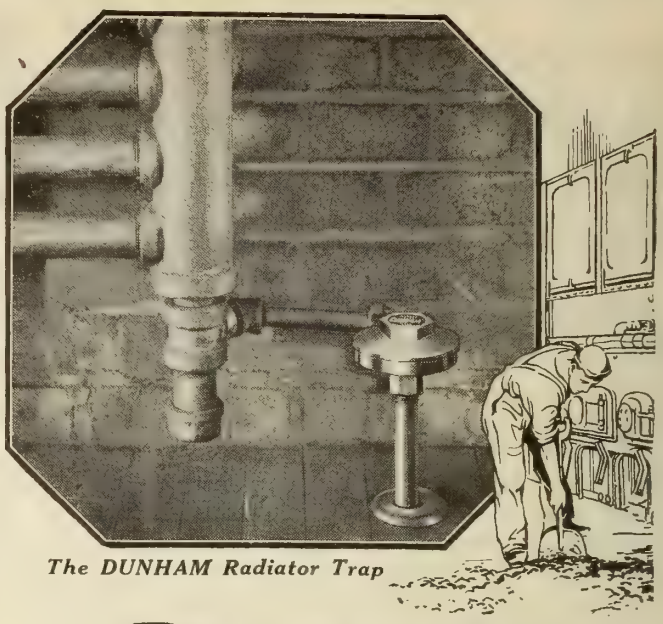
Dunham Specialties

Packless Radiator Valves
Drip Traps
Blast Traps
Air Line Valves
Vacuum Pump Governors
Reducing Pressure Valves
Oil Separators
Suction Strainers
Air Vents
Return Traps
Check Dampers
Damper Regulators

MADE IN CANADA

All are equal in quality to the Dunham Radiator Trap—and that means the best. Whenever better steam heat is needed, one or more Dunham Specialties will serve, and save.

DETAILED DATA ON REQUEST.



The DUNHAM Radiator Trap

The DUNHAM HEATING SERVICE

C. A. DUNHAM COMPANY, Limited

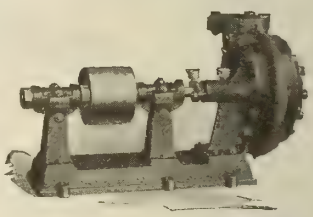
TORONTO, CANADA

Halifax Vancouver Winnipeg Ottawa Montreal Calgary
London: 233A, Regent Street, W.1.

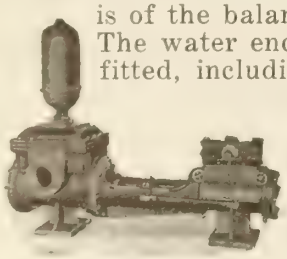
AMERICAN-MARSH PUMPS

SIMPLE RELIABLE EFFICIENT

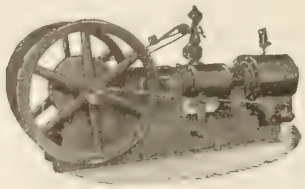
The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.



The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—
Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

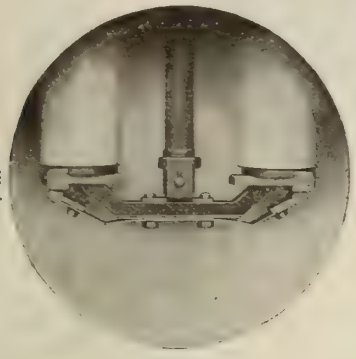
Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

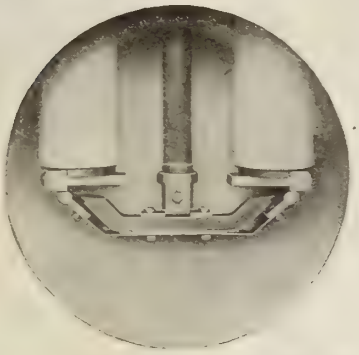
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London, Ont. Gorman, Clancy & Grindley, Limited, Edmonton, Calgary and Vancouver.

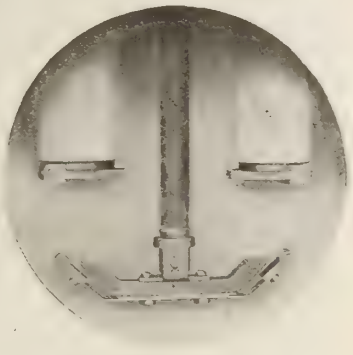
FOUR CONDIT FACTS



1—Closed



2—Arcing Tips Protecting Brush



3—Open

Condit Oil Switch Construction

1. Note the perfect wiping contact of the Condit main laminated brush contacts, closed.

2. The circuit is broken by the auxiliary arcing tips. No arcing from main contacts.

3. Liberal Clearance when switch is fully opened.

4. Condit Type D-13 Oil Switch with individual Tank-per-Pole arrangement, providing high factor of safety.

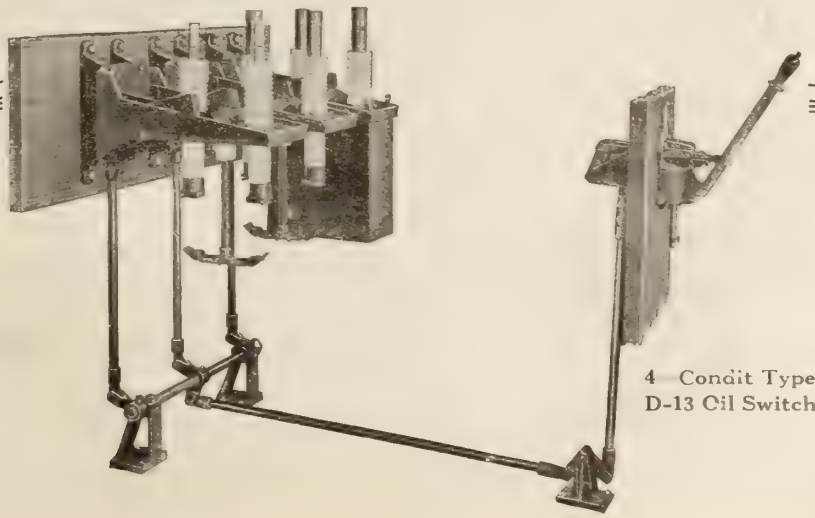
¶ Condit D-13 Oil Switch has a maximum capacity of

300 amperes at.....27,000 volts
500 amperes at.....25,000 volts
and
800 amperes at.....15,000 volts

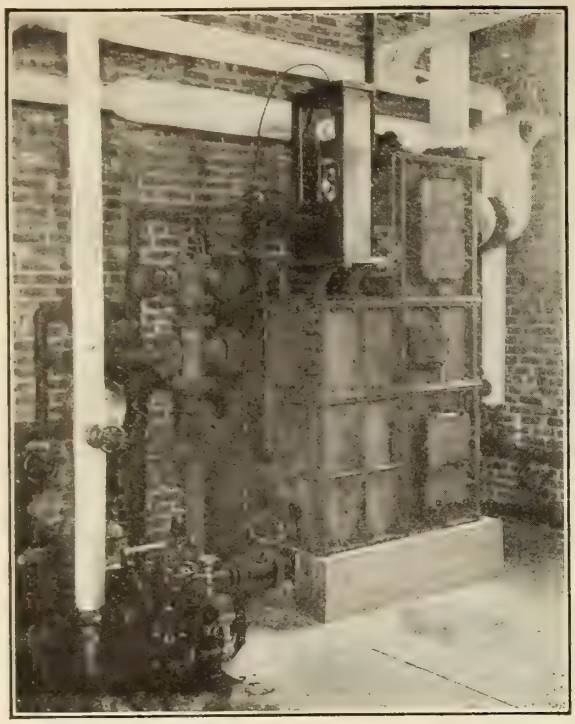
Write our nearest Branch House for full information

Northern Electric Company
LIMITED

MONTREAL OTTAWA TORONTO LONDON WINNIPEG REGINA CALGARY
HALIFAX EDMONTON
QUEBEC VANCOUVER

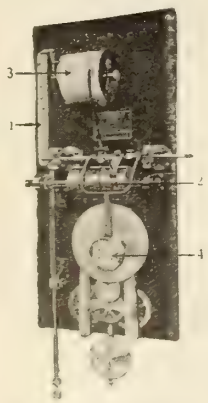


4—Condit Type D-13 Oil Switch



98.5% Accurate at All Times

The value of any metering device is dependent upon the accuracy of the recording instrument itself. And it is not enough for the instrument to be accurate at the time of its installation; it must retain this accuracy under all conditions of service and for a length of time measured in years.



The Yarway-Lea Recorder automatically furnishes four kinds of information:
1. Inches head of flow falling over weir.
2. Instantaneous indication of rate of flow.
3. Graphic paper record in pounds or gallons of liquid during any part of 24 hours.
4. Total volume or weight of flow over any period between two readings.

Sturdiness of construction and simplicity of operation enable the Yarway-Lea V-Notch Recorder to maintain its accuracy of within one and one-half per cent. for an indefinitely long period. In no case has this instrument ever depreciated in accuracy, even after many years of service.

The illustration shows a Yarway-Lea V-Notch Recorder used in conjunction with a feed-water heater-meter at the plant of the Sinclair Consolidated Oil Company, Trembley Point, N.J.

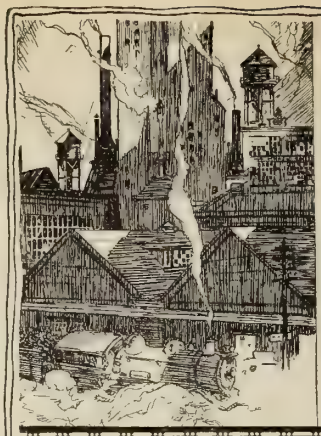
The Yarway-Lea Recorder is the only genuine Lea Recorder made and sold in this country. Booklet L-40 contains complete details. Shall we send you a copy?

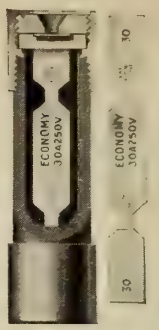
Yarnall-Waring Company

7604-20 Queen St., Chestnut Hill, Philadelphia

Offices in all Principal Cities

Yarway Products are being used in thousands of plants. They are sold under a money-back guarantee.





Ferrule Type, Economy Fuse with Economy "Drop Out" Renewal Link.

ECONOMY *renewable* FUSES

Progressive industries using electrical energy obtain more dependable protection to lives, property and machinery—at less cost—when they discard "one time" fuse equipment for

Economy renewable Fuses

The famous Economy "Drop Out" renewal link cuts annual fuse maintenance costs 80%.

Knife Blade Type Economy Fuse

It is the least expensive and the only portion destroyed when an Economy Fuse blows.

Economy "Drop Out" Renewal Links invariably operate at rated capacity. They are inexpensive—a reserved stock kept always on hand represents but a small investment.

The Fuse itself—fibre cartridge, end caps and the winged washer which locks the link securely in place—is used again and again.

The merits of Economy Fuses have been recognized officially, for they were the first line using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be approved in all capacities by the Underwriters' Laboratories.

Your plant needs Economy Fuses.

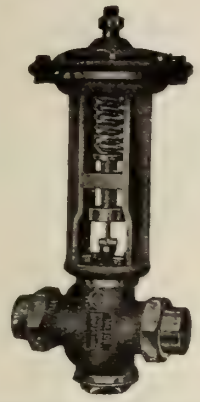
For sale by all leading electrical jobbers and dealers.

Economy Fuse & Mfg. Co., Ltd.

Unity Building

MONTREAL, CANADA

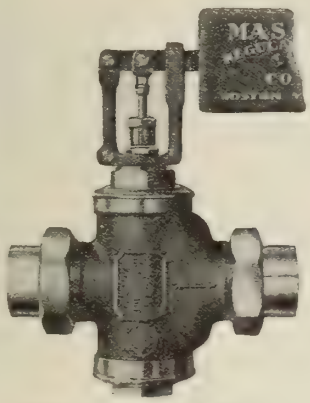
"SERVICE"



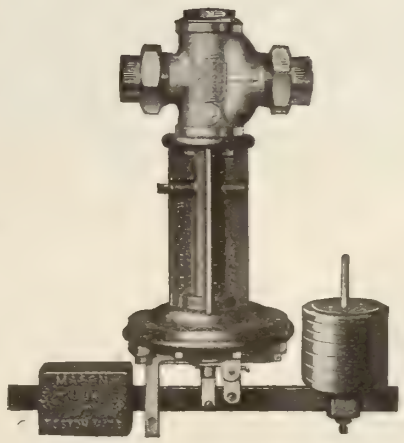
Mason No. 55 Style
Pump Pressure Regulator

Mason Standard
Reducing Valve
Iron Body

Mason Standard Reducing Valve
Bronze Body



Mason Balanced Valve



Mason Lever Style Reducing
Valve

MASON STANDARD REDUCING VALVES ARE MADE IN CANADA

The Mason Regulator & Engineering Company, Limited

135-153 DAGENAIS ST. (ST. HENRY)
MONTREAL

ROOM 5, 145 WELLINGTON STREET WEST
TORONTO

"In the Smugglers' Den"

An Intimate and Dramatic Story of Boot-leggers and the Activities of Rev. J. O. L. Spracklin of the Border Cities.

MR. CHARLES CHRISTOPHER JENKINS, the writer of this story, arrived in Windsor a few hours before Trumble was shot by the Rev. J. O. L. Spracklin; and during the next few days among the experiences which befell MacLean's Magazine special representative was one of particularly dramatic and timely interest —a few hours spent within the lair of one of the smugglers' "Master Minds." This graphic story from Mr. Jenkins' pen will enable you to get a real grip of what this all means, particularly from the side of those who are beyond the pale of the law.

The story is illustrated by some exclusive and timely photographs showing the chief actors and various resorts within the sphere of their activities.

December 1st Issue of MACLEAN'S Brimful of Fascinating Reading

"AUTOBIOGRAPHY OF MRS. ASQUITH"
Wife of the former Prime Minister of Great Britain.
One of the strongest and most interesting stories Mrs. Asquith tells in her extraordinary reminiscences.

"THE CITY OF PERIL"
By Arthur Stringer.
Four more pages of this gripping, enthralling, melodramatic story of Bolshevistic adventure in New York.

"JEFF HEARS THE CALL"
By C. W. Stephens.
The story of a fight with forest fire, of rescue by the air route from a horrible death by flames.

"LINKING TWO INLAND SEAS"
By J. L. Rutledge.
Here you have the account of the struggles which led to the construction of one of Canada's greatest transportation links.

"THE TEST"
By Harry C. Douglas.
This is a charming little short story with a surprising conclusion.

"THE DRAMA OF OUR GREAT FORESTS"
By Arthur Heming.
The second instalment of this gripping serial is entitled "Oo-Koo-Hoo's Eldorado." On the cover will be another Heming picture.

"FLIRTING WITH OUIJA"
By Col. George H. Ham.
The genial George's adventures in the mystic, with necromancers and hypnotists.

"LEAVES OF KACHUBOONG"
By Madge Macbeth.
An intriguing detective story by the well-known Canadian authoress, who has specialized in depicting criminal types.

"FIRST ROW, ORCHESTRA"
By Leslie G. Barnard.
In this you have the catchy story of a small town girl who became a big town actress.

"OUR GOLDEN FLOOD ROARS EAST"
By Nicholas North.
The story of how our grain is graded; the difficulties in marketing 275,000,000 bushels of wheat.

Review of Reviews

Some of the subjects treated in our reviews in December 1st issue include :

Fiume under d'Annunzio.
The War Spirit in the World—Sisley Huddleston.
Russia in the Shadow—H. G. Wells.
Benedict XV, Royal Diplomat.
The Irresistible Thing—Sir Gilbert Parker.
The Russian Intelligence—Leo Pasvolsky.
Simple Solution of the Labor Problem.
Letting the Prisoners Govern Themselves—Frank Tannenbaum.
German Universities Hard Up—Allen W. Porterfield.
The New Search for Oldest Man—Roy C. Andrews.

Secure Your Copy Early—The Supply is Limited

Over 80,000 Canadian Families Buy

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

DECEMBER 1st ISSUE *On All News-stands* ***20c***

Or Send $3.00 for a Year's Subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto, Canada

REGISTERED COPPUS U.S. PAT. OFFICE

COPPUS TURBO BLOWERS EFFECT STEADY SAVINGS

In the modern plant of the New York Ice Company, New York City, this 22" COPPUS Turbo Blower has been saving time, money and labor ever since installation in April, 1917. It has **made possible** the use of cheap fuel, and **made sure** the maintenance of constant steam pressure. So satisfactory has been the service of this COPPUS Blower that two more blowers have since been purchased for other plants of the New York Ice Company.

COPPUS Turbo Blowers are cutting down fuel costs and keeping up steam pressures in old storage and artificial ice plants all over the country. Automatically regulated, self-oiling, quiet running, COPPUS Turbo Blowers are by far the most efficient means of securing mechanical draft.

Let our engineers tell you just what COPPUS Blowers can save you in your boiler room. Write for Blower Catalog.

"COPPUS" Equipment can "Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block

COPPUS TURBO BLOWER

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lukenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal.

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co,, Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co,, Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Montreal
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equipment Co., Montreal
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equipment Co., Montreal
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
International Chemical Co., Toronto, Ont.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Northern Equipment Co.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y

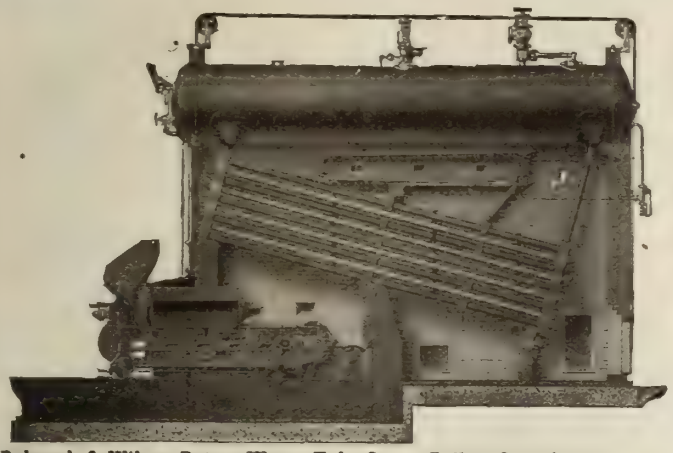
CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

Used the World Over

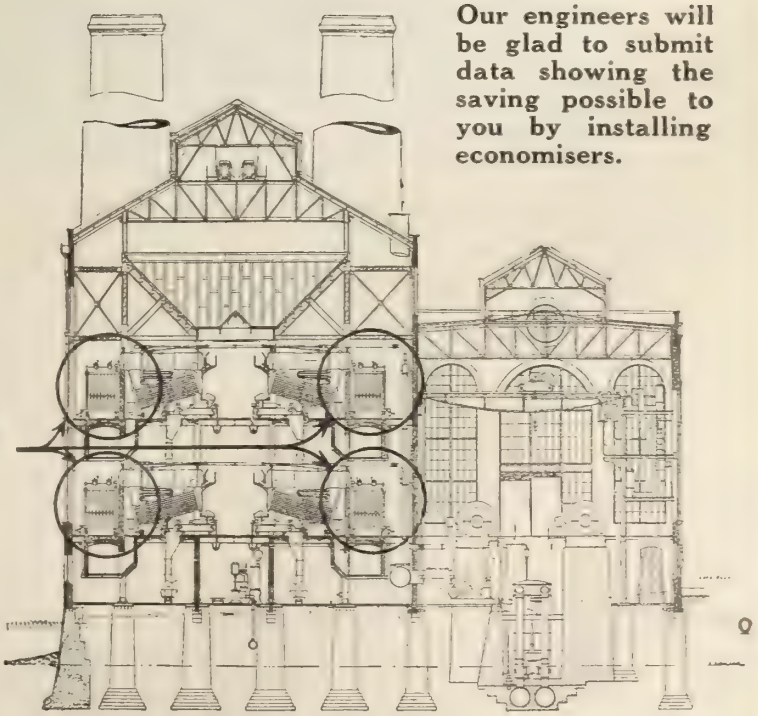
The value of Green's Economisers as fuel savers is proven daily all over the world. In Europe, South America, Japan and China—wherever steam is generated by stationary boilers, especially in the great industrial centres, there you will find

GREEN'S ECONOMISERS

The Green's Economiser installation in Chelsea Station, London, England, is the largest of its kind in the world—about 15,000 tubes. Though of such recognized efficiency as to be chosen for installations of this size, its fuel conserving value is equally as great in the small plant. Let us tell you just how Green's Fuel Economisers will save you 10 to 15 per cent. on your coal bill, **no matter what the size of your plant!**

GREEN'S ECONOMISER, LTD.
TORONTO

Our engineers will be glad to submit data showing the saving possible to you by installing economisers.



Chelsea Station, Underground Electric Railways Co., London, Eng.

Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd, Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrookee, Que.
Ministry of Munitions, London, England

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton. Ont.

COUNTERS
American Steam Gauge & Valve Mfg Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. C., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor. Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
E. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

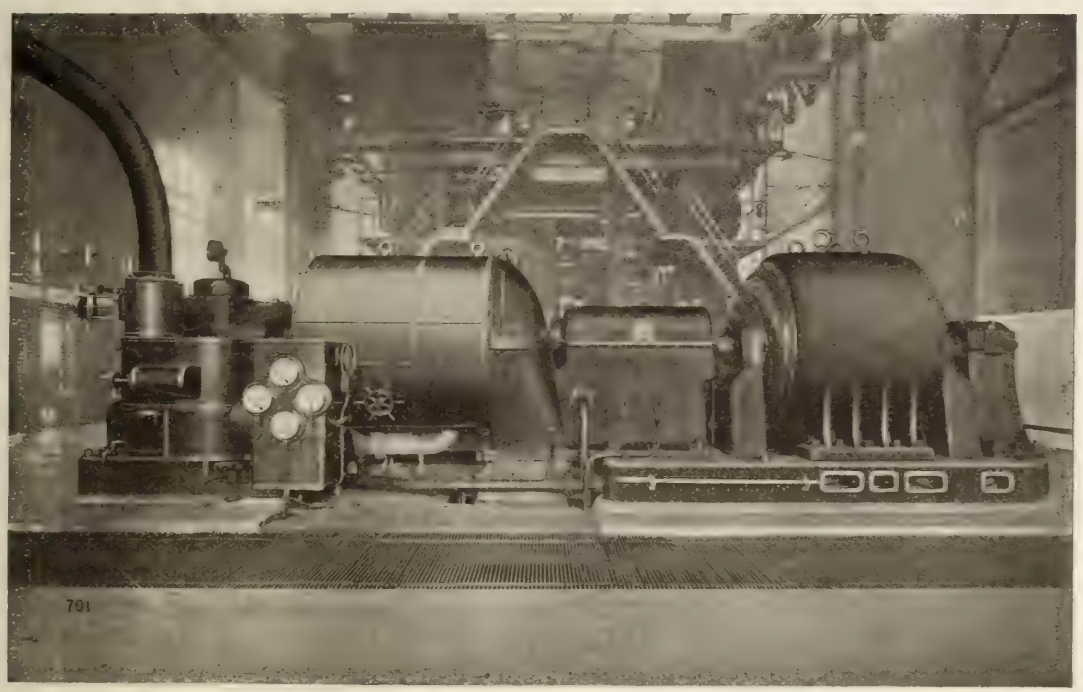
FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk Con.

BELLISS & MORCOM
LIMITED

Engines and Air Compressors

The engineers who purchase equipment for the large engine rooms are invariably keen buyers.

It is a notable fact that Belliss & Morcom Engines and Air Compressors are to be found in many of Canada's largest engine rooms.



Belliss & Morcom 2000 K.W. Steam Turbine at Montreal Tramways Power Plant

High-Grade Power Equipment

Steam Engines	Air Compressors	Pressure Filters
Gas Engines	Condensing Plants	Gravity Filters
Oil Engines	Centrifugal Pumps	Water Softening Plants
Diesel Engines	Boiler Feed Pumps	Refuse Destructors
Steam Turbines	Water Meters	

LAURIE & LAMB
Engineers

211 BOARD OF TRADE BLDG. MONTREAL

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories, Ltd., Montreal.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall. Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Montreal
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equipment Co., Montreal
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equipment Co., Montreal
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

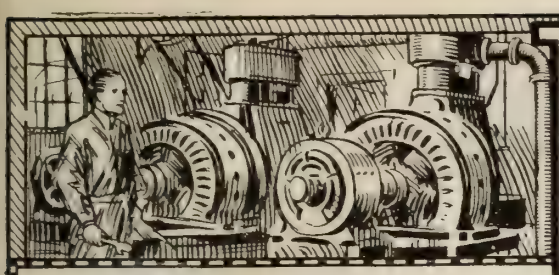
LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

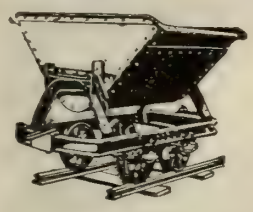
LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

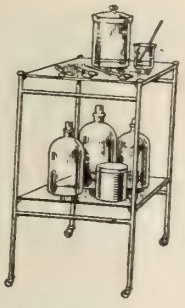
LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

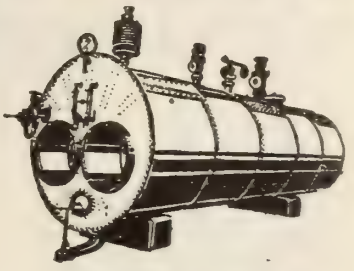


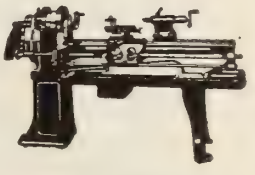
MINISTRY of MUNITIONS

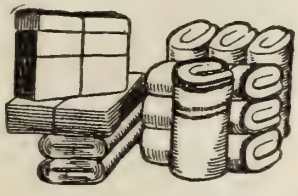
G R

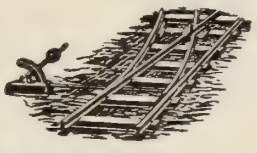


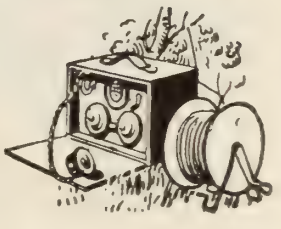


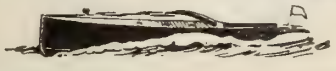












The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

LUBRICATORS, SIGHT FEED AND
MACHINERY INSULATION
PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal.
MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
MACHINE TOOLS
Ministry of Munitions, London, England.
MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.
MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford-Riley Stoker Co., Worcester, Mass.
METERS, AIR
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.
METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS, GAS
Republic Flow Meters Co. of Canada, Toronto, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.
METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Republic Flow Meters Co. of Canada, Toronto, Ont.
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
MIXING VALVES
Crane's Limited, Montreal.
MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont
MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.
MOTOR VEHICLES
Ministry of Munitions, London, England.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.
OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.
OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.
OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.
PACKING, RUBBER
Gutta Percha & Rubber Ltd Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.
PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.
PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PIPE, ACID RESISTING
Hoyt Metal Co.
PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.
PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H. Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.
PRESSURE GOVERNORS
Northern Equipment Co.
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.

Rigidly Tested

NORWALK AIR & GAS COMPRESSORS

You are sure when you purchase a Norwalk Compressor that the machine will arrive in condition to give the specified results as soon as it is properly set up and connected to power.

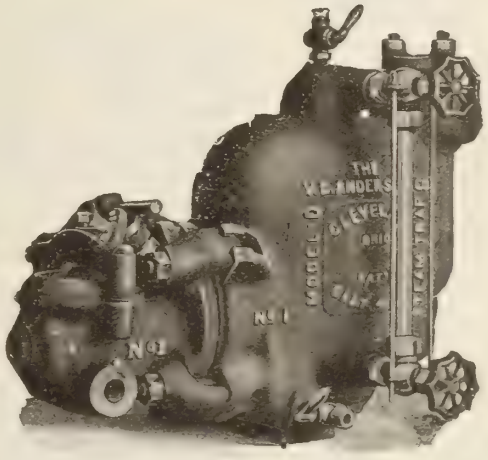
Every Norwalk Compressor is rigidly tested in all details before it leaves our plant. Nothing is left to chance or experiment at your end of the line. This characteristic Norwalk thoroughness saves you time, bother and money.

One or all of the Norwalk Bulletins on compressors for air, oxygen, hydrogen, acetylene and carbonic acid gas will be sent on request.

The Norwalk Iron Works Co.
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

Canadian Sales Representative
A. S. Leitch Company, Toronto

ANDERSON
Model "D"
Steam Trap



Steam Condensation is Impossible

IT is impossible for any condensation to gather with this trap. Three inches of water seals the valve and seat, so when condensation is exhausted no steam is allowed to escape.

The Anderson Model "D" Steam Trap gives efficient and economical service. It automatically drains the condensation from radiators, steam coils or heating systems without reducing pressure or permitting the escape of live steam.

The Anderson, by reason of its interchangeable parts, can be used on any steam apparatus where there is condensation to handle. Its sturdy construction and simple design are unequalled.

If you are troubled with condensation problems, get our catalogue—a post card brings it.

The V. D. Anderson Co.
1935 W. 96th St. - Cleveland, Ohio

Darling Bros Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, FEED WATER
Northern Equipment Co.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SOOT CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

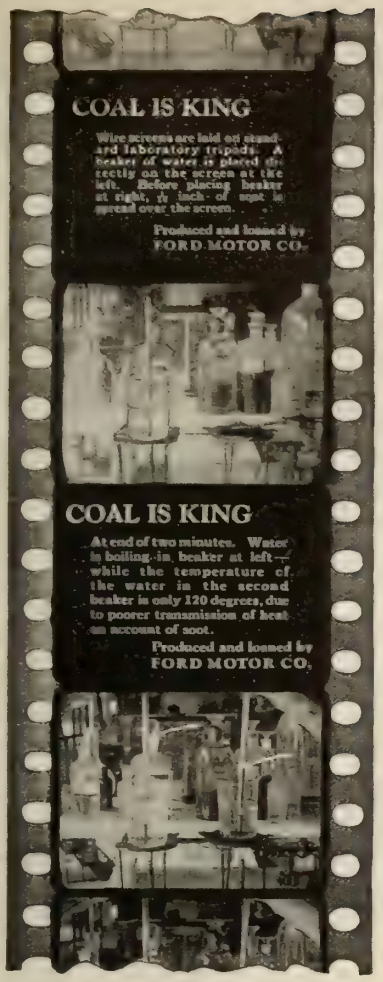
TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.


COAL IS KING
Wire screens are laid on standard laboratory tripods. A beaker of water is placed directly on the screen at the left. Before placing beaker at right, ⅛ inch of soot is spread over the screen.
Produced and loaned by FORD MOTOR CO.
COAL IS KING
At end of two minutes. Water is boiling in beaker at left—while the temperature of the water in the second beaker is only 120 degrees, due to poorer transmission of heat on account of soot.
Produced and loaned by FORD MOTOR CO.

Laboratory Tests Point the Way to Greater Boiler Efficiency

What The Moving Pictures Show

SCENE: Chemical Laboratory of Ford Motor Co.

OCCASION: Production of motion picture, "Coal is King." (This film deals with all phases of coal conservation in the boiler-room. It has been shown before several hundred American engineering societies.)

ACTION: Test to illustrate the bad effects of soot in preventing heat transference when allowed to accumulate on boiler tubes.

RESULTS: The pictures tell the story—water is boiling in the beaker with clean surface exposed to flame, whereas it has only reached a temperature of 120 degrees in the beaker with soot insulated surface.

When soot accumulates on the heating surface of a boiler the result is identical with that obtaining with the soot insulated beaker. A large part of the heat is lost because it is not transmitted to the water. This means excessively high coal bills, and poor, uncertain service from the boiler. Obviously high efficiency in the generation of steam is dependent upon the maintenance of the cleanest of clean heating surface.

In thousands of boiler-rooms "Cleanliness" and "Diamond Soot Blowers" are synonymous terms. Diamond Soot Blowers clean large portions of the boiler which cannot be reached by the hand lance, and clean those which can be so reached, better. As compared to the best possible results by hand cleaning, Diamond Soot Blowers will—save 4% to 8% fuel—increase overall boiler efficiency—and decrease labor required in the boiler-room.

At present fuel prices Diamonds will completely pay for themselves in four to six or eight months. If 100 to 200 per cent. dividends per year from an investment in your boiler-room would interest you, write for Bulletin 280.

DIAMOND SPECIALTY CO.
WINDSOR, ONTARIO, CANADA

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR
H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co. H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.

VALVES, MULTIPORT
Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL
Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VISES AND CUTTERS, PIPE
Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC
W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER REGULATORS, FEED
Northern Equipment Co.

WATER SOFTENING SYSTEMS
Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS
Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES
Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS
Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilsen Mfg. Co., Ltd., Belleville

WELDING COMPOUND
Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE
Electric Welding Co., Montreal.

WELDING SUPPLIES
Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE
Lincoln Electric Co. of Can., Ltd., Toronto

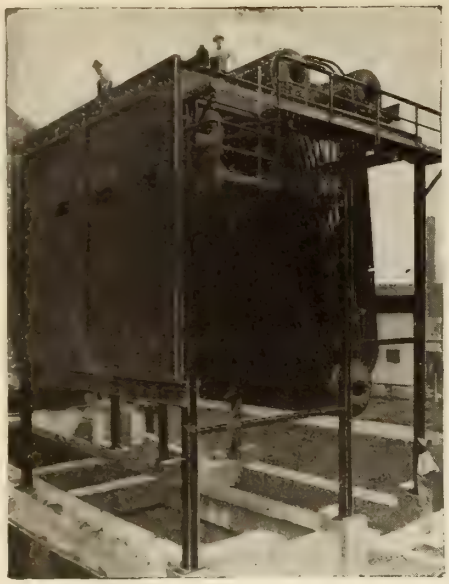
WHISTLES
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)
Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE
Williams Machinery Co., A. R., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.
J. H. Williams & Co., Brooklyn, N.Y.



Connelly Water Tube Boilers (Patented U.S. & Canada)

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no hand-holes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. 150,000 H.P. in successful operation.

E. Leonard & Sons, Ltd. Head Office and Works:
LONDON, CANADA

Branches :
1790 St. James St., Montreal, Que. 62 Water St., St. John, N.B.

86th Year

AGENTS
E. J. Philip & Sons, 57 Queen Street West, Toronto, Ont.
Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
Vancouver Machinery Depot, Ltd., Vancouver, B.C.
Thos. A. Pippy, Waldegrave St., St. John's, Nfld.

LEONARD

INDEX TO ADVERTISERS

A

American Steam Gauge and Valve Mfg. Co. 55
American Steam Pump 64
Anderson Co., V. D. 77
Armstrong Cork & Insulation Co. 11
Audel & Co., Theo 33

B

Babcock & Wilcox 71
Badger & Sons, E. B. 57
Bailey Meter Co. 48
Betson Plastic Fire Brick Co. 48
Brown, Wm. J. 54
Boving Hydraulic Eng. Co. ... 54
Bowser Co., Ltd., S. F. ..... Inside front cover
Busch-Sulzer Bros. — Diesel Engine Co. 56
Buyers' Directory 70, 72, 74, 76, 78, 79

C

Can. Consolidated Rubber Co. 59
Can. Fairbanks-Morse Co. 31
Can. Johns-Manville Co. 7
Can. Mead-Morrison, Ltd. 50
Can. Steam Boiler Equipment. 60
Chaplin-Fulton Mfg. Co. 54
Coppus Engr. & Equip. Co. ... 69
Crane Ltd. 56
Classified Ads. 33

D

Darling Bros. 54
Dart Union Co. 60
D'Este Co., Julian 48
De Laval Separator Co. 61
De Laval Steam Turbine Co... 46
Diamond Specialty Co. 79
Direct Separator Co. 42
Dominion Coal Co. 54
Dunham & Co., C. A. 64
Durabla Mfg. Co. 13

E

Economy Fuse Co. of Can., Ltd. 2
Empire Brass Mfg. Co. 66
Engr. & Mach. Works of Can. 37
Escher, Wyss & Co. 62
57

F

Frick Co. 57
11

G

Garlock Packing Co. 41
Garth Co., The 55
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co...8, 35
Greene, Tweed & Co. 52
Green's Economiser, Ltd. 71
Gutta Percha 49

H

Hayes Corp., The Jos. W. 4
Holden Co., Ltd., The 6
Holmes Metallic Packing Co. .. 55
Homestead Valve Mfg. Co..... 56
Hoyt Metal Co. 54

I

Inglis Co., John..Inside back cover

J

Jamison Cold Storage Door Co. 12
Jefferson Union Co. 51
Jeffrey Mfg. Co. 38
Jenkins Bros. .....Front cover
Jointless Fire Brick Co. 57

K

Kellogg & Co., E. H. 32
Kerr Engine Co. 58

L

La Clede Christy Clay Products Co. 14, 15
Laurie & Lamb 73
Leitch, The Arthur S. 36
Leonard 80
Linde Can. Refrig. Co. 10
Long, J. T. 32
Lunkenheimer Co. 4

M

MacGovern & Co. 46
Magnolia Metal Co. 13
Manny Co., E. S. 54, 56
Mason Regulator & Eng. Co... 67
Mueller Mfg. Co., Ltd., H. 3
Ministry of Munitions 75
Morrison Brass Mfg. Co., Jas. Outside back cover
Moncrieff Ltd., John 55

N

Northern Equipment Co. 39
Northern Electric Co. 65
Norwalk Iron Works Co. 77

P

Page-Hersey Tubes Ltd. 63
Peacock Bros., Ltd. 43
Penberthy Injector Co. 5
Petrie Co., W. H. 56
Pilley Packing & Flue Brush Mfg. Co. 55
Pratt & Cady Co., Inc. 58

R

Robb Engineering Co. 63
Republic Flow Meter Co. 47

S

Sanford Riley Stoker Co. 50
Scaife & Sons Co., Wm. B..... 80
Schaeffer & Budenberg Mfg. Co. 61
Starrett Co., The L. S. 62
Steel Mill Packing Co. 58
Sterling Engine Co. 33
Superheater Co., Ltd., The..... 53
Sturtevant Co. of Can., Ltd., B. F. 44, 45

T

Taylor Instrument Co. 55

U

Uehling Instrument Co. 62
Under-Feed Stoker Co. of Can., Ltd., The 2

V

Victoria Foundry Co. 56
Vilter Mfg. Co., ... 10
Voorhees Rubber Co., Ltd. 42

W

Wall, W. J. 55
Waterous Engine Works Co... 1
Watson & McDaniel Co. 55
Williams & Co., J. H. 42
Worthington Pump & Machine Co. 9

Y

Yarnall-Waring Co. 66
York Mfg. Co. 12

WATER

WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

BOILERS

TANKS AND ENGINES

Of All Kinds for Any Service

Enquiries Promptly Answered

THE JOHN INGLIS CO., LTD.

14 Strachan Ave., TORONTO

Ottawa Representative:
J. W. ANDERSON
7 Bank St. Chambers, Ottawa

Representatives in Eastern Canada
JAMES W. PYKE & CO., LIMITED
232 St. James St., MONTREAL

STEAM MORRISON GOODS

To Convince:

"To free from doubt or uncertainty"

This is just what a trial of Morrison Steam Specialties will do—convince you of their merit; prove that they will eliminate entirely all doubt and uncertainty as to the operation of your steam goods.

"Every Installation is a demonstration of merit"

The James Morrison Brass Mfg. Co., Ltd.

93-97 Adelaide St. W. TORONTO

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

Vol. XIII.—No. 24. Publication Office, Toronto—December 20, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

A Merry Christmas to You

D·K·McLAREN LIMITED

351 St. James St., Montreal

Stock Depots:

Toronto, Ont. Vancouver, B.C.

St. John, N.B.

Paste on Page 1.

EDITORIAL RECORD

of IOWA HOUSE.....issue DEC. 20th.....

This form should be made promptly after each issue of paper and attached to marked copy and sent to General Manager.

All measurements based on col. 10" x 2¼"
Wide measure 20 ems count as 1½ columns

Total columns Reading Matter in above issue 69.....

Original matter written by
Total since Jan. 1 for above issue.

T. H. Fenner 17.2

Stephen Leacock and Agnes C. Laut have been added to the list of regular contributors to your Magazine—MacLean's. These writers need no introduction to Canadian readers. Watch coming issues of MacLean's Magazine.

We have something else to bring to your attention again—the attached statement of your subscription account. May we ask you to favor us with your remittance, thus showing tangible appreciation of a Canadian periodical we ar e trying to make increasingly worthy of your subscription.

We certainly do not like to worry you about this unnecessarily, nor do we allow these items to worry us to the extent of interfering with the service we give you. Wouldn't it be a matter of mutual satisfaction though to have this straightened out?

I sometimes wonder what happens to letters and accounts that we send to some of our friends. May I respectfully suggest that you give this matter the attention you think it deserves—NOW—before you again forget about it?

Every reader in your home derives pleasure and profit from every issue. Remember that $5 will pay your subscription for 3 years.

A return envelope is enclosed and we await an early receipt of your favor.

Yours very truly,

THE MACLEAN PUBLISHING CO., LTD.

A.

A Merry Christmas to You

D·K·McLAREN LIMITED

351 St. James St., Montreal

Stock Depots:

Toronto, Ont. Vancouver, B.C.

St. John, N.B.

DIRECT CONNECTED WORTHINGTON
"FEATHER" VALVE AIR COMPRESSOR

"FEATHER" Valve

(REG. U. S. PAT. OFF.)

insures machine efficiency

AS MR. NAT EMERSON, of the Standard Carbonic Co., writes to his Cincinnati office concerning the original "FEATHER" Valve equipment in the first "FEATHER" Valve Compressor turned out by Worthington. "... These have been in service about five years and two months and you will note are still in good shape."

"This Compressor, as you know, has been very satisfactory and was instrumental in selling a similar one to the Peabody Hotel of this city, and several to the I. C. shops here in Memphis."

All Worthington Gas and Air Compressors, Snow type Oil and Gas Engines and the mammoth Worthington All American designed Marine Oil Engine are "FEATHER" Valve equipped—very pertinent reason why Worthington apparatus has proved so successfully efficient.

Other Worthington Products:
Steam, Power, Centrifugal and Water Works Pumps Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the good-will and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill Machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

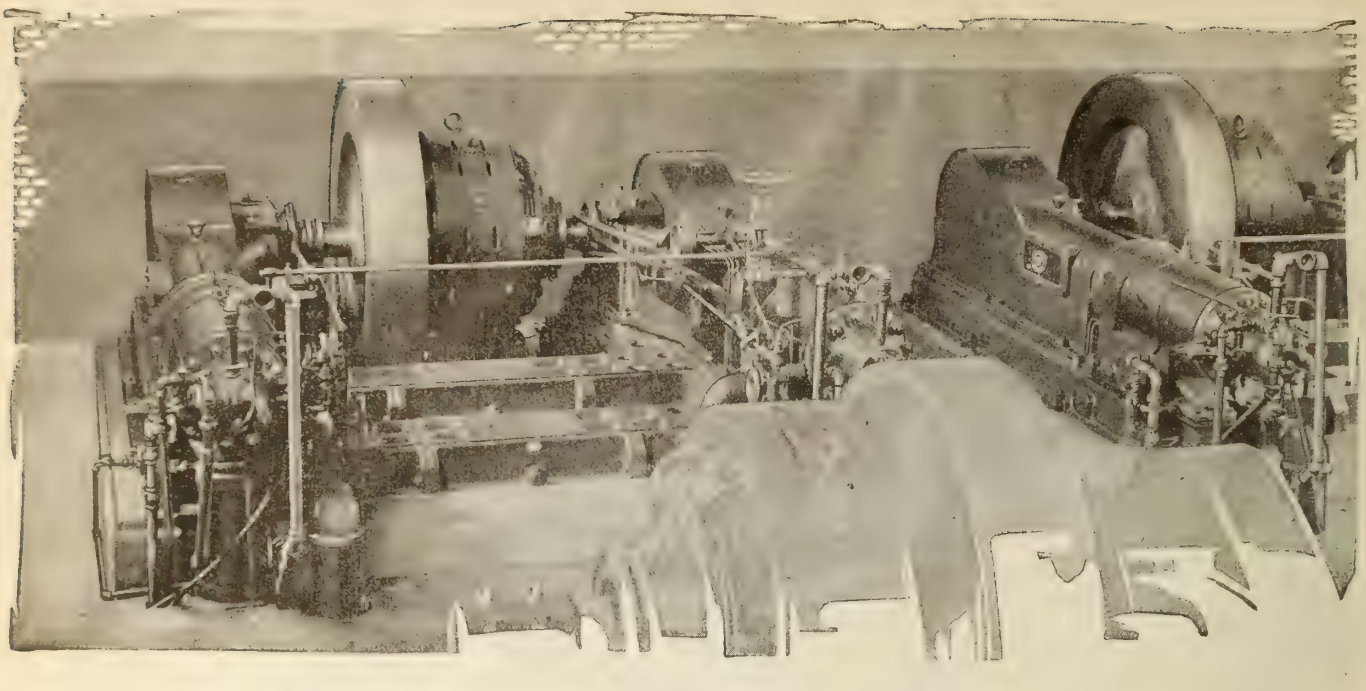
W-273.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

WORTHINGTON

Deane Works, *Holyoke, Mass.*
Blake & Knowles Works *East Cambridge, Mass.*
Worthington Works *Harrison, N. J.*
Laidlaw Works, *Cincinnati, Ohio.*
Hazleton Works, *Hazleton, Pa.*
Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works *Cudahy, Wis.*
Snow-Holly Works *Buffalo, N. Y.*
Epping-Carpenter, *Pittsburgh, Pa.*

POWER HOUSE, December 20, 1920. Vol. XIII., No. 24. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $2; in United States, $2.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



Where standby power became steady power

WHEN you employ a man and he makes good, you want to keep him.

Same way with engines. These Giant Semi-Diesel Oil Engines were put on the job and made good as a standby power. Now they're *regulars.*

Only an engine of Giant dependability could burn low-grade fuel oils, and supply steady power unfailingly. But Giant ruggedness withstands the test of severe service. It operates with day-in and day-out certainty, with negligible upkeep costs.

Scarcity of expert attendants does not concern Giant users. Due to an unusual simplicity of construction and operation it takes little time to start, superintend and stop the engine. No valves, carburetors, costly auxiliaries, or other complicated mechanisms to become inoperative. Result—low attendant costs; low upkeep expense; absolute dependability.

Giants will make good on low-grade fuel oils in *your* plant. Bulletin upon request.

Sales Representatives

The Holden Company, Limited

354-356 St. James Street, Montreal, Canada

Sales and Service Branches: TORONTO, 342 Adelaide Street, West WINNIPEG, 150 Princess Street VANCOUVER, 81 Pender Street

Canadian Factory: Canadian Pneumatic Tool Company, Montreal

EN 44 H

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CANADIAN CP PNEUMATIC

GIANT ENGINES

Dependable Power at Less Cost Per Hour

IMPERIAL

Lubricants

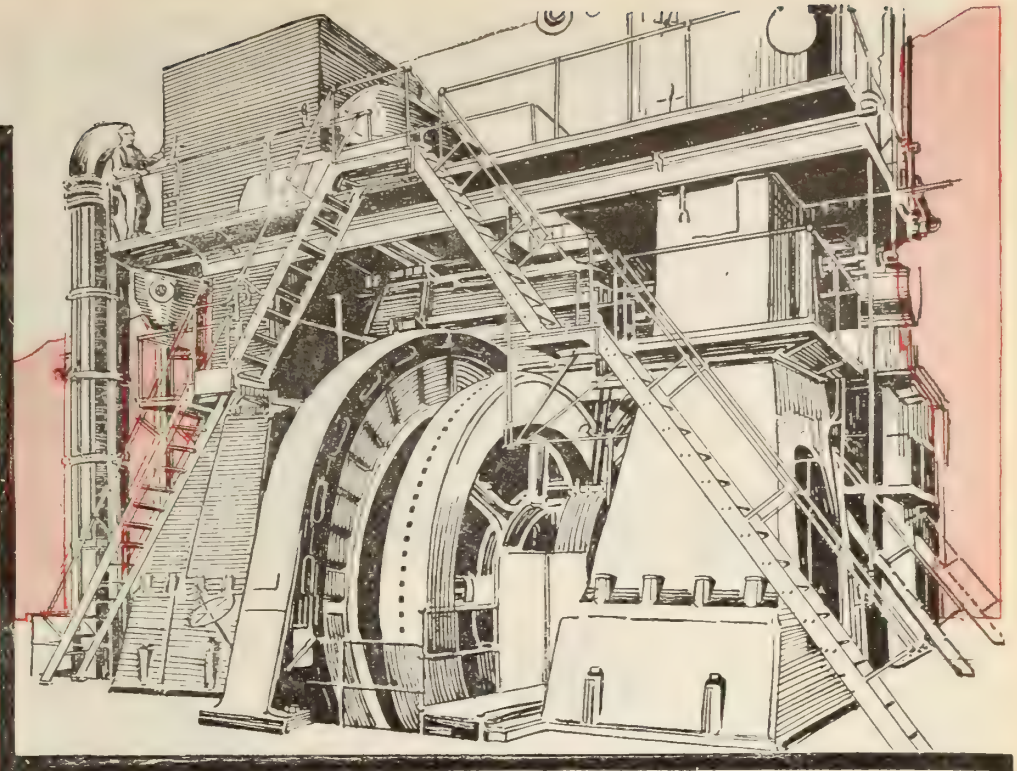
For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Junior Red Oil
Imperial Bayonne Engine Oil
Imperial Renown Oil
Imperial Gas Engine Oil
Imperial Arlo Compressor Oil



Poor Lubrication is Costly

PLANT operators insist upon efficient, scientific lubrication these days. They realize that poor oil is expensive at *any* price.

Imperial Lubricants are especially prepared to meet the modern demand for correct lubrication. There's a grade of uniform-quality oil for each different lubrication requirement of your plant. Supplies are always conveniently available.

Hundreds of firms all over Canada use Imperial Lubricants exclusively. Actual records show a marked reduction in overhead expense and increased capacity throughout plants where Imperial Lubricants are regularly used.

You cannot afford to buy any but the best oils for expensive machinery. Check over the accompanying list of Imperial Lubricants. See how fully it meets every lubricating need.

Imperial Engineers will gladly help you standardize the lubrication of your plant. Write to 56 Church St., Toronto.

IMPERIAL OIL LIMITED

Power-Heat-Light-Lubrication

Five Canadian Refineries Branches In All Cities

Dependable Draft

No mechanical stoker can be more dependable than its source of air supply. Both its efficiency and flexibility in carrying high boiler ratings, depend directly upon the ability of its forced draft equipment to deliver the proper amount of air at the right pressure.

Sturtevant
(TRADE MARK)

Forced Draft Apparatus

—covers every possible requirement from a small undergrate turbo blower to the most powerful types of forced draft turbine fans.

Designed and built by the pioneers in the field and the largest manufacturers of mechanical draft equipment.

Installed in the largest central stations in this country and abroad. Your special draft requirements will receive the consideration of our specially trained fan engineers who will recommend the most economical apparatus for your work.

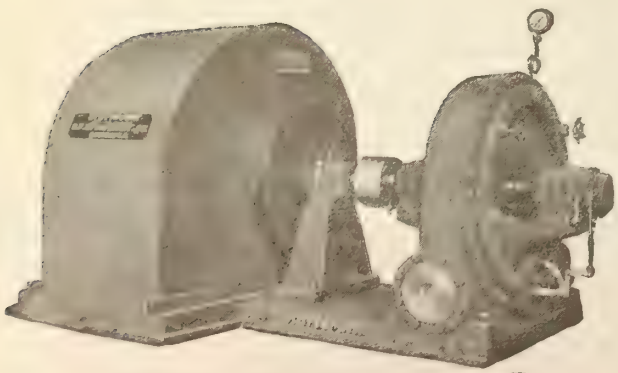
Write for Catalog No. 236-P.

B. F. STURTEVANT COMPANY OF CANADA, LTD.

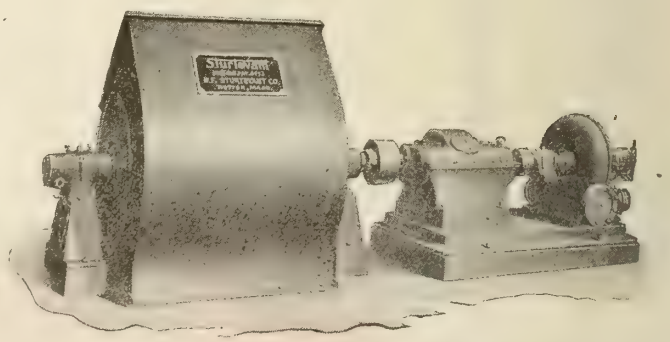
HEAD OFFICE AND WORKS: GALT, ONTARIO

SALES OFFICES: TORONTO AND MONTREAL

Sturtevant
PUTS AIR TO WORK



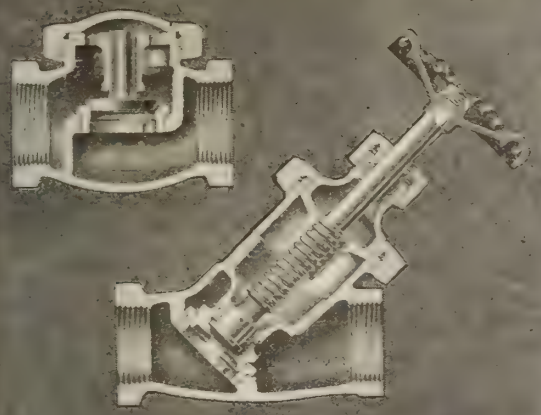
Sturtevant High Speed Multivane Fan

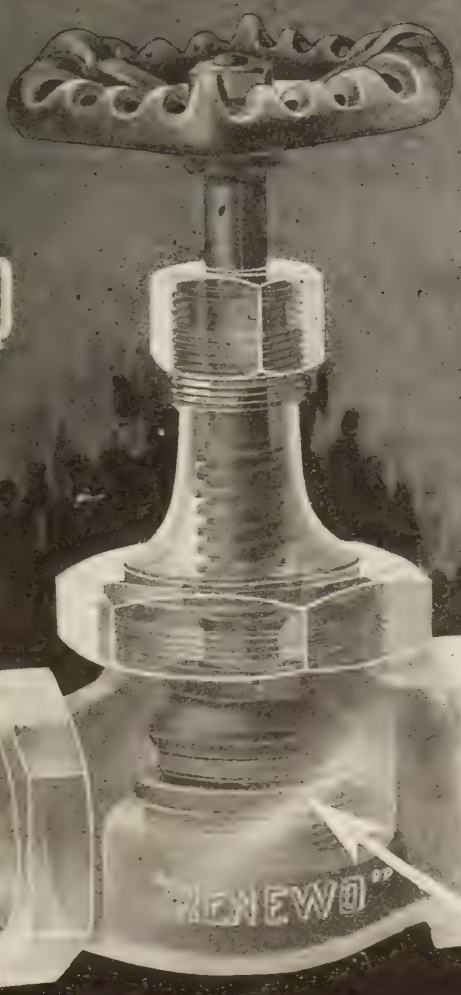


Sturtevant Turbovane Fan driven by Sturtevant Turbine and Reduction Gears

—made to last a long time

LUNKENHEIMER "RENEWO" VALVES





Have achieved an enviable record for economy in steam service. They represent the highest development in valve construction, incorporating all the good features discovered and developed in over half a century of valve manufacture.

Their installation means permanence in the line, because they are as near wear proof as can be attained, and to further enhance their durability all the parts are interchangeable and can be replaced should necessity require.

"Renewo" Valve parts are made of materials best suited to the duty the part performs.

The *Renewable Seat* and *Disc* are made of Lunkenheimer "Valve-nickel," a material having exceptional wear-resisting qualities; the Disc is provided with the celebrated Lunkenheimer "Seat-guard" which aids in preserving the seating faces and keeping them clean, and the seating surfaces are regrindable. The stem is made of a special bronze; the thread is extra long and has full contact when valve is opened or closed.

The union bonnet connection with outside protected threads; deep stuffing box with gland follower, and the self-cooling malleable iron handwheel are other points of merit.

Globe, Angle, Cross, Straightway or Y and Horizontal and Angle Check Patterns for 200 and 300 pounds working steam pressures. Specify LUNKENHEIMER "RENEWO" and insist on having the genuine.

Write for descriptive booklet F535—DC

THE LUNKENHEIMER CO.
—QUALITY—
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
CINCINNATI
NEW YORK
CHICAGO
BOSTON
LONDON

AMERICA'S BEST
LUNKENHEIMER
—QUALITY—
SINCE 1862

A Merry Christmas

TO Our Friends one and all we extend the compliments of the season. May the New Year be one of Prosperity and Success to you all.

FOR your patronage in the past we thank you. May we look for its continuance in the future, and we shall endeavor, as we have done in the past, to show our appreciation by giving you the best service within our power.

Let us resolve to make the coming year one remarkable for larger undertakings and greater accomplishments that Canada may grow in greatness and power.

WILLIAM HAMILTON COMPANY, LIMITED
PETERBOROUGH ONTARIO

The Safe and Certain Boiler Cleanser

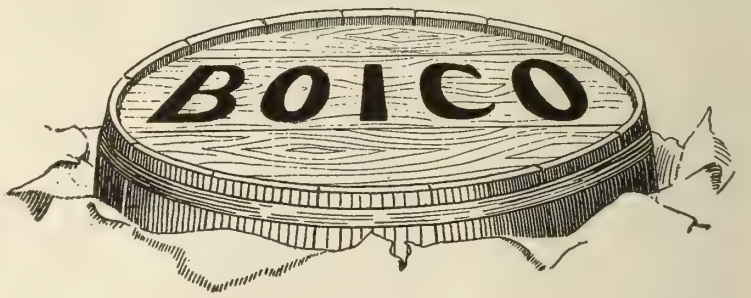
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street **Toronto**

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec
Adam Davis, Cobalt, Ont.

We Design and Construct Power Plant Equipment

WE specialize in the design and construction of power plant equipment. Our engineers are prepared to investigate your problems and advise on the most economical machinery for your needs.

We can supply Corliss, Slide-Valve, Vertical, Horizontal, Simple and Compound Engines, and Water Tube, Return Tubular, Improved Scotch Marine, and Portable Boilers.

Robb Equipment is known to engineers and power plant superintendents for its long and dependable service, standard quality and modern design. When you are in the market —remember it will pay you to purchase equipment that has won the confidence of leading engineers.

Robb Engineering Works Co., Ltd.

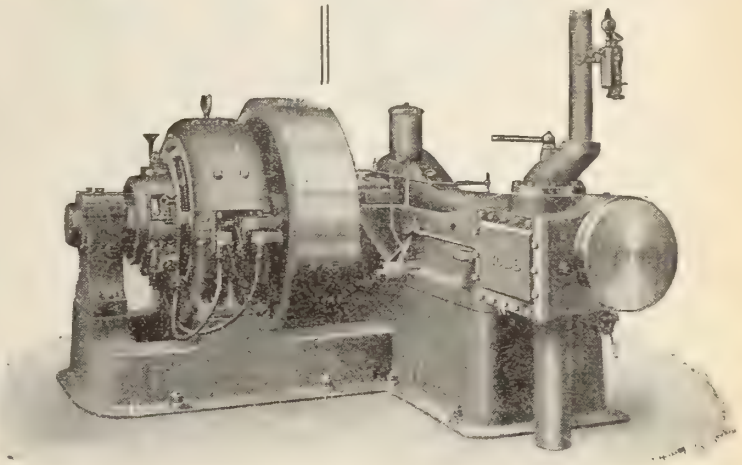
Amherst, N.S.

Montreal Office: 16 Cathcart Street

Toronto Office: 20 Victoria Street

ROBB

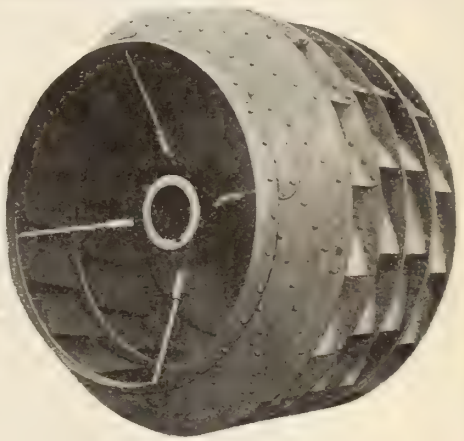
Power Plants



GREEN'S

HI-EFFICIENCY HI-SPEED

RADIAL FLOW FANS



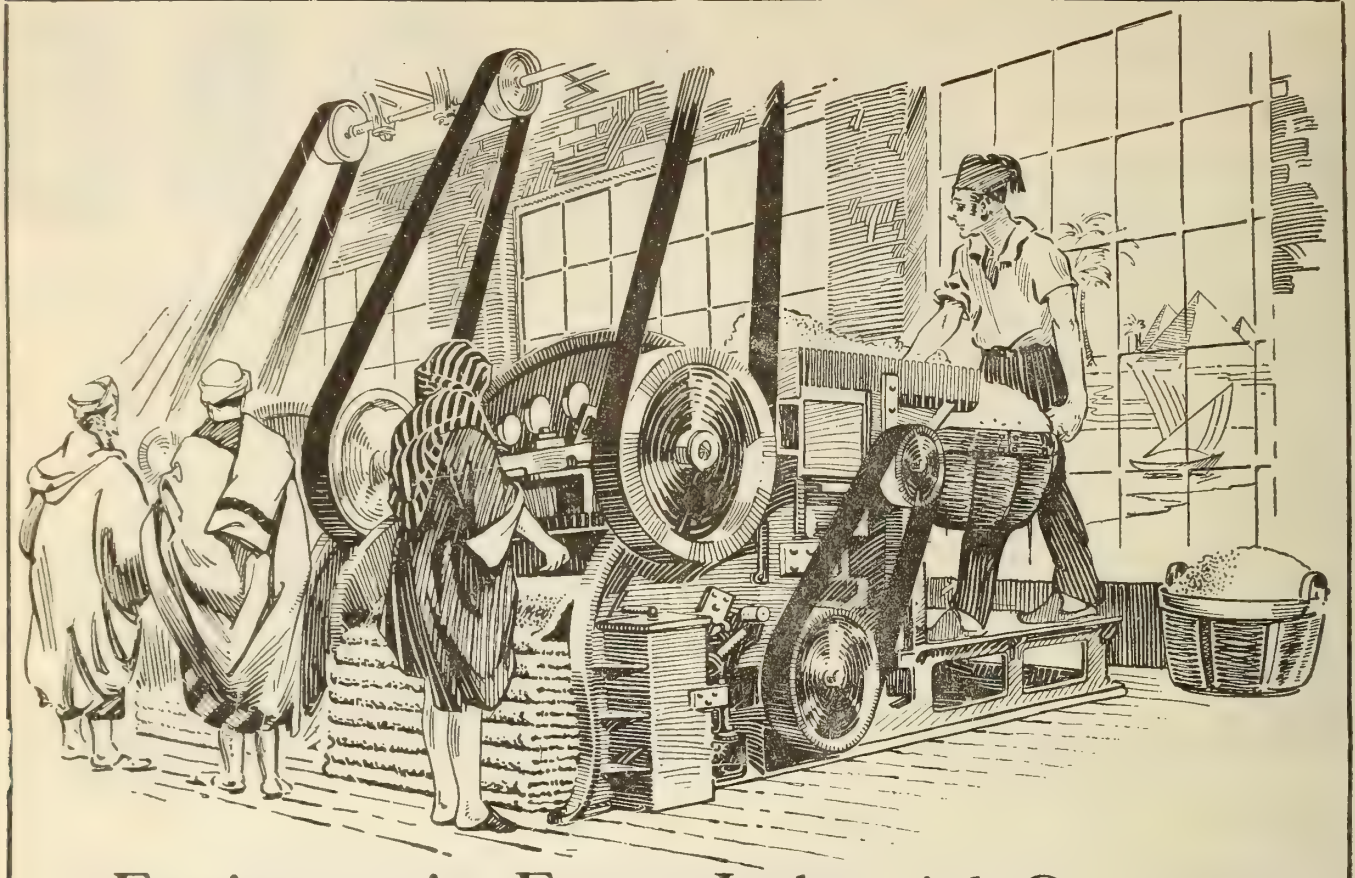
Economical, Sturdy, Efficient

Green's Radial Flow Fans are possessed of many advantages. They require approximately 20% less horse power than any other fans. Are so designed that the rotor and bearings are easily accessible without changing the alignment or dismantling the flue work. Any blow back through the fan inlet or dead space on the fan wheel is impossible due to the design of rotor and housing. They run at speeds best suited for direct connection to turbines or motors and are also suitable for gear or belt drive.

Consult our engineers. They will gladly furnish you complete information with regard to fans to cover your individual requirements.

GREEN'S ECONOMISER, LIMITED.

TORONTO



Engineers in Every Industrial Country Endorse Goodyear Belting

INDUSTRY of other countries approves the economical and satisfactory power transmission which Goodyear Belting is rendering daily throughout Canada.

In the factories and mines of South Africa, the workshops of India and the Orient, the mines of Australia; in industries throughout the world, Goodyear Belting is daily solving power problems. Every obstacle overcome teaches us something more about the efficient specification of the proper belt for each drive Men all over the world who have problems similar to yours will now contribute their experience to the fund of knowledge possessed by the Goodyear belting man who calls on you.

To meet the conditions of this world-wide trade, it has been necessary to change some of the brand names of Goodyear Belts.

For instance, Goodyear Extra Power is now Goodyear Klingtite Belt.

But the change is in name only. Goodyear Klingtite Belt is the old Extra Power in every particular.

Any Goodyear branch will send a man who has studied power transmission problem solved by the use of Goodyear Belting the world over—who will br ng this knowledge to bear in solving yours.

No obligation. Phone, wire or write the nearest branch

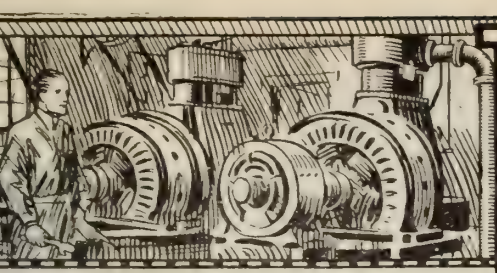
The Goodyear Tire & Rubber Co. of Canada, Limited

Branches:—Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver. Service stocks in other cities.

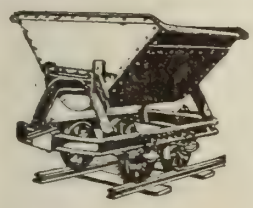
GOODYEAR BELTS

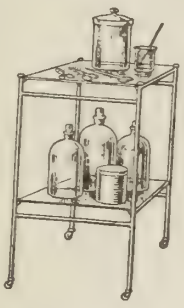
MADE IN CANADA

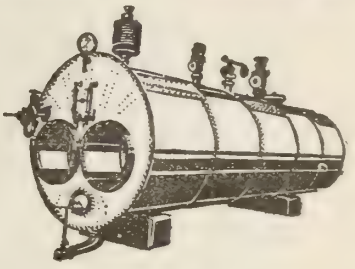
KLINGTITE GLIDE BLUE-STREAK

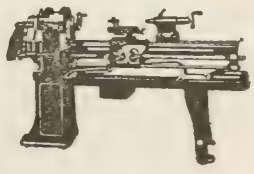


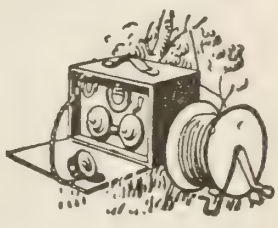
MINISTRY of MUNITIONS G R











The
Disposal Board have

STOCKS

lying in the United Kingdom and Available for Export

OF ENGINEERING STORES

Ferrous and Non-Ferrous Metals
Plant and Machinery
Steam Engines and Boilers
Factory Stores
Machine Tools
Railway Material
Electrical Instruments and Machinery
Medical Stores
Chemicals and Explosives
Motor Vehicles
Agricultural Machinery
Aircraft
Furniture
Textiles and Clothing
Boots and Leather Equipment
Motor Boats, etc., etc.

Buyers should instruct their representatives in the United Kingdom to communicate with the Secretary, Disposal Board, Ministry of Munitions, Caxton House, Tothill Street, London, S.W. 1.

Cable address: "DISPEXPORT, MUNORGIZE, LONDON."

Making the Troublesome Line Trouble Free

A
JENKINS BRASS
GLOBE VALVE
Standard Pattern

Suitable for 175 lbs. Working Steam Pressure
or 250 lbs. Working Water Pressure

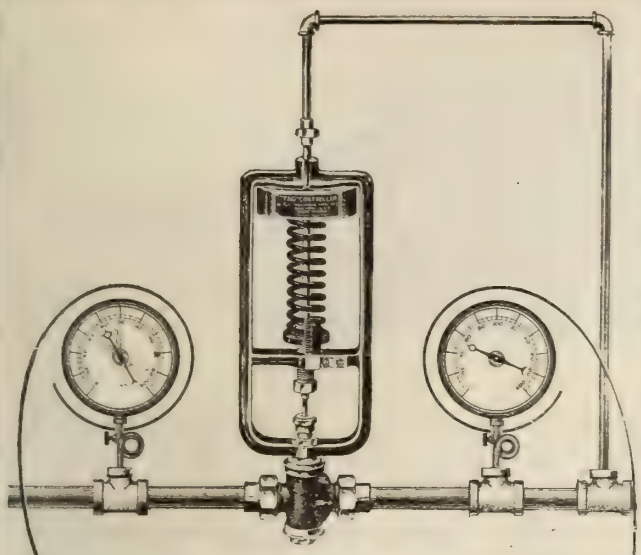
On lines where the pressure and strain is greatest and where ordinary valves fail to measure up—Genuine Jenkins always make good.

The Fifty-six years of experience back of every Jenkins Valve is a guarantee of longevity and dependable performance.

But to be assured of the service that only Jenkins Valves can render look for the Diamond Trade Mark. It is cast on the body of all types and sizes of genuine Jenkins Valves.

Catalog No. 8 (free on request) will show you how very comprehensive the Jenkins line is. Write for copy to-day.

Jenkins Bros.
LIMITED
TRADE JENKINS MADE
TRADE JENKINS MARK
Head Office and Works: 103 St. Remi St. Montreal Can.
TORONTO 5 Great Queen St. Kingsway, London, W.C. 2 Eng. VANCOUVER
European Branch
AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD
Jenkins Bros
Jenkins Bros



UNEVEN PRESSURE MADE CONSTANT

A varying pressure in your supply line can't impair the working efficiency of any apparatus requiring a constant pressure—with the TAG Self-Operating Pressure Controller straddling the motive power and doggedly gripping the pre-determined pressure.

Day in and day out, **constant pressure is automatically maintained**—without any other attention of the engineer to the controller than to "set it and forget it."

What a difference between this simple, economical method that really controls the pressure, and the old wasteful, time-consuming way of juggling the hand valve, which only approximates the desired pressure!

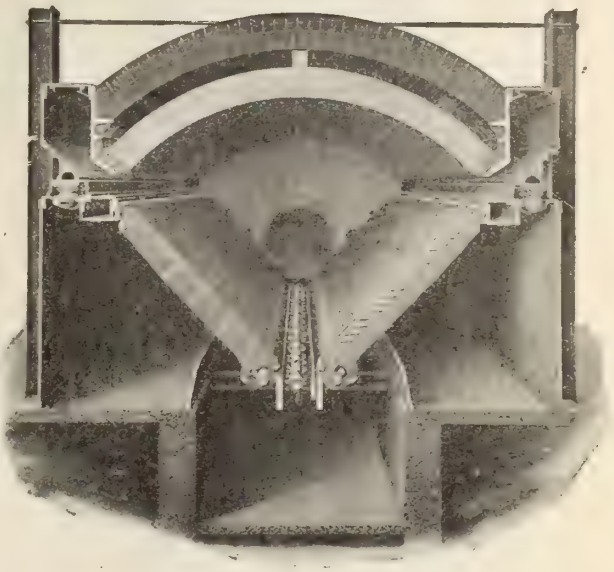
Put a TAG Controller on the pressure line—immediately, uneven pressure is made constant.

Write for

C. J. TAGLIABUE MFG. CO.
18 TO 88 Thirty-Third Street
BROOKLYN, N.Y.

Bulletin PW-488

MURPHY AUTOMATIC FURNACES



WHEN COAL WAS CHEAP —AND NOW

The Murphy Furnace earned its way forty years ago when coal was "dirt cheap." Think how much more quickly it can pay for itself when it saves 15 to 25 per cent. of the price you pay for coal to-day!

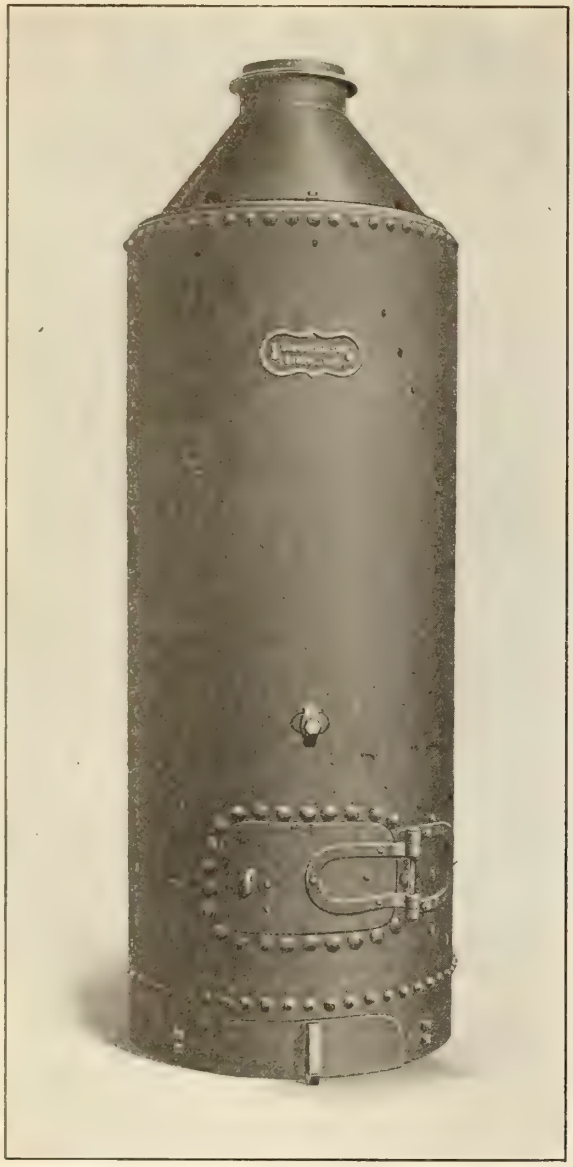
Murphy Furnaces bring to the smaller plant the economical advantages of the larger plant without resorting to forced draft, so the money you save on auxiliary equipment goes far toward paying for their installation.

Under present conditions it is economy to equip even the smaller boilers with Murphy Furnaces—for it saves your fuel and enables you to burn the poorer grades of coal that everyone gets these days.

If your boilers are 50 H.P. or larger you should get in touch with us. Send for Catalog HM-12 and see how easily the Murphy Furnace can be installed under any type of boiler.

For information on Riley Underfeed Stokers for large boilers, see last month's advertisement—or send for Riley Stoker Catalog HR-12

MURPHY IRON WORKS
DETROIT MICH. U. S. A.



UPRIGHT BOILER WITH EXTENSION SHELL

We make the following types of Boilers :

Connelly Water Tube
(*Patented U.S. and Canada*)
Return Tubular
Upright
Locomotive

We specialize in the making of

Smoke Stacks
Tanks of all Types
Plate work of any description
Grey Iron Castings

Head Office and Works: LONDON, CANADA

86th Year

Branches and Agents from Coast to Coast

LEONARD

Carrying Higher Peak Loads Without Adding New Equipment

The peak load capacity of boiler plants may be considerably increased by making it possible for all the heat generated in the furnaces to be used in making steam when there is a sudden increase in demand. To do this, the rate of flow of boiler feed water must be temporarily cut down when there is a sudden increase in load. Otherwise the raising of feed water to the boiling point inside the boiler uses up a considerable portion of the heat generated by the furnace. To carry maximum peak load, all the heat the furnace can possibly generate should be directed towards the generation of steam alone.

Bulletin D tells all about how this is accomplished by the

COPES
Boiler Feed
REGULATORS

Northern Equipment Co.

The World's Largest Manufacturers of Boiler Feed Regulators

112 West 11th Street
Erie, Penn.

Canadian Representatives :
ALLEN GENERAL SUPPLIES, LTD.
205 Yonge St., Toronto, Ont.
MASON REGULATOR & ENGINEERING CO., LTD.
153 Dagenais St. (St. Henry), Montreal, P.Q.
H. N. BROWN
P.O. Box 620, New Glasgow, N.S.
C. C. MOORE & COMPANY, Engineers
618 Mutual Life Bldg., Seattle, Wash.
(Representatives in British Columbia)

104

NONPAREIL GRATES

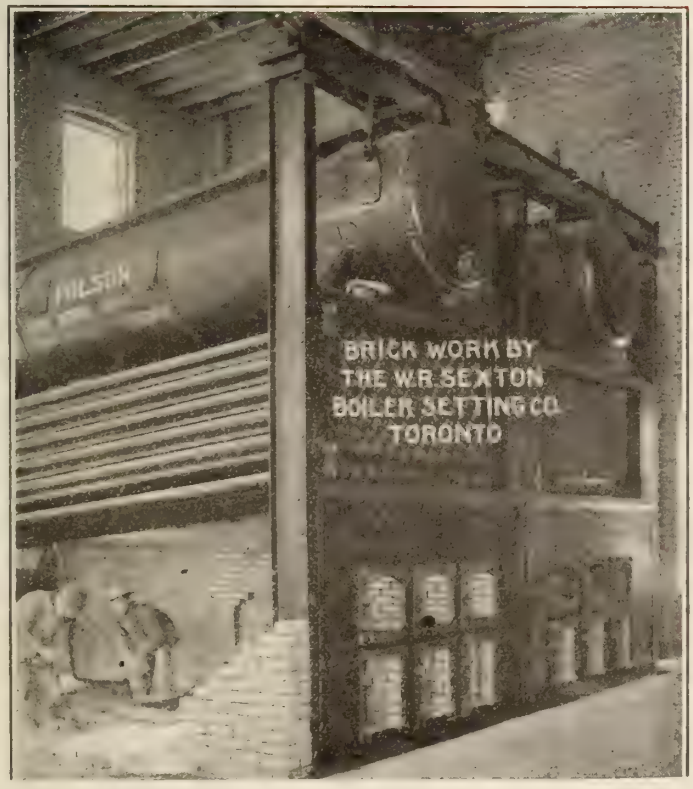
The Enemy of High Fuel Prices

When big manufacturing firms install new equipment they never jump at conclusions or take anybody's word as to its merits. They have their own experts investigate first. This is exactly the course taken by the following well-known firms before installing NONPAREIL SHAKING AND DUMPING GRATES:

The Deloro Smelting & Refining Co.

The International Nickel Co. of Can. Ltd., Two Sets

The Brunswick-Balke-Callender Co. of Can.



Before any of these companies installed NONPAREIL GRATES they satisfied themselves of their efficiency and economy—that they would give perfect combustion, improved service and would SAVE FUEL, and otherwise live up to the claims we make for them. When firms like these place their stamp of approval on Nonpareil Shaking and Dumping Grates, they must surely possess advantages.

Attractive Trial Offer

You are at liberty to order a set of NONPAREIL GRATES and test them out FREE of charge. We guarantee a saving of at least 10 per cent. on your fuel consumption. This is fair and reasonable—why hesitate?

Firebrick Work

Some of the largest power plants in Ontario have had their Firebrick work done by "Safety First" Sexton and his staff. Quality work only! Remember, Nonpareil Grates and Sexton's Brick Work make an unbeatable combination.

REPAIRS—Grate Bars supplied, and repairs made to all kinds of Shaking and Dumping Grates.

THE W. R. SEXTON BOILER SETTING CO.

127 D'Arcy St. and 114 Grenadier Rd.

TORONTO

Phones: Coll. 682; Jct. 2765 W. Established 1900

Once More a Merry Christmas and a Happy New Year

and a little reminder that we will endeavor to serve you in 1921 with the same efficiency that has characterized our efforts during the year now coming to a close.

The Goldie & McCulloch Company
LIMITED
Galt, Ontario, Canada

Christmas Greeting

Wishing a Merry Christmas to our good old friends—

The Engineers

More power to you in the coming year!

Thomas H. Timmis

EDITOR

B. G. Newton

MANAGER

A. D. Freiade

ADVERTISING MANAGER

To Our Readers, Contributors and Advertisers

IT is with genuine pleasure that we take this opportunity of extending to all our friends, who are included in the above, the very heartiest and most sincere good wishes for a bright and happy Christmas, and a New Year full of prosperity and joy.

The end of a year is a time for both retrospect and foresight. We look back over the year gone by with satisfaction, feeling that it has been a year of good effort, and definite results. We look forward to the coming year as a period wherein the works of the past year will be supplemented, and advanced. We fully expect to see our circle of readers extended, more and more influential contributors attracted, and more advertisers taking advantage of the opportunity "Power House" affords them of getting in touch with the people who need and buy their wares.

To do this it is necessary that we, on our side, continue to give the service in both editorial and advertising pages, which we have endeavoured to give during the year gone by. It has been a source of pleasure to see the number of requests for advice that have come in during the year, all of which have been promptly answered, both by personal letter and through the columns of "Power House." We have been also the pleased recipients of many grateful letters from correspondents who have benefited by the advice given in this way.

There is another way in which we serve both our readers and advertisers which is not apparent on the surface. We allude to the not inconsiderable amount of advertising which we refuse, for articles which we do not believe to be genuine, and unable to live up to the claims made for them. Like quack medical nostrums these articles deceive the people who purchase them, and lower the tone of the paper that advertises them, and "Power House" will not accept such advertising.

Editorial plans for the coming year look to giving our readers the highest class of engineering information available. A feature which has met with great favor, our "Course of Instruction," will be continued, and will cover, as stated, all the work for the Ontario examinations The number of expressions of approval this course has received has been a great encouragement, and we feel we are supplying a very urgent demand.

Here's hoping that all those engineers who cannot get away from their duties on Christmas Day will have their turn on New Year's Day. We hope this time next year to address all our old friends, and a whole horde of new ones, so we will leave you all to enjoy the festivities of the season, with the time honored

Merry Christmas and a Happy New Year

POWER HOUSE

Members of the 'Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

A Series of Articles on Power Plant Management

In This Article the Author Discusses the Principle of the Steam Turbine and Its Advantages. The Application of the Turbine, And the Use of High Vacuum are Noted.

By ROBERT JUNE

THE past decade has witnessed a remarkable development of the steam turbine. This development has taken place not only with respect to the design of turbines, but in particular with respect to the very great increase in their application to different services.

Among the classes of work for which steam turbines are now being utilized, addition to the driving of alternating rent generators, are the propulsion of pumps, blowers, turbo-compressors and marine propellers. By means of gearing they are used to furnish power for reciprocating air compressors, rolling mill drives and other classes of slow speed machinery. At every point the steam turbine has found favor on account of its low first cost, low maintenance cost, small floor space requirements, and low cost of attendance. It is, indeed, making appreciable progress in relegating the reciprocating steam engine to a secondary and minor position. Although the reciprocating engine will be an important factor in power plant work for some time to come, its field is being rapidly narrowed.

The Principle of the Steam Turbine

Under given pressure and temperature conditions a pound of steam occupies a known volume and contains a definite amount of heat energy. Now, if our pound of steam is permitted to expand to a lower pressure without receiving additional heat or giving up heat to surrounding bodies, it is capable of doing a certain amount of work which will be the same whether the expansion takes place in the cylinder of a reciprocating steam engine, a rotary piston engine, or the nozzles and blades of a steam turbine.

The process of expansion of the steam in the turbine differs from that in the reciprocating engine in that the flow of steam is continuous instead of intermittent. The steam turbine is a continuous mechanism, whereas the reciprocating engine may be termed a ratchet mechanism. The reciprocating engine is designed to operate by the direct pressure of the steam, while the turbine is designed to work by changing the direction of motion of the flowing steam. The turbine is thus, in fact, a velocity motor and the steam engine a pressure motor.

The kinetic energy of fluid in motion is the source of power in the steam turbine. Let a fluid in motion impinge on moving vanes, change the direction of flow and reduce the velocity of the fluid, and the energy of the fluid will be converted into mechanical work and become available throught the shaft on which the moving vanes are placed.

The successful steam turbine must embody the following characteristics:

1. The highest possible percentage of the heat energy of the steam must be converted into kinetic energy.

2. Provision must be made to utilize this kinetic energy in the most efficient manner by proper design of the rotor, nozzles and guide passages of the turbine.

3. Design and construction of casing, rotor, and blades, must be such that they will hold their form and remain tight against leakage under heat and centrifugal strains.

4. The velocity of all moving parts must be within safe limits and the apparatus must run at the proper speed at point of delivery of power.

Advantages of the Steam Turbine

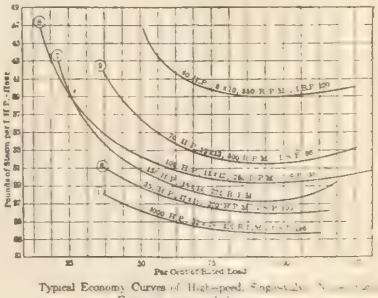
Among the principal advantages of the steam turbine are:

1. First Cost.—As a general proposition steam turbines are lower in first cost than reciprocating engines of equivalent rated capacity. In a general discussion of this character, little would be gained by reciting specific examples to prove this proposition. This is true because of the various uses to which turbines are applied and on account of the extreme variations in design. However, it is safe to say that for general service conditions it will be found that the turbine is lower in first cost than the steam engine in four cases out of five. The way to determine the matter in a specific case is to get actual figures from builders of both reciprocating engines and of turbines.

2. Maintenance and Attendance.—The reciprocating engine contains a much smaller number of parts than the turbine, but on the other hand, the turbine possesses a very great advantage over the other type of prime mover because of fewer moving parts and rubbing surfaces. The only contact between the moving and stationary parts is in the main bearings, and the problem of lubrication is, therefore, a simple one. Furthermore, the absence of pistons, stuffing boxes, dash pots, and friction surfaces reduces the cost of maintenance and attendance to a minimum and limits the possibility of leaking.

3. Economy of Space and Foundation.—Reciprocating engines require much greater floor space than do steam turbines. As compared to a Corliss compound engine, a turbine of equivalent size will only take up from one-third to one-half the space. With straight line, non-condensing, high-speed engines the comparative economy in space is much less marked. However, even in such cases the average space occupied by the turbine is from twenty to fifty per cent. less than that of the engine.

A most important feature of the steam turbine is that it is very much lighter in weight than the reciprocating engine. In the case of central stations, engines and generators may weigh as much as eight times more than turbine installations of equal capacity. Even in



Typical Economy Curves of High-speed, Engines

smaller installations the turbine is very much lighter than the engine, and also because of a total absence of vibration requires a relatively light foundation. In many cases turbine foundations consist simply of steel beams with concrete arches, so that the basement underneath may be used for the condenser and other apparatus instead of being devoted to the massive foundation required for reciprocating engines.

4. Absence of Oil in Condensed Steam.—Requiring as the turbine does no internal lubrication, there is no opportunity for oil to come in contact with the steam. Consequently, all steam from the surface condensers can be used for boiler feeding purposes without purification. This continued use of condensate effects a large saving in cost of feed water and in expense for maintenance and initial cleaning of boilers. Furthermore, the amount of entrained air is reduced to a minimum, and, consequently, the work of air pumps is lessened.

5. Regulation.—It is much easier to regulate the speed of the turbine within close limits than it is a reciprocating engine. With the latter, moreover, a heavy fly-wheel is required to keep the instantaneous angular fluctuation within safe limits. Even with a constant load there are variations of velocity during each revolution of the reciprocating engine, while with the steam turbine the speed is practically constant. A number of published tests of Parsons and Curtis turbines show an average fluctuation of not more than two per cent. from no to full load, and of not more than three per cent. from no load to one hundred per cent. overload.

6. Overload Capacity.—When we come to discuss overload in a prime mover we are at some disadvantage because of the fact that the rated load usually refers to the maximum economical load or the point of greatest efficiency. Both engines and turbines should, of course, be designed with the operating conditions clearly in mind, so that they will operate at all times at high economy. The point of superiority of the turbine over the reciprocating engine lies in the fact that when occasion arises it can be operated with a greater percentage of load above the point of high efficiency than can the reciprocating engine.

Comparative Economy of Steam Engines and Turbines

Any attempt at a specific comparison of the steam consumption per brake horse power of reciprocating engines and steam turbines is very unsatisfactory because of the wide range of operating conditions.

As a general proposition the reciprocating engine is more economical in the use of steam for non-condensing service and the contrary is true for high pressure, high vacuum, condensing service.

The general statement we have just made should be modified so far as it concerns condensing engines of the uniflow or poppet valve type as these engines, under favorable conditions, often show superior economy to the turbine for sizes up to 3,000 horse-power. The superiority of the uniflow and poppet valve engines over the ordinary slide valve type lies in the fact that their construction is such that the steam is not brought into contact with cold surfaces to the same extent.

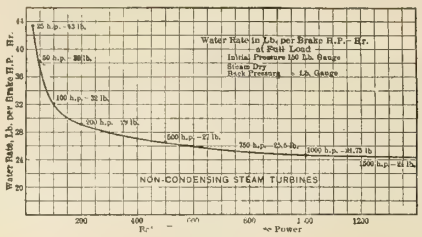


FIGURE 2.

A comparison of the curves in Fig. 1 showing typical economies of high speed, single valve, non-condensing engines, and the curves in Fig. 2 showing the performance of non-condensing steam turbines is somewhat in favor of the reciprocating engine, the difference decreasing as the size of the unit increases. When we come to make a similar comparison on the performance curves of compound, single valve; single cylinder, four valve; and compound, four valve, non-condensing, reciprocating engines with those of steam turbines of the same size we find a marked increase in economy in favor of the reciprocating engine.

In order to give some definite idea of the steam consumption of the small turbine we include Table I, which gives the manufacturer's guarantee on one of the best known makes:

Performance of the Modern Steam Turbine at Rated Capacity.—(Manufacturer's Guarantee).

Rated Capacity	R.P.M.	Initial Pressure, Lb. Abs.	Back Pressure, Inches.	Superheat, Deg. Fahr.	Lb. Steam Per Kw-hr.	Rankine Cycle, Ratio.
25 H.p.	3600	165	At.	0	*43.0	*31.0
50 "	3600	165	At.	0	*38.0	*34.2
100 "	3600	165	At.	0	*32.0	*40.6
200 "	3600	165	At.	0	*29.0	*44.9
500 "	3600	165	At.	0	*27.0	*48.1
750 "	3600	165	At.	0	*25.5	*51.0
1,000 "	3600	165	At.	0	*24.75	*57.5
1,500 "	3600	165	At.	0	*24.0	*59.1

*Based on developed horsepower.

A very interesting combination plant which has frequently been used in this country consists of a high pressure engine exhausting into a low pressure condensing turbine. This arrangement is very hard to beat so far as economy is concerned.

It should be kept in mind, however, that there are a great many other factors besides high economy to take into account in deciding whether to purchase a turbine or a reciprocating engine. Every one of the factors mentioned earlier in our discussion under advantages of the steam turbine should be given consideration, and it is quite possible that they will be found to outweigh the advantage of high economy of the engine.

When plant conditions make it practicable to provide super-heated steam for turbines without incurring more than a normal expenditure, it is desirable to do so. The gain in heat economy due to the use of super-heat is theoretically the same for all types of prime movers. Actually, however, the rate of improvement varies considerably with the type of mechanism. In the reciprocating engine the gain is due mainly to the reduction of cylinder condensation, while in the turbine the improvement in economy is due primarily to the reduction in "windage" and other friction losses. The actual gain is, furthermore, very much greater than the theoretical gain. In the ideal frictionless high pressure condensing turbine an increase of 35 degrees in superheat would effect an increase of about one per cent in thermal efficiency. In the actual turbine we gain 1 per cent. increase in thermal efficiency for each 6 to 14 degrees that we increase the superheat.

Superheat is of greater advantage with non-condensing units than with condensing turbines, and it is more marked with low pressure units than with high. In average practice the maximum temperature of the steam is approximately 500 degrees F., but in large central stations, temperatures of 600 degrees are not uncommon, and a number of recent installations have been designed for total temperatures of 700 degrees F. It should be remembered that the higher the initial temperature, the greater will be the investment cost and that a point will eventually be reached where the increased fixed charges will affect the gain in heat economy.

Influence of High Pressure

In planning new installations it is extremely important to bear in mind the fact that the higher the steam pressure, the higher the economy. As a matter of fact, the increase in efficiency resulting from high boiler pressure is so marked that engineers are considering the possibility of employing pressures far above any now in use. We now have plants designed and in use where the boiler pressure is 350 pounds, and when it is possible to do so, working temperatures of 600 pounds per square inch will be employed.

There is no particular obstacle so far

as the turbine is concerned in the use of such high pressures since it simply means the use of heavier parts for the high pressure end and a somewhat increased cost of construction. The difficulty lies with the boiler construction, and just when or how the problem will be solved, is still a matter of uncertainty.

Installations at the extremely high pressuring just mentioned are and will be chiefly confined to the big central stations. However, it is well to keep the desirability of high pressure in mind in designing a new small plant. In other words, do not assume that a pressure of 150 or 175 pounds is about right, without giving the matter further consideration. It may prove just as easy, far more economical, to use a working pressure of 250 or 275 pounds.

The Influence of high Vacuum

High vacuum can be used to much greater advantage with the steam turbine than with the reciprocating engine. Even if it were practical to expand the steam to one pound absolute, the increased condensation in the reciprocating engine would probably render any gain due to expansion useless. A study of a number of tests of reciprocating engines shows but a slight improvement in overall plant economy due to increased vacuum beyond 26 inches. A test of steam turbines shows a decrease in steam consumption of about 5 per cent. for each inch of vacuum between 25 and 27 inches, six per cent. for the gain between 27 and 28 inches, and eight to twelve per cent for the gain between 28 and 29 inches. These values are approximate only, since the influence of vacuum on steam consumption varies greatly with the type and size of turbine.

Here again we must remember that there is a critical point beyond which it is not economical to go in securing high vacuum. As the volume in steam increases very rapidly with the decrease in back pressure, the corresponding capacity and power required by the air and circulating pumps becomes proportionately larger. There is consequently a point where the improvement in steam economy fails to exceed the increased power demanded by the auxiliaries.

Turbines vs. Engines in Units of Small Capacity

The question of whether to use reciprocating engine or turbine is frequently a puzzling one to the owner of small plants. Some years ago Mr. K. S. Barstow presented a complete summary before the A. S. M. E. covering the applicability of engines and turbines for plants of less than 500 horsepower capacity. In studying this summary it is well to remember that considerable improvements in the turbine and its range of applicability have been made in the past several years, and that it is possible to use turbines in at least some of the applications assigned by M. Barstow to engines.

Applicability of Engines

1. Non-condensing units, direct - connected or belted and used for driving:

Electric generators of all classes excepting exciter sets of small capacity, unless belted from the main engine. Centrifugal pumping machinery, operating under variable head and quality conditions and at relatively low heads, say up to 100 ft., depending on the capacity of the unit. Pumps and compressors for delivering water or gases in relatively small quantities and at relatively high pressures in the case of pumps at pressures above 100 lb. per square inch and in the came of compressors at pressures from 1 lb. per square inch and above.

Fans and blowers (including induced draft fans) for handling air in variable quantities and at relatively low pressures, say not over 5 in. water column.

Line shaft of mills, where the driven apparatus is closely grouped and the load factor is good.

All apparatus requiring reversal in direction of rotation, as in hoisting engines and engines for traction purposes.

2. Condensing units direct-connected or belted, for all the above purposes particularly where the condensing water supply is limited, and where the water must be recooled and recirculated.

Applicability of Turbines

1. Direct-connected units, operating condensing. 60 cycle generators in all sizes, also 25 cycle generators above 1,000-k.w. capacity.

Direct-current generators in sizes up to 1,000-kw.. capacity, including exciter units of all sizes.

Centrifugal pumping machinery operating under substantially constant head and quantity conditions, at at moderately high head, say from 100 ft. up, depending upon the size of the unit.

Fans and blowers for delivering air at pressures fromb 1½ in. water column to 30 lb. per square inch.

2. Direct-connected units, operating non-condensing for all the above purposes, in these cases wherein steam economy is not the prime factor or where the exhaust steam can be completely utilized, and, in the latter case, particularly where oil-free exhaust steam is desirable or essential.

3. Geared units, operating either condensing or non-condensing for all the above-mentioned applications, and in addition, many others which would otherwise fall in the category of the steam engine, on account of the relatively slow speed of the apparatus to be driven.

Next month we will discuss the individual types of turbines and deal with some of the problems incurred in their operation.

COLLINGWOOD CO. GETS THE CONTRACT

And Work at Dominion Shipbuilding Plant Will Be Carried On In a Few Days

The plant of the Dominion Shipbuilding Company at Toronto, which has been idle since the company went into liquidation some time ago, is to be operated again for at least five or six months. The liquidator, Mr. Osler Wade, announced that at a conference with the Minister of Marine and Fisheries, Hon. Mr. Ballantyne, arrangements had been completed for the finishing of work upon the two Dominion Government ships in the yards. The work will be taken over by the Collingwood Shipbuilding Company, which will employ about a thousand men. Places will be found for a large percentage of the old staff and wherever possible preference will be given to returned men. The two vessels are of 4,000 tons each and it is estimated that they will provide employment for a large number of men on into the spring or early summer.

Mr. Wade stated that he would make no attempt to sell the plant at present and that any offer made for it, during the completion of the two ships, would be subject to the arrangement made with the Minister.

OTTAWA LODGE HOLDS OPEN MEETING

Ottawa Lodge No. 6, C.A.S.E., held an open meeting in their hall on Thursday evening, November 25th, which had a very large attendance. The principal feature of the evening was a lantern lecture given by Bro. C. V. Clarke, manager for Darling Bros., Ltd., Ottawa Branch, subject being "Steam specialties and their application to the modern steam plant."

One of the views shown was a typical layout showing a method of using exhaust steam for heating purposes, etc. Consequent views showed various steam specialties in detail incorporated in the typical layout.

Br. Clarke also demonstrated the use of special apparatus for the operation of modern radiator traps and explained their construction.

The demonstration was made with a "Webster" syphon trap and a "Webster" No. 7 trap.

This open meeting and lecture was the means of adding three new members to the order.

Ottawa Lodge intends to hold a series of open meetings during the winter. It is also planning a drive to increase the membership of the C.A.S.E. in Ottawa.

Chas. Berry, President.

R. E. Rodney, Recording Secretary.

The Welding of Locomotive Fireboxes

Full Welded Fireboxes, Semi-Welded Fireboxes, Semi-Welded Half Side Sheets, and Full-Welded Half Side Sheets Are Taken Up in This, the First Part, of Complete Article on Above Subject.

Compiled by J. H. M.

IT IS not often that one is able to state in concise form the experience of two experts, but in the article to follow, dealing with the welding of locomotive boilers, the data contained therein have been gathered by Messrs. Geo. L. Walker and R. T. Peabody, both of the air reduction engineering service department of L'Air Liquide Society. This matter was placed before those interested in book form by L'Air Liquide Society, and through their courtesy the author is now able to compile this material in the form best suited for our purpose.

The oxy-acetylene process has stepped very much to the fore in late years, and has proven of great value in the repairing of fire boxes and flue sheets, principally because the joints are perfectly water-tight, while the speed with which the work can be accomplished adds still more to its value.

Failures have been recorded in the past but these have been traced to incorrect methods employed. This has been largely owing to inexperience on the part of the workman, or even utter lack of knowledge of the conditions. No one can make a success of welding until they become acquainted with the principles involved, choosing suitable apparatus, supplies, and so on.

General Instructions

The information to follow is given chiefly to assist the practical welder who might be or is working on locomotive boilers, and who is ambitious enough to read about what others are doing in that line. The methods advocated constitute the standard practices adopted by many railroad shops on this continent, and if carefully observed will ensure satisfactory results.

In the preparation of the work for welding, to ensure success it is necessary to observe five important things: First—The cleanliness of the sheets at welding seam. Second—That sheets are bevelled at a proper angle. Third—That sheets are in correct position. Fourth—That provision is made for expansion and contraction, and fifth—that you have suitable welding rods as filling material.

Before cutting a new patch, carefully inspect part to be welded and cut out all defective places, then cut only where there is a good foundation for the weld. When cutting out patches, carefully avoid cutting through stay bolts if possible. Do not under any circumstances cut out sheets or patches through old welds. For side sheets or three-quarter door sheets, extend new sheets at least one stay bolt higher; for crown sheet, one stay bolt lower; for patches, extend weld at least one row of stay bolts larger; for flue sheets, extend weld to one row of stay bolts lower.

When cutting out sheets or patches with cutting torch, cut them straight and bevel afterwards—preferably with a chisel. Clean surfaces are essential to good welding. Scale, rust, oil or grease must not be allowed to remain on the part to be welded, otherwise satisfactory welds are impossible. The most satisfactory angle for bevelling plates is an angle of 45 deg., making between the two plates an angle of 90 deg., or a right angle. All sheets and patches must fit with an opening of from ⅛ in. to 3-16 in. between patch and sheet all around—never less than ⅛ in. and never more than 3-16 in.

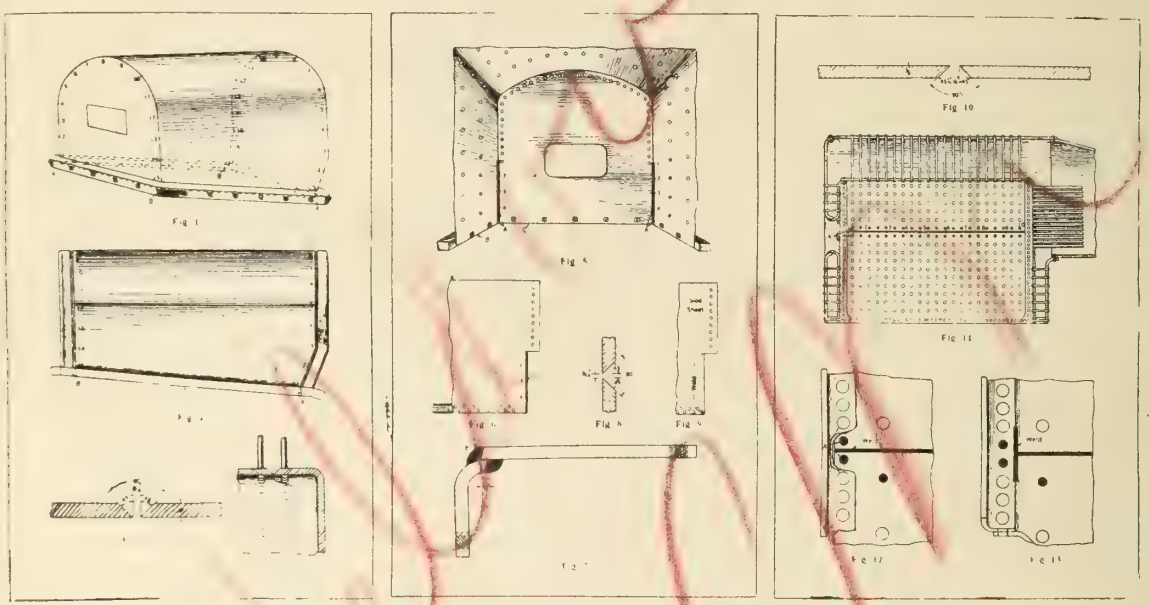
The welding of cracks in side sheets, door sheets, fire doors, crown sheets, bottom and top of flue sheets should not be attempted, or only resorted to in cases **of extreme emergency, to be corrected at the very first opportunity.** Welding cracks in barrel of boiler, welding over stay bolts and welding stay bolts is not allowed under any circumstances.

Welding of Full-Welded Fireboxes

A full-welded firebox is one which has all of its joints welded instead of riveted. The welded joint, to the investigator's opinion, is stronger, more economical, will not leak, and has more durable expansion and contraction properties than the riveted seam. The welding should be performed as follows:

First place the firebox upon the mudring A B A B, Fig. 1, and bolt it fast. Next, prepare to weld the outside, or water side, of say the flanged flue sheet to the firebox, as shown at Fig. 2, by cutting a bevel of about 45 degrees all the way along its edge from mudring to mudring. Now bevel the matched edge of the firebox in like manner. The best practice is to make the flange of the flue and door sheets so as to include a row of radial staybolts. See Fig. 4.

After this set the firebox so that the weld joint remains open at its bottom



FIGS. 1 TO 13. INCLUSIVE.—TEXT DEALS FULLY WITH THESE EXAMPLES.

about 3-16 in., Fig. 3, allow for expansion, to clinch the welding metal and insure a perfect weld through the vee. Start the joint by welding it for about an inch just above the mudring, say at 1, Fig. 1, using 3-16 in. or ¼ in. Swedish iron welding rod, and a good welding blowpipe with suitable tip. From a point about 10 in. up from the mudring weld downward from 2 to 1. Then, continuing the method, weld from 3 to 2, from 4 to 3, and so on. This practice will prevent the spreading of the joint from unequal expansion. Add enough welding rod to raise the surface of the weld about ⅛ in. above the original metal. If practicable, a second welder should follow the outside welder and smooth-flow the joint on the inside while it is red hot. This will be certain to make the joint tight.

Working from the inside, weld the firebox to the mudring at the corners A and B, Fig. 1, then weld on the door sheet the same as the flue sheet.

Welding Semi-Welded Fireboxes

A semi-welded firebox is one on which welding is substituted for riveting along the lower vertical joints of the flue and door sheet with the side sheets. This practice is followed where it is desired to avoid riveted joints in the fire zone, and some shops also weld the bottom horizontal joint of the firebox and the mudring for about 12 inches both ways from each corner. The chief advantage of this welding is the elimination of leakage. The work should be done as follows:

First bolt the firebox to the mudring and rivet the flue and door sheets to the side sheets down to within about 36 inches from the mudring. Omit the rivet holes along the corner joints to be welded from 1 to A, see Fig. 5. Also leave out temporarily the rivets next to the top of the joint at 1, Fig. 5.

Next prepare the side sheets as shown in Figs. 6 and 9, but cutting into the flange about ⅝ in. so that it can be set down flush. Butt the joints and bevel both edges at about 45 degrees on the outside of the firebox. Leave a 3-16 in. opening at the bottom of the vee as shown. Some welders have used a lap weld like that shown at Fig. 7, but it does not make as strong and tight a joint. The butt weld as shown at Fig. 8 is the best for such work.

The next step is to tack-weld the flange at 1, see Fig. 5. Use a good welding blow-pipe for this purpose, making sure you have a suitable tip, and a good grade of welding rod.

Starting on the outside at about 10 inches below 1, weld from 2 to 1. Then from 3 to 2, and 4 to 3. Complete the joint by welding on the inside from A to 4. Weld the other three corners in like manner. If a second welder is available the metal should be flowed on the inside while being made.

Welding of Semi-Welded Half Side Sheets

Semi-welded half side sheets are those which are welded along the horizontal joints to the crown sheets, and are riveted to the mudring at the bottom and to the door and flue sheets at the ends. The welding of the long seams should proceed as follows where the door and flue sheets have not yet been set.

First proceed to bevel the edge of the half side sheets and the corresponding edge of the crown sheet as shown at Fig. 10. Next screw in the second row of staybolts and bolt the sheet to the mudring before starting to weld. To avoid delay, all of the staybolts, except the rows adjacent to the weld may be screwed in and set, and the side sheets riveted to the mudring before the welding is done.

On this being completed, weld about 2 inches of the joint at 1, Fig. 11, then, beginning at 2, about 10 inches from 1, weld back to 1, from 3 to 2, and so on to the end of the joint. Use a good welding blowpipe, with suitable tip, and as before, make sure a good grade of welding rod is used. The door and flue sheets should now be riveted in.

If the side sheets are to be put in after the door and flue sheets have been set, the flanges of the door and flue sheet should be heated and raised as shown at Fig. 12. This will allow the part of the joint under the flange to be bevelled.

When the new door and flue sheets are put on, the adjacent rivets A, see Fig. 12, should be left out until the welding is completed.

In Fig. 13 is shown the practice of welding the end of the long seam when it is desired to change an old riveted joint to a welded one. The vertical weld should be carried to the second rivet each way.

Full-Welded Half Side Sheet

A full-welded half side sheet has no riveted joints at the top or sides, all three edges being welded. The work should be performed as follows: Cut out the flange of the door or flue sheet next to the joint of the crown and half side sheets, as shown at A and D, Fig. 14. Then bevel the flange, including rivet hole C, and set it flush with the half side sheet. Next bevel the crown sheet, including the rivet hole B. Now set the side sheet so that a ¼ in. space is left at its top and sides, and then bevel those edges. If this sheet is not riveted to the mudring, bolt it fast. Screw in and set all staybolts except those next to the welds.

Now weld the horizontal seam for about 1 in. at 1, as shown at Fig. 15. Then from point 2, about 10 in. from 1, weld back to 1, and from 3 to 2, continuing until the joint is completed. Next start about 10 inches down the vertical joint of, say, the door sheet at 10L and weld up to 1, see Fig. 15. Then from 10 inches below 10L and 11L weld back to 10L, from 12L to 11L, and so on to within a few inches of the mudring.

Weld the flue sheet joint the same way as the door sheet, from 10R to 9, see Fig. 15, from 11R to 10R down nearly to the mudring. Weld the bottom of the joints to the mudring at 15L and 15R last. When the flanged joints of the door and flue sheets are in good condition, but the rest of the plate needs renewing, a good job may be performed by setting in the half side sheet, as shown in Fig. 16. It should be tacked at 1. Then weld from 2 to 1, 3 to 2, and so on, following the practice described above.

Welding Cracks In Side Sheets

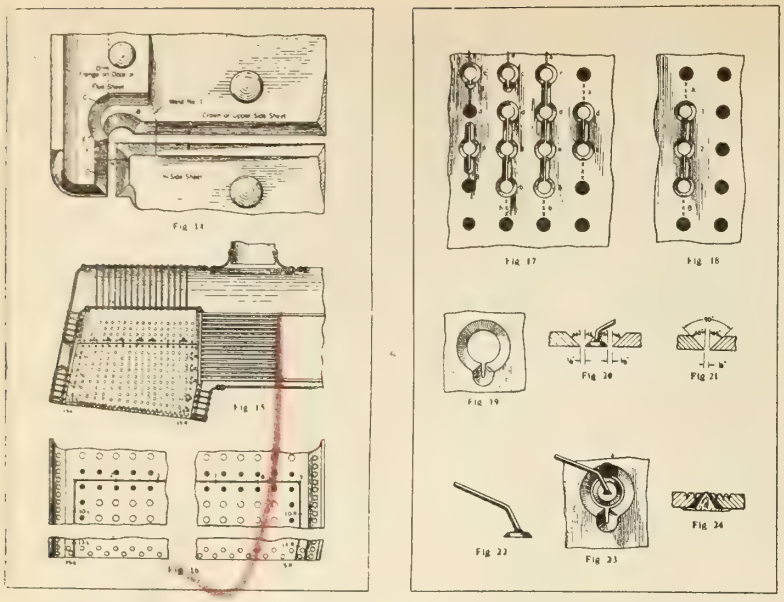
Cracks in side sheets between staybolt holes are not easily welded, because of the difficulty of making proper allowances for expansion of the metal. In fact, if a side sheet has many cracks like those shown in Fig. 17 it would be better to put in a new sheet rather than resort to welding. Much welding of side sheets is being done, however, and the following method may be successfully used when the staybolt holes are to be closed:

To weld a crack like that at Fig. 18, bevel the sides of the hole and crack, as shown in Fig. 19. Prepare for each hole a soft steel disc about 3-16 in. thick and of say ¼ in. smaller diameter than the hole. Bevel the edges of the disc, as shown in Figs. 20 and 21. Melt a piece of welding rod to the disc to serve as a holder, hot-bending the rod, as shown in Fig. 22.

Next place the disc in the hole and melt down the upper edge a, see Fig. 23, to tack the disc in position. Preheat the metal between the two holes at xxxA, Fig. 18, and keep it red hot. Melt off the rod and complete the welding of the disc into the hole. Now allow the hot section xxxA to cool with the weld at 1. This provides for uniform shrinkage. Weld hole 2, Fig. 18, in the same way, and then weld the crack from 2 to 1.

PREPARING WORK

To secure a successful weld, you must first prepare the work properly. There are five important things to observe, viz., the cleanliness of the sheets at the welding seam, that the sheets are bevelled at proper angle, that they are in correct position, that provision is made for expansion and contraction, and that you have suitable welding rods for filling material.



FIGS. 14 TO 24.—FURTHER EXAMPLES. SEE TEXT FOR DESCRIPTION.

Preheat the section xxxB when welding the last hole of that line. The weld should be reinforced, as shown in Fig. 24.

In some cases where it is not practicable to replace a badly cracked side sheet by a new one, or put on a patch, the welding may be done as follows: Referring to Fig. 17, preheat the top of the left row of holes at xxxa. Then weld in hole c of this row. Preheat the area xxx down to d, as well as that at xB. Weld the crack at the bottom of the hole e of the first row, then the staybolt hole e, the crack at the top of this hole, and finally weld the joint around the head of the staybolt d, which is assumed to be in good condition. Reheat the area xxxa to relieve the shrinkage strains, and let the job cool down before proceeding with the other rows.

Weld the last row on the right next by preheating at xxxa, filling the holes at d and e, and then the crack between them. Reheat the lower part of the row at xxx, and allow the whole job to cool uniformly. Now weld the second row from the left in the usual way, and allow the sheet to cool again. Weld the third row from the left last, which is done in this case because it is the longest continuous crack.

THE ADVANTAGES OF REDUCED GRATE AREA

By W. H. Casmey

In the burning of coal the average maximum percenatge of CO_2 is 19.2 per cent. With 1 pound of coal and 12 pounds of air, the CO_2 is 19.2 per cent., and the furnace temperature 3844 deg. Fahr. As this temperature is too high for steam-raising purposes, the practice by which the author has secured the best results is to allow 50 per cent. excess of air to the products of combustion, the resulting temperature being 2630 deg., and the CO_2 13 per cent. If, then, the CO_2 indicator forms, as it should do, a part of every steam plant, the economical conditions are as easily maintained, other things being equal, as the height of the water in the boilers by means of the pump and gauge glasses.

In everyday practice the percentage of CO_2 seldom exceeds 7 per cent., and taking this figure and the same quality of coal as before—i.e., 12,000 B.t.u. per pound, 7 per cent. CO_2 means 33 pounds of air per pound of coal, the furnace temperature being 1510 deg., or 1120 deg. lower, due to having 15 pounds more excess air per pound of coal.

We have abundant proof that an over-all efficiency of 75 to 80 per cent. is possible—in fact, is now being secured—but in comparison there are thousands of boiler plants to-day giving less than 60 per cent., and one battery of ten boilers tested by the author gave an over-all efficiency of only 53 per cent., including boilers and economizers.

During the last few years many old boilers have been fitted with parallel flues; two of such, 8 ft. in diameter, are now in the yard of the author's firm, the flues 3 ft. 8 in. diameter, or 2 inches less at the front end than in the modern boiler of same diameter, and 4 inches larger in diameter at the back end; but this old type will evaporate 15 per cent. more water per hour than one of modern design under exactly the same conditions. To prove this statement, let us assume that each boiler was operated by a suction equal to 1200 ft. per minute at the rear end; the old boiler offers 14 sq. ft. to this suction, the modern boiler 11.2 sq. ft.; the old boiler has an air supply sufficient to burn 1116 pound of coal per hour, and, taking 8 pound of water per pound of coal, gives an hourly evaporation of 8928 pounds. The modern boiler has only air supply for burning 942 pounds of coal, and at the same rate of evaporation per pound of coal the hourly duty will be 7536 pounds, from which it is clear that six Lancashire boilers, as made one hundred years ago, will evaporate as much water as seven boilers of the same diameter of present-day type. This is not progress.

From the above it is clear a relationship exists between the grate area of a boiler and the area through which its gases escape, and in the old type the ratio is 2.57 to 1, and in the modern boiler of equal diameter 3.5 to 1, the respective evaporations per square foot of grate being 248 and 197 pounds.

In our Lancashire boilers as made today—standard length 30 ft., diameter ranging from 7 ft. to 9 ft. and upwards, grates 6 ft. long, and furnace flues contracted at the rear end 6 in.—the practical results under such conditions are that a boiler 7 ft. diameter requires 4 sq. ft. of grate to evaporate as much water as can be done with a 9 ft. diameter boiler with 2.7 sq. ft. If boilers 7 ft., 8 ft., and 9 ft. diameters were worked with equal draught, the respective evaporations per square foot of grate would be 144, 184, and 238 pounds, but if the grates were modified until the ratio of grate to outlet was 2 to 1 in each boiler the evaporations in all three would be equal to, say, 312 pound per square foot of grate. The whole subject of modified grates is explained in the author's booklet on coal economy recently published by Charles Griffin and Company, London, and specially written for firemen and enginemen.

"We backed the wrong horse in taking on the boiler of 1873 with contracted flues instead of holding on to the straight-flued boiler of 1811, but we cannot now, without great expense, increase the diameter of our present boiler flues at the back and secure the 2 to 1 ratio; we can, however, secure it by merely reducing the area of our furnaces and share in the value of the idea, as the following extracts from letters received indicates others are doing:

(a) "We have four Lancashire boilers 30 ft. by 8 ft., fitted with coking stokers and induced draught; we have cut down our firegrates from 6 ft. to 3 ft. 10 in., and reduced our coal consumption over 700 tons per year."

(b) "Our plant consists of two Lancashire boilers, 30 ft. by 9 ft., fitted with sprinkling stokers; length of grates 3 ft. 6 in., with a dead plate behind the bars 2 ft. 6 in. long. Our engines develop 800 h.p.; class of fuel, rough slack; evaporation per pound of slack, 9 pound."

(c) "We have one Lancashire boiler, 30 ft. by 8 ft., and by cutting down the grates from 6 ft. to 4 ft. we have reduced our coal consumption 140 tons per year."

(d) "Since cutting down our boiler grates one-third we have saved 10 per cent. in fuel and stopped black smoke."

(e) "Since reducing the grates in our 28 ft. by 7 ft. 6 in. Lancashire boilers from 6 ft. to 3 ft. 9 in. eighteen months ago, we have reduced our coal consumption two tons per week."

(f) "In the author's own works the grates of the 30 ft. by 8 ft. boiler have been reduced one-third, and the saving effected exceeds one ton of coal per week."

The Utilization of Waste Heat Under Boilers*

The Various Methods of Applying Waste Heat Under the Furnaces of Boilers Are Discussed, and a Direct Fired Unit is Compared to a Waste Heat Boiler Unit.

By D. S. JACOBS and A. D. PRATT

IN the earlier practice with waste heat boilers it was the custom to minimize the frictional resistance of the gases flowing through the boiler by providing a large flow space, in order to interfere as little as possible with the draft leaving the industrial furnace, such as a copper smelting furnace which supplied the waste heat. This practice limited the field of application of waste heat boilers. To show the progress in the art we will deal with the modern practice of our own particular company, in which a boiler is provided having a high draft resistance and in which the baffling is arranged to give a relatively small area of flow space through the passes so as greatly to increase the velocity of the gases. A suction fan is used to overcome the higher draft loss due to the increase in velocity of the gases, and the heating surface of the boiler is arranged in series in such a manner that in connection with the added draft loss under the increased velocity the desired draft will be afforded at the outlet of the furnace supplying the waste heat as well as at the outlet of the boiler.

The total capacity of waste heat boilers, built in accordance with our modern design, which we have installed during the past seven or eight years in various classes of waste heat work is over 150,000 rated horse-power. The capacity these boilers are developing in terms of normal rating varies, of course, with gas weights and temperatures. A conservative figure would be 70 per cent. of normal rating, which is on a basis of ten square feet per horse-power, which would mean a total of 105,000 horse-power actually developed. In the ordinary plant where waste heat installations are made, the coal burned in direct fired boilers of various types, averaging the poor results with the good, will in all probability be at least four pounds per hour per horse-power developed. On the basis of 105,000 horse-power developed, four pounds of coal per hour per horse-power, 24 hours' operation, 300 days a year, the total annual saving in coal alone is over 1,500,000 tons. It can thus be seen that the saving effected by the use of these waste heat boilers is a decided factor in the conservation of the coal of the nation. Aside from the aspect of conservation, there is a large saving in money to the users of waste heat boilers with coal at its present price—or, for that matter, at any price. The return on the investment in this class of apparatus is such that the owners of any plant where spent gases of sufficient volume and temperature are available cannot afford to disregard the possibility of a waste heat installation.

*Paper read before the Engineering Society of Western Pennsylvania.

While the term "waste heat" will in all probability continue to be used, it is obvious from the savings through its utilisation, that it is a decided misnomer in many cases.

War conditions made it imperative to minimize the cost of fuel, and great credit is due to those who labored to promote a saving and to the users of fuel who co-operated to secure the saving that was effected. On account of the increase in the cost of fuel, the attention of the engineer is now turned more earnestly than ever to the problem. We should go further than we have in the past. With apparently unlimited resources, the dollars-and-cents side—obtained by balancing the interest on capital investment, etc., against the fuel saving—has been the controlling factor in deciding whether a more economical plant should be installed to take the place of one that is recognised as being wasteful. Eventually we must consider the conservation of fuel for future generations, and it may not be long before there will be laws with this in view.

The first installations of our modern design of waste heat boilers were made in connection with open-hearth steel furnaces. Certain minor difficulties of operation arose with those first installed, but these were no greater than were to be expected with a type of apparatus essentially new in that particular field, as well as different from the same class of apparatus in use in other fields of steam generation. That the initial difficulties of operation were overcome, is borne out by the fact that there are to-day in the United States over 210 open-hearth steel furnaces equipped with such boilers, the total capacity of these furnaces being conservatively stated as 12,000,000 tons per year.

The steam engineer of to-day, while he is familiar with the use of waste heat boilers in one or possibly two classes of work, may not realise the widely varied classes of industrial plants in which waste heat boilers have been installed and are in successful operation. The tabulation following gives the different classes of industrial plants using our modern waste heat boilers:—

Open-hearth steel furnaces.
Heating furnaces.
Cement kilns.
Dolomite kilns.
Copper refining furnaces.
Nickel refining furnaces.
Zinc refining furnaces.
Gas benches.
Glass tanks.
Oil stills.
Bee-hive coke ovens.

The necessity for an increase in transfer rates in waste heat boilers, over that which exists in direct fired boilers to give results that are at all comparable, is perhaps not generally appreciated. In burning fuel under a boiler, a temperature is developed greatly in excess of the average waste gas temperature. For comparison of direct fired with waste heat practice, let us consider (1) a direct fired unit equipped with an underfeed stoker, and (2) a waste heat boiler set, in connection with oil stills. In the former case, with proper stoker operation, the furnace temperature will approach 2,700 deg. F., while in the latter case the temperature of the gases entering the boiler will be approximately 1,000 deg. F.

In direct fired practice a considerable proportion of the total heat absorbed by a boiler is absorbed through direct radiation to the tubes which are exposed to the radiant heat of the furnace. How great a proportion of the total absorption is accomplished in this manner is not ordinarily realised.

With a reasonably constant furnace temperature the amount of heat absorbed through direct radiation is, within reasonable limits, a constant, irrespective of the capacity developed by an individual boiler. It naturally follows that, as the capacity of a direct fired boiler is increased, the percentage of total absorption through radiation is decreased, as this represents the ratio of the total number of heat units absorbed from the gases (which remains constant) divided by the total heat absorbed by the boiler (which increases with capacity). In comparing direct fired with waste heat installations it is necessary, because of the comparatively low ratings developed in the latter class of work, to consider the direct fired unit operating at a low capacity.

Experiment has shown that for a furnace temperature of 2,700 deg. F. the absorption through direct radiation is, for a 4-in. tube spaced on 7-in. centres, slightly over the equivalent of 80 pounds of water evaporated per hour from and at 212 deg. F. per lineal foot of tube to direct radiant heat in the furnace—an absorption of some 77,630 B.t.u. per hour. In a 500-H.P. Babcock & Wilcox boiler, with the baffle arrangement ordinarily offered for underfeed stokers and with the boiler operating at its normal rated capacity, this evaporation, due to absorption through direct radiation, would represent approximately 66 per cent. of the total heat absorption.

The effect of absorption due to radia-

tion varies approximately as the fourth power of the absolute temperature of the radiating medium. On the basis of an absorption through radiation equivalent to an evaporation of 80 pounds per hour from and at 212 deg. per lineal foot of tube in the furnace for a temperature of 2,700 deg. F., the corresponding absorption for a furnace temperature of 1,000 deg. in the case of the waste heat boiler would be approximately 3.65 lb. from and at 212 deg. per hour per lineal foot of tube exposed. If for the sake of comparison, we assume that both the fired boiler. In a 500-H.P. direct fired unit develop their normal rated capacity, the absorption through direct radiation would be only 3 per cent. of the total absorption for the waste heat boiler as compared to 66 per cent. for the direct fired boiler. In a 500-H.P. direct fired boiler, operating at its normal rated capacity, the absorption through convection will then be equivalent to 170 H.P. If the 500-H.P. waste heat boiler is to develop its normal rated capacity, the absorption through convection must be equivalent to 485-H.P.

The temperature of the gases leaving the radiant heat zone in the direct fired boiler will be somewhat higher than the temperature of the gases entering the waste heat boiler, the relative temperature with the direct fired unit and waste heat boiler both developing the rated capacity—approximately 1,200 deg. and 1,000 deg. F., respectively. If the two units be operated at the same pressure, and the gases be cooled to the same ultimate temperature, we will have relative average temperature differences of approximately 460 deg. and 360 deg. F. The total absorption through convection is represented, approximately, by the product of the transfer rate, the heating surface, and the range of temperature difference. To develop the above capacities through convection, it would be necessary to obtain transfer rates as follows:—

Direct fired. . $R \times 5000 \times 460 = 170 \times 33{,}477$. $R = 2.47$
Waste heat. . $R \times 5000 \times 360 = 485 \times 33{,}477$. $R = 7.02$

In other words, if each of the two units is to develop its rated capacity, it would be necessary in the case of the waste heat boiler to arrange the heating surface in such a manner as to give a transfer rate more than three times as great as that in the direct fired unit. This comparison is an extreme case which has been used to indicate the necessity of high gas velocities where the gases are of low temperature; conclusions should not be drawn from it respecting the effect of the absorption of radiant heat on the efficiency of a direct fired unit as other elements enter the problem.

The heat absorption, or heat transfer rate, is dependent upon the gas velocity and not upon the number of passes, except in so far as the number of passes affect the velocity. For equal gas weights, the velocity is the principal factor affecting the transfer rate; for, at any velocity so far used in modern waste heat work, the effect of the mean temperature difference of the gas and absorbing medium is slight as compared with the velocity. Naturally, for a given transfer rate, the greater the temperature difference the greater the total heat absorption, but the temperature difference for the gas velocities employed has so slight an effect on the rate itself that any difference in the rate may be neglected.

First, assume the heating surface of a water-tube boiler with horizontally inclined tubes arranged to give the gases four passes over the tubes. If the boiler were, say, 18 tubes high, a gas particle would strike the tubes 4×18, or 72 times.

Again, take this same amount of surface arranged to give three passes of the gases in a boiler of a given width. In order to obtain the same gas velocity, and the heat transfer corresponding to such velocity in the three-pass unit, it would be necessary to reduce the length of the tubes 25 per cent. below that employed in the four-pass unit, and the equivalent amount of surface would be added in height. The three-pass unit would be 24 tubes high to give the same heating surface. In such a boiler, a gas particle would again strike the tubes 3×24 or 72 times.

Carrying the comparison to an extreme case, if the same amount of heating surface were arranged to give a single pass of the gases, still maintaining the same gas velocity and transfer rate resulting from such velocity, it would be necessary to shorten the tubes 75 per cent. This would result in a unit 72 tubes high, and a particle of gas would naturally strike the tubes 72 times as in the other case. Such an arrangement of heating surface would, of course, be impracticable, but is described to indicate the principle involved.

The heat transfer rate would be the same for the three cases considered—that is, for four passes, three passes, or a single pass; whereas the frictional resistance to the flow of the gases, or the draft drop, would increase with any increase in the number of passes, on account of the added resistance due to changing the direction of flow of the gases in the different passes.

Because of the flexibility of design, through varying the arrangement and the amount of heating surface by changing the width and height of the boiler and the length of the tubes, it is theoretically possible to give the gases any desired number of passes over the heating surface and still maintain the gas velocity which will give the greatest commercial return. Under such conditions the proper number of passes to employ in waste heat work becomes a question depending upon commercial rather than engineering factors, and these should be given consideration in each specific installation.

There is the question of cost, though because of the relatively large return on the investment with this class of apparatus this is usually not of primary importance. A single-pass boiler without baffles is the simplest unit that can be offered. With a single-pass boiler, however, in order to maintain a velocity resulting in adequate transfer rates, it is ordinarily necessary to make use of short tubes; and this leads to a construction of relatively high cost.

A second consideration in the proper number of passes to be offered is that of the point of removal of gases from the boiler setting. For any waste heat boiler where the gases enter beneath the tubes at a point corresponding to the furnace in ordinary direct fired practice, where the number of passes is made odd—that, is one, three, or five—the gases must be removed from the the setting at or near the top of the boiler. Where the number of passes is even the gases must be taken from the bottom and at the rear of the boiler.

The best arrangement to use, in most cases, is three passes. Where an overhead connection is desired, fan supports and platforms are provided. Where it is desired to place the fan and its drive on the floor, an easy connection can be made through the rear water circulators to the fan.

Economizers are frequently installed in connection with waste heat boilers. What we believe is a desirable—and certainly the most compact—arrangement of boiler and economiser, is a recently developed combination in which a three-pass boiler is used. The gases pass from the boiler, through the vertical, rear circulating tubes, directly into an economiser which is made up of horizontally inclined tubes extending transversely to the boiler setting. The gases pass downward over the economiser tubes while the water has an upward flow, a counter-flow being obtained between the water and the gases, and the water in the economiser flowing continuously upward so as to avoid any pockets should steam be formed in the economiser. The fan location is at or near the floor line. The apparatus as a whole is much more compact than one in which the boiler, economiser, fan, and fan drive are extended horizontally. Furthermore, the path of the gases over the economiser surface is downward, and experience has shown that with heavily dust-laden gases it is much easier to keep the heating surface clean where the gases flow downward than where they flow upward. This advantage, which is an important one, is not possessed by an economiser where the flow of the gases is in a horizontal direction.

Draft is the most important factor in the determination of the proper number of passes to be offered in waste heat. The draft loss through a water-tube boiler is a function of two factors—the loss due to frictional resistance to the gases in their passage over the tubes, and the loss due to the making of the turns over the baffles. In any upward pass of the gases there is a stack effect, due to the pass itself, which tends to

offset the loss due to friction; and it is no uncommon occurrence in high-temperature, direct fired practice to find a greater draft suction at the bottom than at the top of an upward pass in a boiler. In a downward pass of the gases, on the other hand, there is a negative head to be overcome in addition to friction.

In order to recover the major portion of the power used for the fan drive through utilisation of the heat in the exhaust, it is almost universal practice in waste heat work to use a steam-turbine drive for the induced draft fan. Experience has shown that with the gas velocities best adapted for this class of work, the exhaust from the fan turbine, when producing draft sufficient to overcome the total resistance through a properly designed three-pass boiler unit and giving the required draft at the outlet of the primary furnace, is just about the amount required to heat the feed-water entering the waste heat boiler to 212 deg. F. While the amount of heat recovered in this manner will, of course, vary with the gas temperature, the fan and turbine efficiency, and the class of primary furnace, the statement above may be accepted as generally correct.

Single pass, waste heat boilers without any induced draft apparatus are the simplest that can be employed and in fact it is this design that was probably among the first of the water-tube boilers used in waste-heat work. The early installations, however, were made of a low draft resistance in order not to interfere with the operation of the primary furnace.

There is a considerable field for the single pass, natural-draft, waste heat boiler even under modern conditions. In plants where such boilers are applicable, the gas temperatures are high, approaching those of direct fired practice, and greatly in excess of the temperatures for which our modern design of waste boilers was developed. This statement is not to be taken as indicating that high gas temperature alone, without taking into consideration the other factors involved, makes the installation of a single-pass unit advisable, rather than a multiple-pass unit, but to indicate the limitation of the field of usefulness of the single-pass unit.

The single-pass unit can be successfully used only in connection with a furnace requiring a low draft. In some instances, such as in a puddling furnace, the heating surface can be so arranged that the boiler itself serves to some extent as a stack; and in serving as such the available draft from a given stack, although less than if no boiler were installed, will, when added to the stack effect of the boiler, provide enough draft for operating the furnace. If, on the other hand, we consider a primary furnace from which the gases emerge at low temperatures and which requires a greater amount of draft for proper operation—such as an open-hearth steel furnace—the cooling effect due to the installation of boiler heating surface, even in a single-pass unit of low gas velocity, would reduce the available draft to a point where the furnace operation would not be possible. In open-hearth steel practice a draft of 1.5 to 2.7 in. is required at the checkers. Where no waste heat boiler is installed, with an available gas temperature of, say, 1,100 deg. to 1,200 deg. F., a stack 160ft. to 175ft. high will produce the necessary draft. If, however, there is installed a waste heat boiler which would cool the gases to, say, 600 deg. F., the stack which would give 1.6in. draft with a gas temperature of 1,200 deg. F. would give probably less than 1in. with a temperature of 600 deg. F., which would be too low for operating the furnace, even should a single-pass boiler be employed. If we allow a total draft loss, including the loss due to a single-pass unit, of 0.75in. between checkers and stack, the height in order to secure proper furnace operation would have to be about 400ft. Under such conditions it is evident that with open-hearth and similar furnaces, waste heat boilers, either single or multiple-pass, cannot be installed except in connection with induced draft.

A single-pass boiler may be used to advantage where a low weight of gas is available, as where the gas weight is small and the total cost corresponding return low, the expense of an induced draft apparatus in addition to that of the boiler may not be warranted. This applies particularly to plants where, though the gas weights are low, the temperatures are high.

A single-pass rather than a multiple-pass boiler is sometimes the best to install in the case of an isolated plant where there is no outlet for the power developed except for use at the plant. In such a case, if the single-pass, natural-draft boiler will cool the gases to a point where the steam produced will meet the total requirements for the plant, there is obviously no necessity nor object in going to the expense of a more complicated multiple-pass unit with its induced draft apparatus. Naturally, in this case, the draft requirements of the primary furnace must be such that a single-pass, natural-draft unit may be satisfactorily installed.

There is a wide difference in the economiser problem in waste heat and in direct fired practice, on account of the widely different ratios of gas to water weights in the two classes of work. If we consider a waste heat unit utilising low temperature gas, and a direct fired unit, both having the same heating surface and developing the same capacity the ratio of the gas to the water weight in the case of the former is some four times as great as the same ratio in the latter case.

While special forms of economisers can be advantageously applied, which will operate properly when steam is formed in the economiser, in the ordinary form of economiser the temperature of the feed-water leaving the economiser must be kept below that due to the pressure at which the boiler is operated, under the extreme conditions that may occur in order to avoid steaming. If steam is formed in the economiser there will be a tendency to pass the water into the boiler in slugs, which would result in a prohibitive variation in water level. Under such conditions, the water level in the boiler would rise when the steam is formed. The operator would naturally shut off the feed in an endeavour to prevent the water level in the boiler becoming too high, which would, for a time, increase the amount of steaming in the economiser. Eventually, when the water level in the boiler would fall, the economiser would be partly filled with steam, and during the time that the economiser was being filled no water would be passing to the boiler, which might cause trouble through low water in the boiler. Again, when steam is being made in the economiser, objectionable strains may be set up through heating the portions of the economiser which contain steam to a temperature in excess of that of the portions which contain water, and when water is again fed to the economiser and the steaming ceases, trouble may result from sudden cooling and from water-hammer. Obviously, under these conditions, it is necessary that the maximum temperature of feed leaving the economiser of the type considered shall be kept below the steaming temperature.

If a waste heat and a direct fired boiler having the same heating surface and developing the same capacity are equipped with the same amount and arrangement of economiser surface, the economiser fitted to the waste heat boiler will increase the temperature of feed more than the economiser fitted to the direct fired boiler. This is because of the higher ratio of gas to water weight in the case of the waste heat boiler as compared with the direct fired boiler.

Another condition that must be taken into consideration, and one which emphasizes the difference in the economiser problem for the two kinds of work, is that in direct fired practice any increase in the weight of water passing through the economiser—that is, an increase in the boiler capacity being developed—is ordinarily accompanied by a corresponding increase both in temperature and weight of gas entering the economiser; whereas, in waste heat practice, due to the possibility of irregularity in the operation of the primary furnace, there is no fixed relation between gas weight, water weight and gas temperature.

In view of the above, in order that the temperature of the feed-water leaving the economiser shall be kept below the steaming point, the amount of economiser surface that can be installed in waste heat work is greatly below that

which can be installed in direct fired practice. Furthermore, because of the possible irregularities of the operation of the primary furnace, the safe margin between the steam temperature and the temperature of the feed-water leaving the economiser must be made greater in the case of waste heat than in direct fired practice, where there is a more or less fixed relation between the functions determining economiser performance and where allowance may be more readily made for extreme conditions.

In general, in waste heat work, the economiser should be proportioned to and not in excess of 12 per cent. or 13 per cent. of the total heat absorbed by the boiler and economiser. Ordinarily, with low and moderate waste gas temperatures, this will result in an economiser which under normal conditions of operation will heat the feed to a point not closer than 60 deg. F. to the steaming temperature. While, of course, the amount of economiser surface necessary to give this result will vary with the gas weight and temperature conditions, in the average waste heat installation with entering gas temperature of from 1,000 deg. to 1,500 deg. F. it will usually be from 30 per cent. to 35 per cent. of the boiler surface.

Though not strictly dealing with the recovery of waste heat, a development that may be considered in connection with water heating boilers is the use of our modern waste heat boilers for direct fired practice. In the burning of a fuel under a boiler, if high furnace temperatures are developed and sufficient heating surface is exposed to radiant heat in the furnace, the absorption due to direct radiation is ordinarily a large proportion of the whole. To develop the same capacity from a given boiler, with fuels such as blast-furnace gas, where it is neither practicable nor possible to obtain high furnace temperatures, the amount of heat absorbed through convection compared to that absorbed through radiation must be greater than in the case of the high furnace temperature unit. In this case, it is advantageous to apply the principles of our modern waste heat boiler design.

While furnace temperatures of 2,200 deg. or 2,300 deg. F. are theoretically obtainable with blast-furnace gas, it is probable that, even with the best design of burners, the temperatures do not average over 2,000 F. with this furnace temperature, the absorption through radiation will be less than 40 per cent. of that absorbed through radiation with a furnace temperature of 2,700 deg. If, therefore, the total return from blast-furnace gas is to be made comparable with that to be expected in high-temperature work, it becomes necessary to increase the percentage of total absorption through convection.

Until the past few years blast-furnace gas was regarded as more or less of a waste product. No particular effort was made to develop an efficient method of burning the gas and, as in the case of early waste heat work, any steam generated through its use was simply accepted as "something for nothing." As indicative of the efficiencies secured with blast-furnace gas, quotations from a paper presented before the American Iron and Steel Institute, by Mr. Ambrose N. Diehl, are of interest:

"The average efficiency of a blast-furnace plant, using common burners and operating without the aid of technical supervision, is not over 50 per cent., and frequently much lower. . . .

"Of a total of 60 blast-furnaces in the Corporation under observance, the tests and information from the operators indicate a practice of not exceeding 55 per cent. The increase of 10 per cent. probably possible with improved conditions will show a yearly saving of one and one-half million dollars."

In line with other movements toward general conservation, steel-mill operators began to realise that any increase in the efficiency with which they could burn blast-furnace gas would result in a decrease in the consumption of a higher cost fuel in other portions of the plant.

Assuming a furnace of proper form and volume, the logical starting point in the development of any improved method of burning the fuel in question, was in the design of the gas burners. The designers and manufacturers of blast-furnace gas burners developed their product to a point where they were able to burn this fuel more efficiently than in the older practice. For combustion completed within the furnace the conditions were similar in all essential details to those under which our waste heat boilers had given eminently successful results. The gas temperatures entering the heating surface were no higher than in bee-hive coke-oven and in certain classes of heating furnace waste heat work. The gas weight, in common with waste heat practice, was higher than for coal firing; for, even with a minimum of excess air, the weight of products for combustion for blast-furnace gas is some 75 pounds or 80 pounds per boiler horse-power developed, as against 45 pounds or 50 pounds in the case of underfeed stokers. The furnace volume and the length of gas travel are the important factors. The furnace volume measured in cubic feet per rated boiler horse-power, is some three times as great as the volume formerly believed to be ample in this kind of work. The furnace arrangement, is in general, designed to secure a maximum furnace temperature, rather than to expose any large proportion of the tube surface to the action of the radiant heat. These modern units operating at about their rated capacity are showing efficiencies of some 76 per cent. When operating at 200 per cent. of normal rating the efficiencies are approximately 73 per cent.

PERSONAL

Ethan Viall, for ten years a member of the staff of the American Machinist, has resigned as editor-in-chief to become a member of the firm of T. W. Minton & Co., Barbourville, Kentucky, U.S.A., the largest producers of hickory dimension stock in the country. Previous to joining the staff of the American Machinist Mr. Viall was associate editor of Machinery, and before that he was for fourteen years foreman and superintendent in several of the largest specialty manufacturing plants in the Middle West. He was at that time also a frequent contributor to Canadian Machinery and other technical journals. He is a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society of Automotive Engineers, the American Welding Society, the American Society for Testing Materials, and the Franklin Institute. He is author of Broaches and Broaching, Gas Torch and Thermit Welding, Electric Welding, United States Artillery Ammunition, United States Rifles and Machine Guns, and the Manufacture of Artillery Ammunition. The last named book was compiled by the staff of the American Machinist largely from material gathered in Canada during the early days of the World War, and did much to assist shop men in fitting up for munition work. Mr. Viall is especially well known to the machine tool men around Cincinnati, Cleveland, Detroit and throughout the Middle West, where he travelled for six years in the interest of his paper.

Modern fireproof buildings will be built to replace those destroyed by fire at the Muskoka Free Hospital at Gravenhurst. The cost of the buildings will be $175,000 and with the necessary equipment the total expenditure will be $250,000.

Let Contracts.—Premier Foster of New Brunswick announced that contracts for machinery for the hydro-electric installation at the Musquash River had been awarded on the recommendation of the water powers commission. The contractors and the contract prices are as follows: S. Morgan Smith, $93,056, hydraulic machinery; Canadian General Company, $162,000, electrical machinery.

Boiler Exploded.—One man was killed and eight others injured when a small boiler used for heating water in connection with operations on the new cooperage factory at Fort Coulonge, Quebec, exploded, wrecking the boiler room of the building and sending flying debris and scalding water into a crowd of workmen. The factory belongs to the Sutherland-Innes Company, Limited, of Sunbridge, Ontario. Two of the injured were taken to Ottawa.

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

WE have dealt in the previous articles of this course with the vessels that are used for the generating of steam from water. It has been shown on what principles their construction is based, and the means of obtaining the necessary strength to resist the internal pressure placed upon them. Before being in a position to discuss the action of steam in the prime movers, the student must first form a proper idea of what steam is, and what makes it capable of doing the work which it performs.

Heat

First of all, just as we explained that coal was merely a vehicle for the storage of heat, we must imagine steam to be also a mode of storing and conveying heat. The heat which was stored up in the coal has been released by combustion, conducted through the boiler plates to the water, where it has been absorbed until sufficient heat has been present to change the water into steam, and is now present in the steam. The steam will carry it out through the valves and pipes into the machines, either reciprocating or rotary. Here some of the heat will be given up by doing work, but only a small portion of it. The greater part will be carried away to the atmosphere and lost, or carried off in the circulating water and lost, or it may be usefully employed in heating a building or heating water, or some other purpose.

We have been speaking of heat as though it was something that could be picked up and carried about, and this was the conception that the early investigators had of it. They imagined heat was a substance that could be handled like water, ice, coal, or any other material. As time went on, and this elusive material could not be found in any definite form, new ideas were formed. The fact that heat could be generated by the rubbing together of two surfaces turned the investigators' thoughts to the relation between heat and motion, and from the field opened up by that channel our present theory of heat has grown.

Heat, as it is now understood, is energy or motion. That is, the gain or loss of heat by a body can only be performed through a gain or loss in energy. The body that receives the heat is made capable of performing work, and the disappearance of heat is always accompanied by the giving out of energy, or the performance of work. This work may be either external or internal, which means it may be performed entirely in the body itself, in changing its shape, or it may be performed on an external object, such as moving a piston. For instance, the work performed in changing a liquid to a gas is internal work, while the work done by the gas in a mechanical machine is external work.

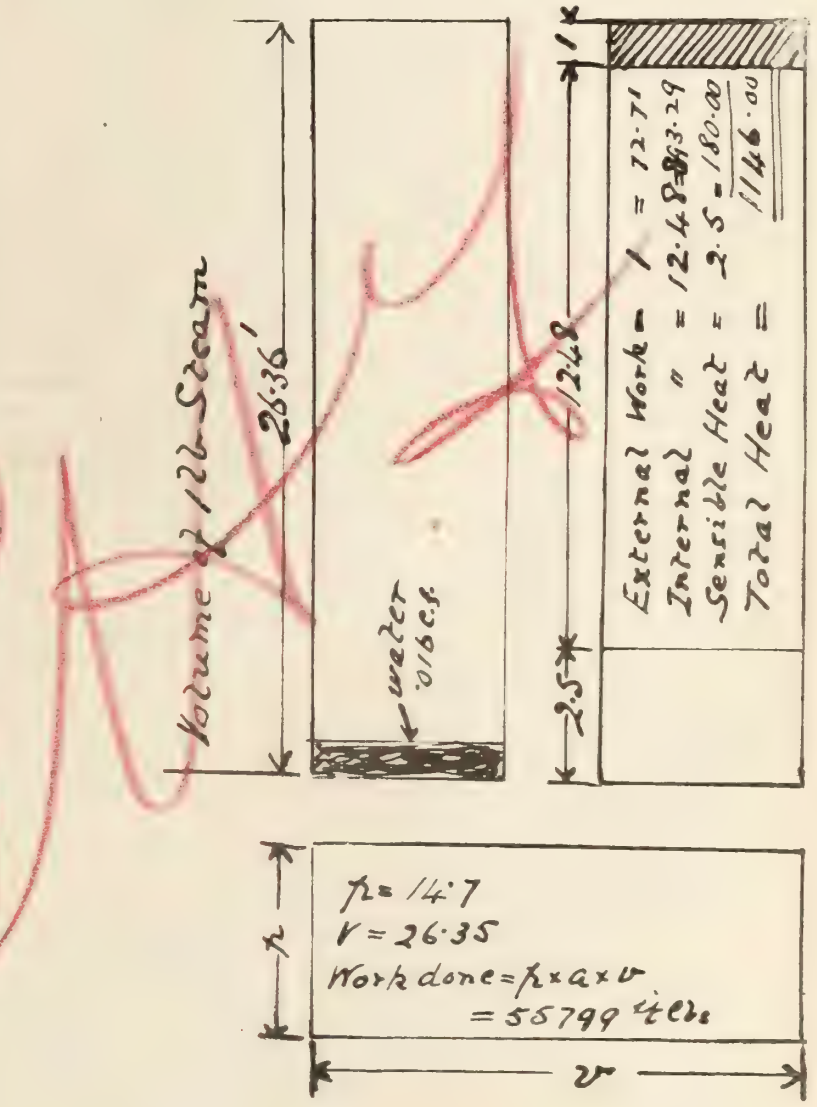
Relation of Heat and Work

We gave at the beginning of this course the laws governing the relation of heat and work. However, for the benefit of those readers who have taken it up since then we will repeat them.

The unit of heat, known as the British thermal unit, is the quantity of heat required to raise 1 pound of water 1 deg. F. when at its maximum density, that is, 39 deg. F.

The unit of work is the foot pound, which means the amount of work that is performed by raising one pound weight one foot high.

A definite relation exists between these two units, and one that is most important to realize. We have said that heat and work are mutually convertible, and therefore one unit of heat must be in a definite proportion to the unit of work. This relation has been definitely established by eminent investigators, who have found that 1 unit of heat, or 1 B.t.u., is equal to 778 units of work, or foot pounds. That means that the quantity of heat required to raise the temperature of one pound of water one degree contains sufficient energy to raise one pound weight 778 feet high.



Sensible and Latent Heat

Having established the relation be-

tween heat and work, we can now consider the action of raising water to boiling point, and then changing it from a liquid to a gas. In considering this phenomenon we will come across the problem of sensible heat and latent heat. Sensible heat may be defined as heat that applied to a body increases its temperature and is capable of being detected by the senses and measured on a scale. Latent heat is heat that is employed in performing internal work in the body itself, and is not apparent or capable of being measured by ordinary instruments. These definitions are all right in themselves, but we must go further than this to get a clear idea of the properties of these two kinds of heat. The clearest way in which to illustrate this is by means of a diagram.

If we have 1 pound of water at a temperature of 32 deg. in a cylinder whose area is exactly 1 square foot, and on top of the water have a weightless, frictionless piston, which is open to the atmospheric pressure, the weight on the piston will be equal to $a \times p$, where a=area of piston, and p=atmospheric pressure. Suppose now we apply heat to the bottom of the cylinder, and raise the temperature of the water to 212 deg., which is the boiling point at atmospheric pressure. We will have added 212—32=180 degrees to the temperature of the water, and the volume will have been increased but very slightly. If now we continue to apply heat, there will be no further raise of temperature, and no change of volume until the water starts to evaporate. The piston will then start to rise until we have evaporated all the water and in place of the water have 1 pound of saturated steam at atmospheric pressure and the same temperature. Now let us see what has occurred. The weight of one cubic foot of water is 62.5 pounds, so that the volume of one pound of water is $1 \div 62.5$ or .016 cubic foot. The volume of one pound of steam at atmospheric pressure is 26.36 cubic feet, so that we have raised the piston against atmospheric pressure a distance of 26.36 —.016, which is practically 26.35 feet. Now we have seen earlier that work is the product of force by displacement, and that it is measured in units known as foot pounds. Therefore we have, in performing the work of raising the piston, expended

$$26.35 \times 14.7 \times 144 = 55{,}799 \text{ foot pounds.}$$

Now we know that 778 foot pounds are contained in one unit of heat, therefore the heat units used are

$$55{,}799 \div 778 = 71.72.$$

Now we have put into the water very many more heat units than this. The total heat of steam above 32 degrees at atmospheric pressure is 1,146 B.t.u., which is made up of 180 B.t.u. of sensible heat, and the balance 966 B.t.u. of latent heat. So that of the 966 heat units which have been absorbed into the steam only 71.72 have done any useful work. If the water had been allowed to evaporate freely into the atmosphere after reaching the boiling point, the whole of the latent heat and sensible heat would have been carried away.

To come back to our diagram. The sensible heat is 180. The latent heat absorbed in internal work is 966—71.72 =896.28, and the external work, which has been given out on raising the piston is 71.72, all in B.t.u. This is in the proportion of 71.72 : 180 : 894.28 or 1 : 2.5 : 12.47. We can show these proportions by the rectangular areas of our diagram. The proportion that goes to perform useful work is represented by the small shaded area at the top, and this is also a measure of the efficiency of the steam. This efficiency is of course the ratio of the useful heat to the total heat put into the steam. The whole diagram is exactly what would take place in a non-expansive steam engine, that is an engine carrying the steam the whole stroke. Now we have 71.72 B.t.u. useful work to 1,146 B.t.u. put in and the efficiency will be

$$71.72 \div 1{,}146 \times 100 = 6.25 \text{ per cent.}$$

Supposing now we surrounded our cylinder with cold water, and condensed the steam until we had again our one pound of water at 32 deg. temperature, and a volume of .016 cubic foot. The heat that was put into the water to raise the temperature and to perform the internal work must be returned. Where will it go? It will be absorbed by the condensing water, raising the temperature of the latter. The condensing being performed at atmospheric pressure, just as the evaporating was, the external work put into the piston to raise it against atmospheric pressure will be given out again in causing it to descend the same distance, against the same pressure. Therefore, the total heat rejected to the condenser will be equal to the total heat supplied to the water originally, or if Q=total heat of evaporation, and R=heat rejected, Q=R. This is a strictly elementary case, and we have not taken into account any loss by radiation through the walls or condensation on the walls of the cylinder which would occur in actual practice.

Let us now consider a case where we are evaporating steam at a pressure higher than atmospheric. Suppose we have our water again at 32 deg., and evaporate it to steam against a pressure of 100 pounds absolute, or roughly 7 atmospheres. The first thing we shall find is an increase in the sensible heat, or, in other words, a higher boiling point. The boiling point of water at 100 pounds pressure is 327.7 deg. We have therefore to add 327.7—32=295.7 B.t.u. to the water before we reach boiling point. To turn the water into steam at 100 pounds absolute pressure we must now add 884 B.t.u., which is the latent heat or heat absorbed in the steam. Now as the pressure increases the volume decreases and we find the volume of one pound steam at 100 pounds absolute pressure is 4.35 C. F. Let us now compare the internal and external work. The total weight on the piston will be 144×100 and the work done will be $144 \times 100 \times (4.35 - .016)$. The volume of the water will be so small in comparison that we may safely neglect it, and assume the work done to be $144 \times 100 \times 4.35 = 62{,}640$. The external work expressed in heat units will be

$$62{,}640 \div 778 = 80.5 \text{ B.t.u.}$$

The total heat is 1,181.9, or nearly 1,182, and the efficiency will therefore be

$$80.5 \div 1{,}182 \times 100 = 6.8 \text{ per cent.}$$

Here we see that the efficiency of steam under these conditions is but very little greater than that of atmospheric pressure. The gain in using high pressure steam without expansion is very slight indeed, but when we consider it used expansively we will see a difference.

Let us now consider the effect of heating the water, or rather of making steam from water of a higher temperature than 32 deg. Suppose we have our water at 100 deg. to begin with. Then to bring it up to the boiling point we have to add only $295.7 - (100 - 32) = 227.7$ B.t.u. The latent heat is the same, 884, so that we now have added only $227.7 + 884 = 1{,}111.7$ B.t.u. altogther. Now the external work will be the same, 80.5, and the efficiency will be

$$80.5 \div 1{,}111.7 \times 100 = 7.2 \text{ per cent.}$$

That is, we have increased the steam efficiency from 6.8 per cent. to 7.2 per cent. We have, however, instead of putting in 1,182 B.t.u. only put in 1,112 roughly, or 70 B.t.u. less, so that the saving in heat is $70 \div 1{,}182 \times 100 = 5.9$ per cent., say 6 per cent. If this added initial heat be gained from a source which would otherwise have been lost, the saving is apparent.

We have considered the case where our piston having been raised by the steam was brought back to its original position by the condensation of the steam at the same pressure. In this case we have seen that all the heat that was put into the steam was rejected to the condensing water, thus making the work usefully employed nil. That is the piston had work put into it to raise it, but had to give out that work again in descending. We will now consider the effect of removing the pressure from under the piston entirely when the steam is condensed. In other words, imagine the steam to be opened to a condenser in which there is a perfect vacuum. It is obvious that in this case the piston in descending will have no resistance to overcome. That is, there will be no force used, though the displacement takes place. Or else consider that the pressure of the atmosphere is removed at the moment the steam is condensed, and being weightless the piston remains poised where it is. Either way amounts to the same thing, for no work is done in either case. We then will have less heat rejected to the condensing water, by the amount of the external work. The heat rejected will be the total heat Q minus the external work E, and the equation for heat rejected will be Q—E=R, or in

the first case we considered 1,146—71.7 =R. The 71.7 then becomes useful work, and the heat rejected to the condenser is 1,146—71.7=1,074.3 B.t.u.

If now, instead of condensing in a perfect vacuum, or at zero pressure, the condensation takes place at a back pressure of 2 pounds absolute. Then the work done by the falling piston will be $14.7 \div 2 \times 71.7$, or approximately 10 B.t.u. Then the heat rejected will be

$$Q-(E-10)=R$$
$$1,146-61.7=1,084.3.$$

Then the efficiency will be: Heat put in — Heat rejected ÷ Heat put in, or

$$\frac{Q-R}{Q}=\frac{1,146-1,084.3}{1,146}=\frac{61.7}{1,146}\times 100=5.3\%$$

From the foregoing we can get a formula to express the same results. If H=total heat, L=latent heat, and S=sensible heat, then H=L+S. Now S is equal to the temperature of steam, t, minus 32 or S=(t—32). The latent heat of steam at any temperature may be found from the formula 966—.7(t—212), so the expression for H becomes

$$H=(t-32)+966-.7(t-212)$$
$$=t-32+966-.7t+148.4$$
$$=1,082.4+.3t.$$

Now the heat lost by the steam is equal to the heat gained by the condensing water, and may be expressed as follows. In the first case where all the heat was lost. Taking one pound of steam, and supposing the final temperature of the condensing water to be t_3, the initial temperature to be t_2, and temperature of steam to be t_1. Let x=number of pounds condensing water required. Then $H=1(t_1-32)+966-.7(t-212)$ and the gain of heat by water $=x(t_3-t_2)$, we have

$$1(t_1-32)+966-.7(t-212)=x(t_3-t_2)$$
$$x=\frac{1,082.4+.3t}{t_3-t_2}$$

Substituting figures, suppose the initial temperature of water to be 40 deg., and final temperature 100 deg. Temperature of steam 212 deg.

$$1(212-32)+966-.7(212-212)=x(100-40)$$
$$180+966=x60$$
$$x=(1,146\div 60)=19.1 \text{ pounds.}$$

Now suppose we had only wished to mix water at 212 deg. with sufficient water to make the mixture 100 deg., we should have only required

$$1\times 212=x(100-40)$$
$$x=212\div 60=3.53 \text{ pounds.}$$

This shows the influence of latent heat.

The formula for latent heat may be expressed in shorter form, thus:

$$966-.7(t-212)$$
$$=966-.7t+148.4$$
$$=1,114.4-.7t.$$

Then total heat $=(t-32)+1,114.4-.7t$.

Suppose we wish to find the latent heat of steam at a temperature of 212. Then

$$L=1,114.4-.7\times 212$$
$$1,114.4-148.4$$
$$=966.0$$

and total heat will be $(212-32)+966$

$$=180+966$$
$$=1,146.$$

Making Pipe Bushings From Standard Pipe

By W. F. SCHAPHORST. Copyright in U.S.A., 1920.

IT IS a good thing to know that bushings can be made out of standard pipe. Many pipe fitters don't know that it can be done. Or, if they know that it can be done they don't know the correct size of drill to use for tapping. I have always known that it can be done and have occasionally made bushings out of pipe, but each time I found it necessary to first look into my handbook for the drill size to use and that is so much trouble that it is frequently easier to go to the store and buy a new bushing. Recently, though, it has been very difficult to buy bushings in stores on account of shortage of all pipe fittings, hence I feel that the following information should be of much value. I have collected all of the data together for all bushings that can be made out of ordinary sizes of extra heavy and double extra heavy piping.

To bush from ¼" to ⅛," for example, get a piece of ¼" extra heavy pipe sufficiently long for cutting the outside thread. Then cut the end off to the desired length, drill or ream with a 21/64" drill (diameter of drill 0.328") and then tap with a ⅛" pipe tap. That's all there is to it.

The table enclosed tells the complete story for all ordinary sizes. Note that in one case, ⅜" to ¼", the internal diameter of ⅜" extra heavy pipe is such that no drilling is necessary.

Also note that in bushing from ½" to ⅜" either extra heavy or double extra heavy piping can be used.

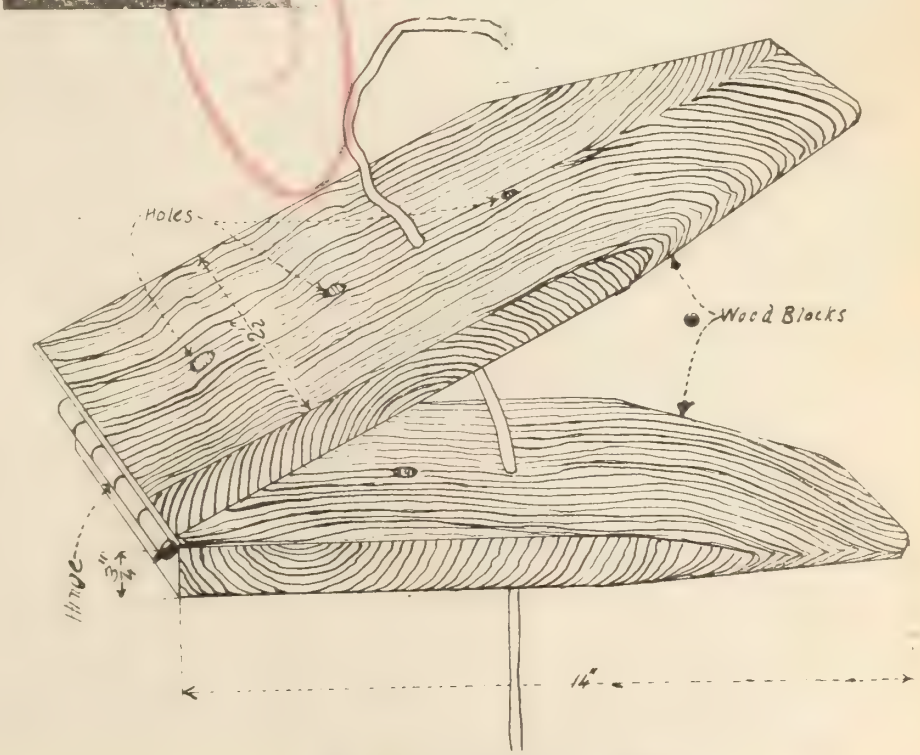
To Bush From	Use This Size of Pipe	Use This Size Drill or Reamer
¼" to ⅛"	¼" Extra Heavy	21/64" Drill 0.328"
⅜" to ¼"	⅜" " "	None
½" to ¼"	½" Double Extra Heavy	21/64" Drill 0.328"
½" to ¼"	½" " " "	27/64" Drill 0.422"
½" to ⅜"	½" " " "	9/16" Drill 0.562"
½" to ⅜"	½" Extra Heavy	9/16" Drill 0.562"
¾" to ⅜"	¾" Double Extra Heavy	9/16" Drill 0.562"
¾" to ½"	¾" " " "	11/16" Drill 0.688"
1" to ¾"	1" " " "	29/32" Drill 0.907"
1¼" to 1"	1¼" " " "	1⅛" Drill 0.125"
1½" to 1"	1½" " " "	1⅛" Drill 0.125"
1½" to 1¼"	1½" " " "	1 15/32" Drill 1.468"
2" to 1½"	2" " " "	1 23/32" Drill 1.72"
2½" to 2"	2½" " " "	2 3/16" Drill 2.187"
3" to 2½"	3" " " "	2 9/16" Drill 2.562"
3½" to 3"	3½" " " "	3 3/16" Drill 3.187"
4" to 3½"	4" " " "	3 11/16" Drill 3.688"
4½" to 4"	4½" " " "	4 3/16" Drill 4.187"

HOW TO STRAIGHTEN WIRE

By L. P. Roberts

(Copyright. All rights reserved)

A convenient wire straightener is shown herewith. Two blocks of ⅞-inch board are hinged together at one end and have a number of different-diameter holes bored through them to accommodate the various sizes of wire. To straighten the wire it is merely pulled through the holes in the block.



RIG FOR STRAIGHTENING WIRE

POWER HOUSE

Member of the Audit Bureau of Circulation

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Electric, Gas, Air and Water Power, and to the design and operation of Refrigerating Machinery.

T. H. FENNER, Editor. Associate Editor: J. H. RODGERS (Montreal)

A. R. KENNEDY, Managing Editor.

B. G. NEWTON, Manager. H. D. TRESIDDER, Advertising Manager.

OFFICES

CANADA—TORONTO (Head Office): 143-153 University Ave., Telephone, Adelaide 5740. MONTREAL: Southam Building, 128 Bleury St., Telephone Main 1004. WINNIPEG: 1103 Union Trust Bldg., Telephone Main 3449. VANCOUVER: R. A. Hunter, 314 Carter-Cotton Bldg., 198 Hastings St. W. EASTERN REPRESENTATIVE: G. E. Pearson. ONTARIO REPRESENTATIVE: S. S. Moore. TORONTO AND HAMILTON REPRESENTATIVE: C. H. Broad.

UNITED STATES—NEW YORK: Ken. Couillard, 1133 Broadway, New York, Telephone Watkins 5869. CHICAGO: A. H. Byrne, 405 Transportation Bldg., 608 So. Dearborn St., Wabash 9430. BOSTON: C. L. Morton, Room 734, Old South Bldg., Telephone Main 1024.

GREAT BRITAIN—LONDON: The MacLean Company of Great Britain, Limited, 88 Fleet Street, E.C.; E. J. Dodd, Director; Telephone Central 11960. Cable Address: Atabek, London, England.

SUBSCRIPTION RATE

Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year; other countries, $3.00. Advertising rates on request.

Subscribers who are not receiving their paper regularly will confer a favor by telling us. We should be notified at once of any change in address, giving both old and new.

THE MACLEAN PUBLISHING COMPANY
LIMITED

143-153 UNIVERSITY AVENUE, TORONTO, ONTARIO

Vol. XIII. TORONTO, DECEMBER 20, 1920 No. 24

PRINCIPAL CONTENTS

A Series of Articles on Power Plant Management	533
The Welding of Locomotive Fire Boxes	536
The Utilization of Waste Heat Under Boilers	539
A Course of Instruction	543
Editorial	546
Our Question Box	548
Progress in New Equipment	550
Operator's Point of View	553

A Year of Graded Certificates

THE act requiring the stationary engineer in Ontario to hold a certificate of a certain grade in order to operate a plant of a definite size has now been in force for one year, or will have been at the end of this month. During that year quite a number of engineers have availed themselves of the opportunity of obtaining a certificate of the highest grade, while a larger number have obtained the second-class certificate. The actual numbers are, of course, not yet available, but will no doubt be made public in the annual report of the department when that is issued. The Board suffered the loss during the year of the late W. C. McGhie, the first chairman of the Board, and a widely known and popular man among the engineering community. The position was left vacant for a considerable time, the work of the Board being carried on in the meantime by Mr. Mosely, whom it was expected would be the appointee for the vacant chairmanship. This did not turn out to be the case, as Mr. Brown was recently appointed by the Minister to carry on the work. This gentleman is well fitted by his experience and training for the work and the appointment met with satisfaction generally.

The administration of the act, has, we believe, been conducted with a spirit of absolute fairness to all, and we have heard no definite statement to the contrary. On the other hand we have received a number of vague statements regarding men who have received certificates of a grade to which they were not entitled. To all these correspondents we have returned the same answer, that they should procure definite proofs of what they state, and then submit their case. None of them have done so, but on the other hand we know of at least one case where a man secured a certificate by making a false statement of his experience, a fact that was brought to the knowledge of the Board. The action taken by them was swift and definite, and such as to discourage any further attempts along this line.

Power House holds no brief either for or against the Board, but from what we have seen we are convinced that they are absolutely fair. What we wish to convey is that if anyone knows of a case where a man has been granted a certificate that he is not entitled to, that case with all the facts should be brought to the attention of the Board. If there has been any injustice we believe that the Board will rectify it. If any case arises where there is injustice clearly proven and investigation or rectification refused, then we shall be only too glad to take it up and give all possible assistance to the cause of the right. We do not believe there are any such cases, but that is our position in the matter.

During the year a change was made in the rating of plants which could be operated under the different grades of certificates, by which a third-class certificate is sufficient for a plant up to 200 h.p. and a second-class up to 600 h.p. This gives the holders of these grades a wider latitude when seeking or changing positions and is a great benefit to them.

We believe from the results of this first year that the Ontario certificate will gradually become known in the other provinces as something worth having. The holder of a certificate of the 1st class for Ontario will have no difficulty in obtaining the first-class in any other province of Canada and the same will apply to the lower grades. The Ontario Stationary Engineers' Certificate will be in the future a thing to prize, instead of as in the past, a thing to laugh at.

New Year Resolutions for the Chief

THE time is approaching when we shall all, from long habit, make good resolutions, which will be kept for a greater or less period, according to how arduous they are to carry out. The chief engineer of a power plant should make up his mind that he will aim for a higher efficiency in his plant during the coming year than he has ever achieved in former years. This will keep him sufficiently busy during the year to prevent him having time to break any other resolutions he may have made on the side. On the other hand, keeping a plant at the top-notch of efficiency that the equipment he has will allow will show such good results that it will be an easy matter for him to persuade the management that much better performance could be shown if the additional equipment he has been asking for so long should be installed. Then it will be easier for him to maintain the results already obtained and get better ones, so that gradually his work will be decreased and his value proportionately increased. There are but very few plants where it is not possible to show results if the losses are gone after in a systematic manner and one of the first things that should be done is to get the physical condition of the plant up to the highest mark. It is of little use having a furnace which is giving the highest efficiency of combustion if the steam that is generated is allowed to wander away through leaky joints and glands without usefully giving up the heat that it has absorbed from the furnace. You may have the steam valves set to a nicety when the engine is still, but if they are allowing steam to leak through to the cylinder when they should be shut, the accuracy of opening and closing is not sufficient to make up for the effects of leakage. In Corliss engines and in engines like the McIntosh Seymour, lost motion on the various links will seriously interfere with the steam distribution in the cylinder, besides making an unpleasant noise and increasing wear and tear. In a

power plant there is nothing more true than the old adage of a stitch in time saving nine. Get after the little things before they have time to become big things and life in the engine room will become easier in consequence. When boilers, furnace, engines and pumps are in such working order that they can be safely left to the ordinary attendants, then the chief can go with a clear mind to the task of chasing the elusive B.t.u., but when he is being called every five minutes to a knock that seems to be getting worse, he has but a poor chance of looking under the surface for the faults that have to be traced. At the same time he should make it a point to get enough relaxation to keep himself in proper condition as well as the plant. Man does not live by bread alone and some recreation is a necessity.

Oil Versus Coal

REPORTS from Vancouver state that on account of the oil shortage, oil-burning equipment in boats and locomotives is being taken out and replaced by coal burners.

There is something in this move that may cause a number of very careful students to make one of those "I-told-you-so" remarks. For some time the view has been held that oil-burning equipment was being boomed out of all proportion—that it could never live up to all the advance notices that were being put up for it.

There is a shortage of oil, so marked in fact that it is not possible to secure the 70,000 barrels daily the Canadian Pacific requires.

There must be fuel for the automobiles, joy-riders and others, no matter if there is no fuel for locomotive and steamships.

Many a firm that has spent its good money in perfecting coal-burning apparatus could hardly be blamed for getting a little hot under the collar by the booming that has accompanied every move made by the oil burners.

The oil burning type has many advantages; it is easier to operate; it gives almost a maximum heat right at the start.

But when there is no fuel oil to be had, or when it is in very limited quantities, what then?

The oil burning equipment is desirable on railroads that run through wooded sections, for the foot-hill country of British Columbia, Oregon and other coast territory can bear gaunt testimony of the way in which the old belching locomotive used to strew its live coals on dry material along the right-of-way.

It is an expensive proposition changing over from oil to coal burning equipment. For a locomotive the cost might be from $10,000 to $12,000, while a fair-sized steamer of the ocean-going sort could hardly be altered for less than $50,000 or $60,000.

The coal burner will be with us for some days, and the part of wisdom is to use every possible means devised and improved for getting as much energy as possible out of every ton of coal burned.

The oil burner will be here, too. There is plenty of room for them both.

Strength of Materials

OUR knowledge of materials, particularly metals, has increased to a great extent within the past few years, but according to Professor F. C. Jenkins, president of the Engineering Section of the British Association, we are, as yet, only on the threshold of that complete knowledge which is essential before we can really tell the cause of a failure, or provide with certainty against accidents.

He states as follows: surely an engineer should be able to say whether a cylinder is safe without dropping it from the roof or rolling it down the front doorstep to see if it breaks. The time has come when the fundamental data on which the engineering theories of the strength and suitability of materials are based require thorough overhauling and revision.

When one considers the matter carefully, the professor is not far from wrong. Judging from some of the formulae we have seen, it would be a much better plan to drop the part under discussion and see if it would break, rather than try to figure out the theoretical chances of its proving too weak.

This condition should not exist, and if sufficient research work is made in this particular field, there is no reason why the formulae can not be simplified to a great extent. We should not have to depend on actual physical tests, but should be able to figure with certainty the strength of our various materials.

Cases exist where theoretical tests alone would not suffice. For example, suppose some structure is being built on which life depends. In such a case both theoretical and physical tests are made. Every boiler must undergo a water test before being fit for use, the various members of a bridge must be tested for their physical properties, and so on.

These precautions are essential with all due respect to theory, because defects can, and do, occur in process of manufacture. Theory does not allow for such defects, therefore they must be checked up by physical tests.

A great need exists, however, of our present formulae being simplified. Here is a chance for the heads of our colleges. Let them concentrate on the task, for by so doing they will be rendering a real service to the machine tool industry.

Mechanical Accuracy

"TAKE a hair from your head (the average is about 2½ thousandths of an inch in thickness) and if you could split that hair into ten strands of uniform dimensions, just one of those strands would give a fair conception of the closeness to a mean standard prescribed in more than 300 operations on our car.

"Our work calls for more than 5,000 operations in which the deviation from a mean standard is not permitted to exceed the one one-thousandth of an inch; more than 1,200 in which it is not permitted to exceed a half one one-thousandth, and more than 300 in which it is not permitted to exceed a quarter of a thousandth."

These statements appeared recently in a wide advertising campaign carried out in various national magazines, and were prepared to appeal to mechanical men in general.

Can you imagine such technical copy reaching the columns of popular magazines, even ten years ago?

It is only another proof that this is becoming more and more a mechanical age and that things are changing for the better.

Why are the limits held so close? Simply to obtain accuracy and an interchangeable product. We owe a great deal to the automotive industry in this respect, for they have been largely responsible for our seeking after interchangeability.

Working to fine limits became common practice in Canada during the days of the shell shop. We hear much of the shell-buster-funny chap no doubt. But we don't hear so much about many mechanics who had never measured anything much closer than a sixteenth.

Memory recalls one chap who used to carry a brass rule in his overalls' pocket. He could work to sixteenths all right. The question of shells was put up to him and after a study of the required standards he explained that it was out of the question—it couldn't be done in his shop.

What happened? Simply that in a few months he was working in thousandths of inches and turning out a good shell.

Fine limits indicate high class machine shop and tool room practice, as well as excellence of design. Canadian shops should never drop from these standards of mechanical superiority.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

PUMP OR INJECTOR

Question.—I am fitting up a small boiler, about thirty horse-power, and would like to know whether a pump or injector would be the best for feeding it?

Answer.—The question of fitting pump or injector depends on the conditions. If your boiler is going to run an engine, and the exhaust be used for heating purposes, a pump is more suitable as being able to handle the hot feed water. An injector, while being very inefficient in the sense of pounds water lifted to pounds steam used is, on the other hand, efficient in that it returns practically all the heat of the steam back to the boiler. For a small plant the injector is handy and low in first cost, and costs practically nothing for maintenance. A pump is very wasteful of steam, requires a fair amount of maintenance, but, on the other hand, is able to keep a more regular feed rate and can handle hot feed water. On a small boiler such as you describe, the injector would be quite suitable.

HORSE-POWER FOR DYNAMO

Question.—What horse-power will be required to drive a direct connected generator delivering 85 h.p.?

Answer.—The horse-power of the engine will have to be sufficiently high to overcome friction losses in engine and generator. The loss in the engine may be figured at 10 per cent., and if the generator is 95 per cent. efficient the engine must have 15 per cent. more power than the generator. That would be

$$\frac{85 \times 115}{100} = 98$$

horse-power, or an engine of 100 I.h.p. would fill the bill.

Capacity of Bin

Question.—We have a coal bin of the following dimensions: 19 feet 6 inches by 17 feet by 6 feet high. How much coal is in the bin, and how do you determine the quantity.

Answer.—The bin you mention will contain about 50 tons. The method is to multiply together the length, breadth and height of the bin, which gives you the cubical contents. These must be divided by 40 if the coal is of average size, as there is about 40 cubic feet to a ton of coal. If the coal is very fine it would only occupy about 35 feet, and very large, lumpy coal might run as high as 45 cubic feet. The following is the calculation for the dimensions you give: $19.42 \times 17 \times 6 = 1980.84$ and this divided by 40 gives 49.52 tons.

ALTERING CUT-OFF

Question.—In a compound or triple expansion engine what is the effect of, (1), making the cut-off in high pressure cylinder earlier; (2), altering cut-off in the other cylinders, making it either earlier or later?

The power of a compound engine depends on the weight of steam delivered to the high pressure cylinder. Cutting-off early in the high pressure cylinder decreases the power of the engine as a whole, while making the cut-off later increases the power. Leaving cut-off the same in the high pressure cylinder and altering the low, or altering intermediate and low in a triple engine, merely changes the distribution of power in the different cylinders, leaving the total power the same. For instance, making cut-off similar in the low pressure cylinder of a compound engine decreases the power of the high and increases the power of the low pressure. This is because the mean pressure of the high is decreased through having a high back pressure, due to early cut-off in the low. The low is increased, because while cut-off is earlier, initial pressure is higher.

HIGH OR LOW PRESSURE

Question.—In a building which is to be heated with live steam is there any advantage in using high pressure steam as against steam at, say, 10 lbs. per square inch?

Answer.—There is nothing gained in using high pressure steam for ordinary heating purposes. In special cases, where high temperatures have to be reached, it is compulsory to use steam having the necessary temperature. For ordinary heating the use of high pressure steam means more initial cost, higher maintenance costs, and more actual fuel costs. The temperature of steam at 10 lbs. gauge is 240 degrees, and the total heat 1,160 B.t.u., while at 100 lbs. gauge the temperature is 339 degrees, and the total heat 1,189. Thus while the temperature is very much higher, the total heat is not so much more. The higher temperature means much greater radiation losses from pipes between the boiler and the rooms to be heated, greater losses from the boiler itself, and greater wear and tear on the whole system. Allowing that the steam is kept in the coil until it is condensed, it will yield up only 29 more B.t.u. than the low pressure steam, and less of the total heat will be usefully employed.

BURNING WOOD REFUSE

Question:—I am operating a steam boiler of the horizontal return tubular type and used for heating purposes only. The heating system is a one-pipe overhead and the return water comes back by gravity and returns to the bottom of the boiler by a 5-inch pipe. The boiler is 16 feet by 60 inches diameter, having 3-inch tubes. It is only necessary to carry from 6 to 8 pounds steam pressure to heat the building, which is fairly large, with the grade of coal I am using and firing by hand, and I can obtain good results.

Now, I have been experimenting a lot lately on the saving and economy of fuel by burning a lot of our plant refuse, namely, sawdust, shavings and small blocks of wood mixed in it. Now, my experience with this is that I cannot raise my steam pressure above 3 to 4 pounds, although I have a much greater fire and longer flame than I ever have with the grade of coal I am burning. I wonder if you would be kind enough to tell me in your next issue of Power House just why I can't get a very good steam pressure with this sort of fuel, as I was of the impression that my furnace temperature would be very high and steaming up would be a rather easy matter with this fuel fired by hand. I have tried to arrange drafts to get the proper mixture of air but without results.

Answer:—Your experience in burning wood refuse is not unusual, and is easily accounted for. The value of wood as a fuel is only about one-third that of coal, or some authorities give 2¼ pounds wood to equal 1 pound coal. With the ordinary boiler setting and the usual size of fire grate it is difficult to burn the required amount of sawdust, shavings, etc., per hour to obtain the same rate of evaporation per hour as you were getting with the coal. If your boiler is not set close to the grate bars, this will be a further drawback. Wood requires a large combustion space, and with the ordinary

setting the gases come in contact with the shell of the boiler, and are extinguished before proper combustion is completed. The gases are carried away too quickly to do their work. With the ordinary fire bars and setting, it is difficult to get the correct amount of air to mix with the fuel, and if the bars are covered altogether with fuel it is worse. The bars should be of semi-circular form, and perforated, and the sawdust should be kept back from the front of the dead plate about one foot, and kept high in the middle of the grate. This of course makes your grate area smaller. The only really satisfactory way to burn shavings and sawdust is in a Dutch oven, which allows the whole length under the boiler to be a combustion chamber. If you have moisture in the shavings you are again losing heat value, in the ratio of 1.1 deg. heat value to 1 per cent. moisture.

ELECTRIC GENERATING APPARATUS

The Dodge Manufacturing Co., Mishewaka, Ind., have placed on the market an electric generating apparatus that is of rather interesting design. The photograph herewith shows clearly its general construction, and this outfit consists of complete power units for electric generating. Tests have been made on these units in strict accordance with the rules adopted by the American Institute of Electrical Engineers.

The generating units are made up either direct connected or belted in all standard voltages using Dodge heavy oil engines as motive power. The sizes manufactured at present range from 12½ h.p. to and including 75 h.p. The wide range of sizes in these outfits makes the fact evident that the power units are equally adaptable to either marine or stationary power plant service.

Oil Engine Used as Prime Mover

The heavy oil engine used is said to be sufficient guarantee of low cost operation, which of course results in a great saving in the cost of current generation. The engine is sold under a standard guarantee which specifies a consumption of fuel oil of .5 lb. per B.H.P. hour, using fuel as low as .28 Baume, containing not less than 18,500 B. t.u. per pound. It is said that every engine turned out must use less than the amount guaranteed on actual brake test; otherwise such guarantee could not be made with any degree of safety.

The engine illustrated has a brake output of 50 h.p. and is direct connected to a 30 K.W. 220 Volt D.C. generator, running at a normal speed of 425 R.P.M. It would therefore use 10,000 gallons of fuel oil per year, if operated 10 hours a day under full load for 300 days. This fuel costs on the average of 5 cents a gallon and would mean a total of $500 for annual fuel cost. This reduces the fuel-cost of current to $.005 per K.W. hour.

Construction of Generator

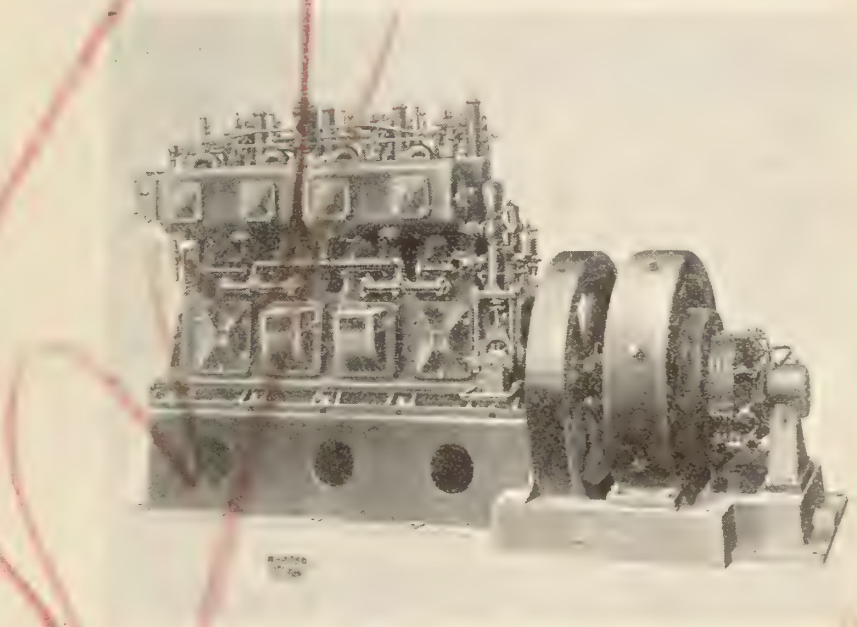
The generator used has been developed especially for this particular service by the Engberg Electrical & Mechanical Works at St. Joseph, Michigan. The armature is of the iron clad ventilated type, with laminated core, being built of electrical sheet steel, thoroughly japanned before assembling. The drum and core are provided with air ducts, permitting a thorough circulation of air through same.

Nothing but the very best double-covered magnet wire of the highest conductivity is used, and the insulation is thoroughly waterproof. A very desirable feature in connection with the armature is that it has been so designed as to eliminate a coupling on the armature shaft, the crankshaft coupling is direct connected to the armature drum, by such construction that the engine drives through the armature and not on the armature shaft. This method of construction is very substantial and makes it very easy to remove the armature—in fact this can be done without disturbing the engine in any manner whatever. Close regulation is assured by having the flywheel of the engine located close up to the armature and on the same end of the crankshaft.

The commutator is made of copper bars, insulated with the best grade of mica plate and is very heavy, thus insuring years of continuous operation without need of renewal. It is built up on a separate sleeve and bolted to the armature drum, so that the shaft can be removed without disturbing the windings. The bars are collected in a steel chuck, especially designed for this particular purpose, which is provided with large steel screws. The chuck is heated and allowed to expand, at which time screws are tightened to the very extreme. When the chuck cools and shrinks, the commutator is drawn into a perfect and lasting position.

Every part of both the engine and generator is of the highest possible grade in regard to material, workmanship and design. All bearings are extremely large and accurately fitted, thus assuring smooth and constant operation with comparatively little attention.

Both engine and generator are carefully tested and inspected at frequent intervals during the course of construction. Both are mounted on a heavy cast iron sub-base and dowelled in place, after which they are subjected to a final operating test under load.



GENERAL VIEW OF THE GENERATING APPARATUS.

BOILER EXPLODES AT FORT COULONGE

The cooperage plant of the Sutherland-Innes Company, Ltd., Fort Coulonge, P.Q., was the scene of a disastrous boiler explosion recently. A small boiler, which we understand was used for heating water for the cooperage, exploded, killing one man and injuring eight others. The dead man was not killed outright, but died later from his burns and shock. We are not in possession of any of the details of the boiler or the accident at time of writing.

TRADE ANNOUNCEMENT

The Beldam Asbestos Co., of Hounslow, Middlesex, England, have opened a Canadian branch at Toronto, under the managership of Mr. J. A. Robertson, who has just returned from England following the organization of the company's plans for Canada. A heavy stock of the well-known "Lascar" and allied brands will be carried at the Toronto house. It is interesting to know that the works at Hounslow have trebled in size and output in the last three years. The Canadian address is 19 Jarvis Street, Toronto.

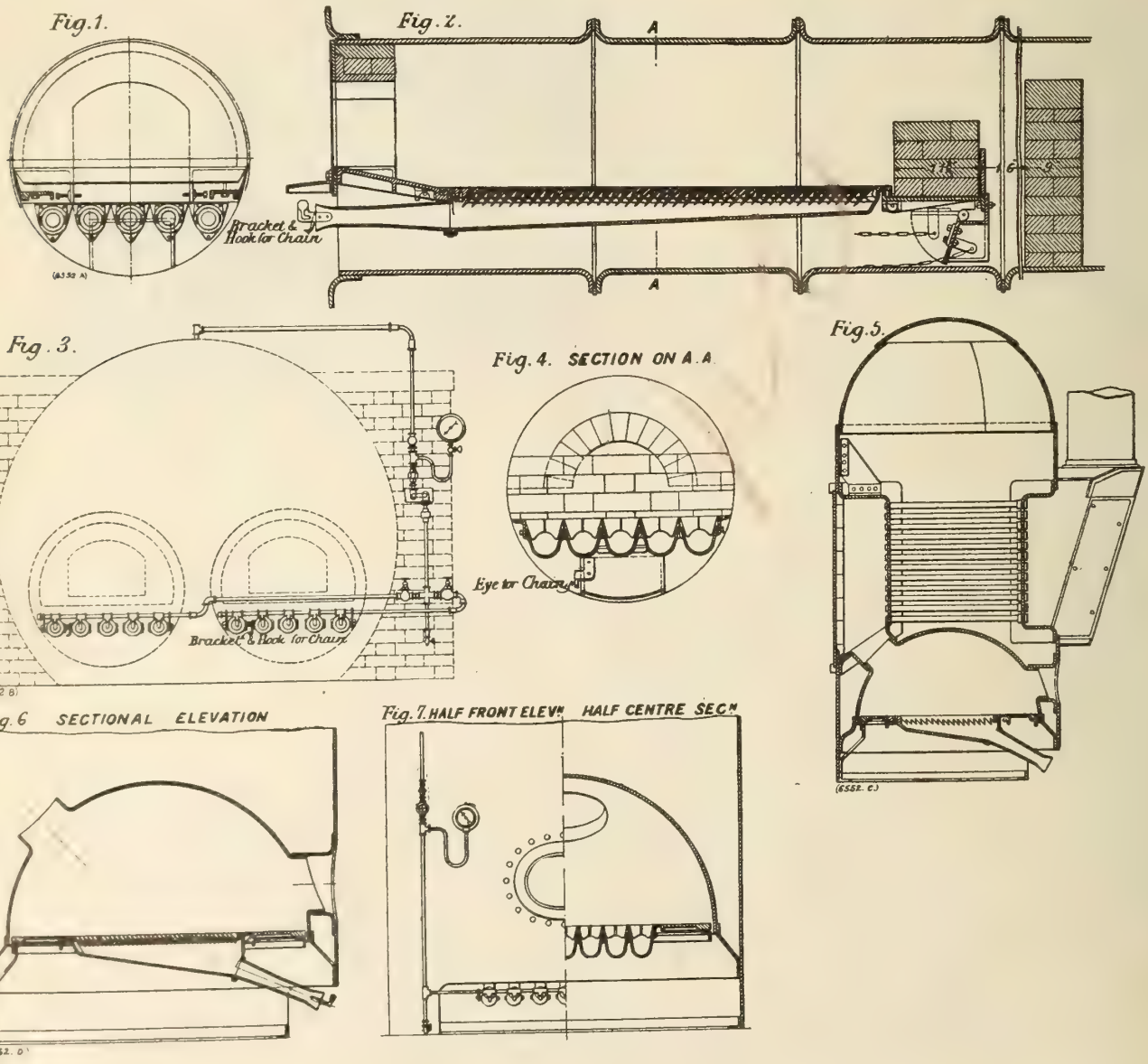
Progress in New Equipment

THE TURBINE FURNACE

The following interesting description of a new type of furnace is taken from the pages of Engineering (London). This should be of interest to steam users on this side of the Atlantic, where fuel has reached unheard of prices, and seems inclined to stay there.

The present fuel situation and the fact that there are no indications of any important fall in the cost of fuel in the future renders any appliances for utilizing the cheaper, or poorer, grades of great importance. Much has, of course, been done in various directions to accomplish this, but in many cases expensive reconstruction work is necessary before the appliances can be utilized, so that the ease with which it can be installed would appear to be not the least valuable of the features of the furnace which has been brought out by the Turbine Furnace Company, Limited, of 5, Budgerow, London, E.C. 4. The appliance has other important qualifications, however, as will appear in the course of this description. For the moment it may briefly be said that it will efficiently burn almost anything which can be described as fuel; coke breeze, slurry, small slack, cinders and similar poor fuels are being successfully utilized in many boilers to which the furnace has been fitted.

The details of the furnace will be clearly followed from Figs. 1 to 4, above, which show an installation applied to a Lancashire boiler. This arrangement consists of a series of troughs which lie side by side, and form the base of the furnace. These troughs carry the firebars. As will be seen from Fig. 2, the troughs have a cross-sectional area di-



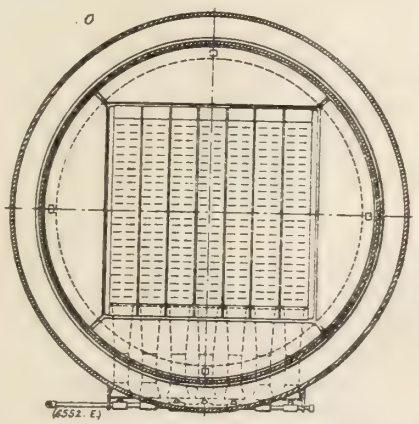
APPLICATIONS OF THE TURBINE FURNACE

minishing from the front to the back. The way they nest side by side is best shown in Fig. 4. The front of each trough forms an air injector and is fitted with a steam jet. This arrangement of troughs forms one of the special features of the furnace, and it will be clear that it results in the air supply being divided up and distributed evenly over the fire. This even distribution prevents the formation of holes and uneven burning. A further special feature of the furnace lies in the form of the fire-bars. As will be seen, these are of vee section inclined to meet the incoming air blast. It is this feature of the furnace which has given it its name of the "Turbine" furnace. The air troughs can be likened to the nozzle and the fire-bars to the blades of an impulse turbine, and it will be evident that some approach to a stream-line flow of the air from the injector up through the fire will be obtained. The arrangement should certainly cut down resistance and economize the expenditure of energy in the steam jets, and the performance of the furnace in numerous installations would appear to show the arrangement to be a very satisfactory and efficient one.

The fact that the division of the incoming air through the series of troughs breaks it up and ensures a uniform supply to all parts of the fire has already been referred to. The uniform distribution which is obtained, however, also owes much to the gradually diminishing section of the troughs and the shape of the fire-bars. The overall result of the arrangement would appear to be a uniform air pressure below and throughout the whole of the furnace. The uniformity can be well seen if a thin fire is maintained, when an even burning with an absence of holes is obtained. These special air-flow arrangements naturally tend to keep down the power required from the steam jets, and as a result a small jet only is necessary. The nozzles are of gunmetal with holes something less than 3-32 inch diameter. The holes are formed with a square shoulder near the entrant end with the result that considerable contraction is obtained, and a jet of considerably smaller diameter than the hole issues from the nozzle. To further economize the consumption in the jets the steam is superheated before being carried to them. This decreases the density and so decreases the quantity of steam used.

It is not necessary to say anything in great detail about the mechanical construction of the furnace, as its features are well shown in the illustrations. It may be stated, however, that the whole arrangement is self-contained and sits in the boiler flue without any drilling for bolts, or rivets, being necessary. As will be seen, front and back castings are provided on which the air troughs hang. The troughs are of uniform width, and in the cases of flues of greater, or less, diameter, more, or fewer, troughs are fitted. The fire-bars are comparatively small castings, and each holds the one immediately behind it in place. A special locking bar is used at the front end. The superheater is a simple U-tube arrangement fixed in the flue to one side of the boiler. Its position together with the run of the steam connections to the jets are clearly shown in Fig. 3. In many Lancashire boilers no great degree of superheat will be obtained with this arrangement, but the steam will be dried and its density lowered, which is the object aimed at.

A further point which should be mentioned is that the grate is set somewhat lower than is usual. The dead plate at the front of the furnace has a downward slope to allow of this. The idea of this arrangement is to increase the combus-



TURBINE FURNACE IN COCHRANE BOILER

tion space. Other details are the two firebrick bridges and the cleaning door operated by a chain, all of which are shown in the figures. In operation, the steam jets may, of course, be regulated to suit the fuel or the conditions of any natural draught arrangements which may be fitted. There is no tendency for the forced draught to return through the flue door, and this door may be opened at any time without the steam jets having to be attended to in any way. Owing to the form of the bars and the distribution of the draught very small fuel may be burned without choking of the bars. Very little ash makes its way through into the troughs, and what does can be removed without difficulty with a half-round scoop. An installation of the furnace applied to a Cochran boiler is illustrated in Figs. 5 to 8. These are of interest as showing the adaptability of the furnace, but it is not necessary to refer to them in detail as the arrangements are well shown in the figures.

This furnace was, we believe, introduced very shortly before the outbreak of the war, and from that time up to the present we understand some 600 equipments have been installed. This rapid advance during a period of difficulty may, no doubt, partly be explained by the ease with which the furnace may be installed and its adaptability to a wide range of fuels. In some cases an entirely satisfactory boiler plant has been dependent on supplies of a particular grade of coal. Such a state of affairs was a workable one before the war, but in the new conditions which have now arisen it has become necessary to burn fuels of poor quality or of widely differing grade, and a device such as the "Turbine" furnace is of great value. We may say that a boiler fitted with a "Turbine" furnace is employed by the Gas Light and Coke Company for the purpose of testing the steam-raising powers of various fuels. As an example of the operation of the furnace we may quote the results of a test taken by the General Electric Company, Limited, at Birmingham. The test was carried out on Galloway boilers, 28 feet long by 7 feet 6 inches diameter. An economizer was fitted, and there was a chimney 120 feet high. Midland slack of a calorific value of 9,076 British thermal units was burned. A comparative test with ordinary fire-bars and the "Turbine" furnace was made. The test extended over 6 hours and during that time the "Turbine" furnace burned 9,034 pounds of fuel against 6,272 pounds in the ordinary furnace. It evaporated 50,800 pounds of water against 25,800 pounds, giving a result of 4.34 pounds of water from and at 212 deg. F. for the ordinary furnace and 6 for the "Turbine" furnace.

A NEW COMPENSATED HEAT-METER

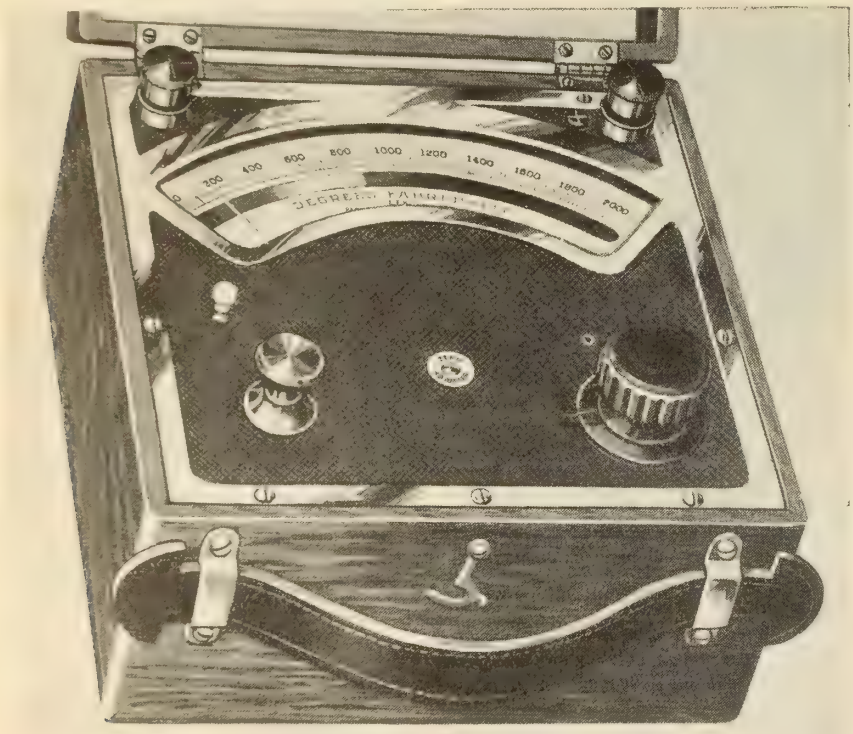
Until comparatively recently, the determination of furnace and kiln temperatures by means of thermocouples was attended with complications and difficulties which made practical men impatient, and in some instances doubtful in regard to the intrinsic value and reliability of the method.

Technical men, however, have realized from the beginning that, within certain temperature limitations, the results obtained by the use of thermocouples were not only accurate, but could be made "direct reading," provided that the thermocouple be connected with a galvanometer which would indicate the actual value of the e.m.f. obtained by heating.

On first consideration, this problem did not seem difficult of solution, since it is an established fact that the e.m.f. or voltage of a thermocouple bears a direct relation to the difference in temperature between its hot and cold ends. It is also true that the movable coil of a millivoltmeter will be deflected to an extent which is directly proportional to the e.m.f. of the thermocouple. Therefore it would seem the simplest operation imaginable to connect the thermocouple and the instrument together by means of insulated conductors, figure the scale in temperature values and regard the problem as solved.

Unfortunately, however, we have also to contend with factors which cannot be ignored if accurate results are required; namely, line resistance, thermocouple resistance, and the resistance of the indicator itself, because, to be pre-

cise, a direct current millivoltmeter actually is not a millivoltmeter at all, except in name, but is a milliameter or current indicator. All instruments of the d'Arsonval type depend primarily upon current for their operation and the extent of the deflection obtained with any given current is established by the intensity of the magnetic field, the controlling force of the springs, and the number of convolutions or ampere turns in the movable coil, and not by a remote e.m.f. Therefore, if the conductors which carry the current from the source of e.m.f. to the terminals of the instrument do not have a negligible resistance, then, in accordance with Ohms' law there will be an appreciable fall of potential along the line, with the result that the movable system will receive a diminished current and therefore



GENERAL VIEW OF THE HEATMETER.

be low in its readings. To reduce such errors to a minimum, it is desirable that the instrument resistance be as high as possible, so that the line and thermocouple resistant may be proportionately insignificant. For instance, if the resistance of the millivoltmeter is 300 ohms, and the resistance of the line (A) and thermocouple (C) is 3 ohms, the current through the circuit will be reduced ½ of 1 per cent. instead of 1 per cent., and the instrument indications will be 1 per cent. low. Figured in degrees Fahrenheit, this would mean an error of approximately 14 deg. in 1400 degs. Fahr. if a thermocouple were used.

The advantage of high-resistance instruments, therefore, becomes evident. For instance, if the pyrometer has a resistance of 600 instead of 300 ohms, and the line resistance remains the same, an error of 3 parts in 600 will result or only ½ of 1 per sent. instead of 1 per cent., or about 7 deg. Fahr. in 1400 deg. Fahr.

Until within the last five years it was customary to use a so-called low resistance pyrometer to measure the current from the thermocouple. These instruments had from 2 to 5 ohms internal resistance and were naturally materially affected by the external resistance of the thermocouple and leads. In the past few years high-resistance pyrometers have been almost universally adopted. These instruments have an internal resistance of usually from 300 to 1200 ohms. The higher the resistance naturally the less effect on the readings due to variations in line resistance, but will increase in internal resistance; something has to be sacrificed, and usually control or torque is weakened. In consequence, the instrument is not as substantial or dead-beat, and, due to the use of lighter springs is more apt to be affected by spring fatigue.

It has been found by trial that an instrument of medium resistance (about 500 ohms) can be produced in a satisfactory and substantial form, but an instrument of this class is necessarily affected in its indications when leads of considerable length are employed. Material variations in the length of thermocouples are also a source of error, as well as the introduction of compensating leads. When compensating leads are employed, as well as long wires, in connecting the thermocouple with the instrument, it is a common practice to reduce the resistance of the instrument in order to offset the effect of line resistance. This is at best a method of doubtful value, since it interferes with checking the scale by comparison with a standard, and does not compensate for changes in the resistance of the line or thermocouple, due to variations in temperature.

Various devices and attachments have been made for use in connection with indicating and recording millivoltmeters and pyrometers, by means of which the instruments will remain direct reading, and at the same time be compensated for external or line resistance. Inventions of this class range all the way from a simple step rheostat connected in series with the "dead" resistor of the instrument, to the elaborate and complicated apparatus employing the substitution and deflection methods, the potential of the thermocouple being first balanced against another potential derived from a dry cell, and after an intermediate operation and on intercomparison of deflections, the effect of line resistance is finally balanced out by means of a rheostat, and direct deflections are obtained from the thermocouple current.

It remained for two physicians, Paul D. Foote and T. R. Harrison, of the Bureau of Standards, Washington, to offer an invention of theirs, which, incorporated in a Brown pyrometer, eliminates the effect of line and thermocouple resistance by means of an operation which is so simple that anybody can use the instrument and obtain accurate results.

This improved heatmeter will unquestionably appeal to the practical man who wants results and does not care especially how the instrument functions provided its indications can be relied upon.

In testing with this apparatus all that is necessary is to connect the thermocouple with the instrument binding posts in the usual manner, press a button, turn a knob, and take a reading, which will be the correct e.m.f. of the thermocouple at its hot end, even if the line is miles in length. In fact the line may have as much as 15 ohms resistance. The Brown Instrument Company, Philadelphia, are the manufacturers of this equipment, and the accompanying illustration shows one form of the complete instrument. As will be seen, the accessory details incorporated into the instrument do not decrease its portability and convenience nor increase its size.

AN ANCIENT STEAM ENGINE

The closing up of an old dry dock at West Harbor, Greenock, brings into prominence the old pumping engine, which has been in use for the past 135 years, and is still in good working order. The graving dock was built by James Watt in 1785, and the engine was also built by him, and has been there ever since. The engine is fitted with the Watt governor for controlling speed by opening and closing the throttle, differing but slightly in design and nothing in principle from the throttle governors used today. The fact that Watt built the dock brings back to memory the fact that he was a civil engineer, and in that capacity built the first dry dock in Scotland, at Port Glasgow, in 1762, and the dock is still in use.

The Operators' Point of View

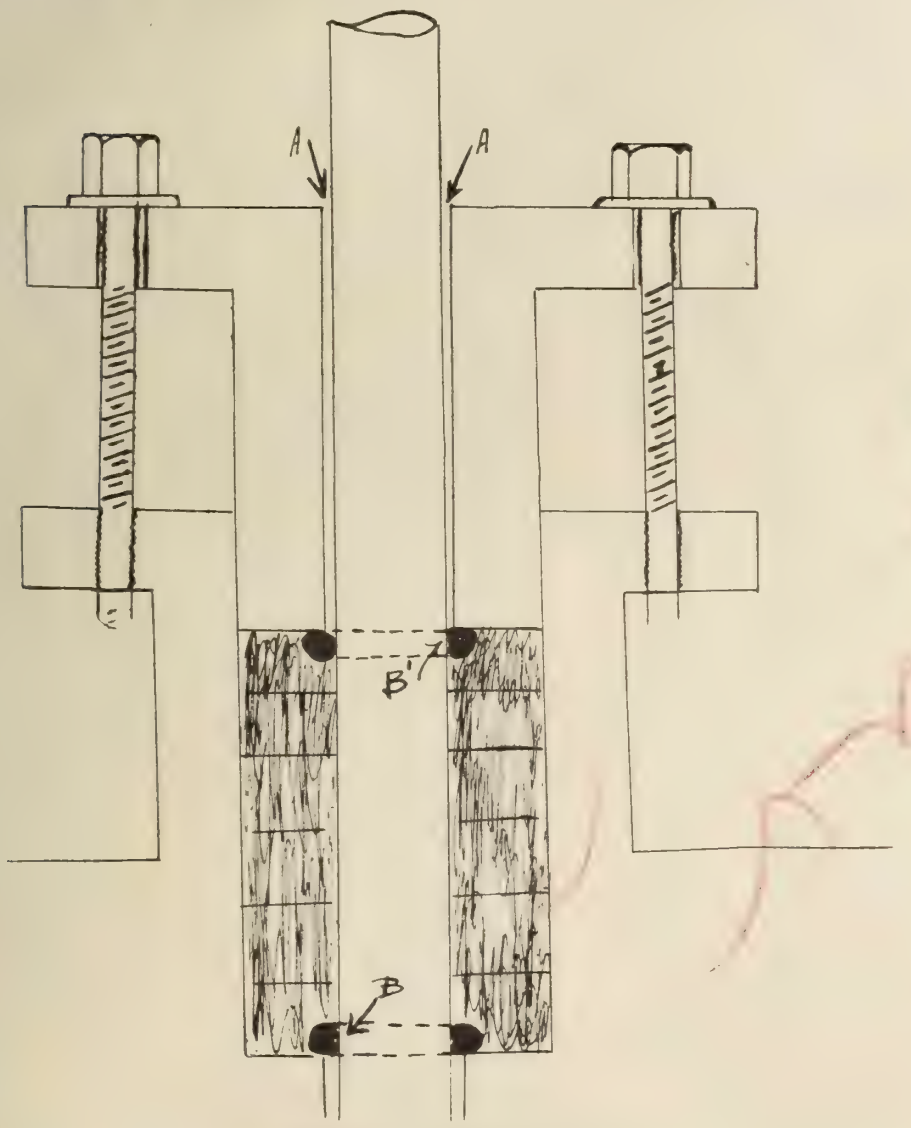
FOR WORN RODS

It is a common trouble for a rod to become worn, also the packing follower and the bottom hole in the packing box may be enlarged to a diameter greater than the rod. When these things come to pass much trouble is made. The packing around the rod becomes worn and steam or water finds its way through, making it necessary to be continually tightening up on the follower nuts. Numerous remedies have been suggested, most of them having good points.

If the rods are small, such as valve rods on the average power plant duplex feed pumps, the trouble can be practically eliminated by forming a ring around the valve rod, with ordinary wire solder, such as electricians use, allow it to be on the bottom of the box, fill the box with packing and use another ring at the top as BB in the sketch.

If the rod is of larger diameter and rapid moving, something more substantial must be used. Nothing is better than a pair of rings made from soft copper solid cable. The rings can be formed on the rod, using a piece of wood to knock them into shape. Experience would seem to teach that such circular rings work out better than flat rings.

JOHN JAMES.



MAKING UP WORM NECK BUSH

HEIGHT HOT WATER CAN BE LIFTED

By C. C. Warren

(Copyright. All rights reserved)

Hot water cannot be lifted to the same heights as can cold water. In drawing boiler-feed water from a hot well, the boiler-feed pump may be required to "suck" or lift the water to the location where the pump is situated. For each temperature of feed water there is a maximum height to which it can be thus lifted. Water at ordinary temperatures can be lifted a distance of from 32 to 33 feet. (Theoretically, the maximum lift distance at the sea level is 33 1-3 feet.) If an endeavor is made to lift the cold water farther than the heights just specified a vacuum is established and the water cannot be raised. In practice, because of leaks, imperfect pumps, imperfect valves, pipe friction and other conditions, the possible lift for cold water is usually much less than 30 feet. Under ordinary working conditions the greatest possible cold-water lift is usually assumed to be about 20 feet. But if the water is hot it vaporizes readily when suction is applied. This limits the possible lift. It is customary to so arrange the feed pump that the water will, where the temperature exceeds 120 deg., flow into it by gravity.

Following is a table indicating the maximum theoretical lifts at various temperatures. Actually, the heights of lift indicated can not be attained. The decrease will be determined by pipe friction, leakage and similar effects. In practice, lift values of from possibly 60 to 75 per cent. of those tabulated may be effected.

Temperature of Hot-Well Water Degrees Fahr.	Lift Theoretically Possible in Feet.
40	33.6
50	33.5
60	33.4
70	33.1
80	32.8
90	32.4
100	31.9
110	31.3
120	30.3
130	29.2
140	27.8
150	25.4
160	23.5
170	20.3
180	16.7
190	12.8
200	7.6
210	1.3

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	30 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$6 50	$7 00
Plates, ¼-in. up	6 00	6 60

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	5.31	7.41	5.91	8.01
⅜	5.31	7.41	5.91	8.01
½	7.10	8.63	7.95	9.48
¾	8.80	10.87	9.95	12.02
1	13.01	16.07	14.71	17.77
1¼	17.60	21.74	19.90	24.04
1½	21.04	25.99	23.79	28.74
2	28.31	34.97	32.01	38.67
2½	44.75	55.28	....	....
3	58.52	72.29	....	....
3½	74.06	90.62	....	....
4	87.75	107.37	....	....

Standard Lapweld Pipe

Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$32.01	$38.67	$35.71	$42.37
2½	48.26	58.79	54.11	64.64
3	63.11	76.88	70.76	84.53
3½	75.90	92.46	85.10	101.66
4	89.93	107.55	100.83	120.45
4½	1.05	1.29	1.30	1.54
5	1.22	1.50	1.52	1.80
6	1.58	1.95	1.97	2.33
7	2.06	2.53	2.53	3.01
8L	2.16	2.66	2.66	3.16
8	2.49	3.07	3.07	3.64
9	2.98	3.67	3.67	4.36
10L	2.77	3.41	3.41	4.05
10	3.56	4.39	4.39	5.21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 30%.
4½-in. and larger, 10%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; unions, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 30c lb.; class C black, 20c lb.; galvanized, class B, 40c lb.; class C, 30c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	29½
Palacine	32½
Palacine	27½
Machine oil, per gal.	65
Black oil, per gal.	34
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	19

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	Net
Carriage bolts, 7/16 and up	+10%
Coach and lag screws	—15
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	+10
Machine bolts, ⅜-in. and less	+10
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 50
Nuts, hexagon, tapped	add 3 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 28½
Solder, guaranteed	0 30½
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	20 35
Red dry lead, 100-lb. kegs, cwt.	16 00
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	3 15
Linseed oil, raw, single bbls.	2 37
Linseed oil, boiled, single bbls.	2 40
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	4 00
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$35 00	$37 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	40 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	43 00	46 00
Copper sheet, planished, 16-oz. base	47 00	50 00
Braziers', in sheets, 6 x 4 base	39 00	42 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white	20
Dark colored	09
Mixed colored	10

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	35½
British Manila rope	28
New Zealand hemp	28
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS

Gross

	Mont.	Toronto
Tin	$45 00	$50 00
Spelter	8 75	10 00
Lead	7 75	9 00
Antimony	8 25	9 00
Aluminum	35 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

FAIRBANKS-MORSE

A National Institution of Mechanical Service

IN Canada, as in every country in the world, there are names which, through years of service, have warranted national confidence and good-will. In the Canadian world of mechanical and engineering efficiency there is one name which enjoys the distinction of leadership. Its prestige carries through the entire coast-to-coast chain of sales offices and warehouses into every city, town, and hamlet.

Fairbanks-Morse products mark the farmer, the manufacturer, the artisan, and all users as careful and practical buyers of mechanical goods. The Fairbanks-Morse 100% quality seal is the buying guide for the consumer—the guarantee of satisfaction.

The Canadian Fairbanks-Morse general catalogue is a reference of what is standard in design and practice in mechanical goods. This book lists the largest variety of scales, valves, steam goods, oil engines, pumps, electrical machinery, machine tools, woodworking machinery, transmission appliances, railway contractor's and machine shop supplies ever published in Canada in one book. Your copy will be sent on request.

The Canadian Fairbanks-Morse Co., Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, St. Catharines, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Vancouver, Victoria. 1

Canada's Departmental House for Mechanical Goods

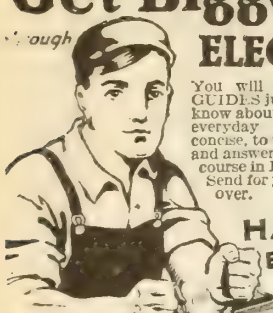
READER'S NOTICE

Regarding

CHANGE OF ADDRESS

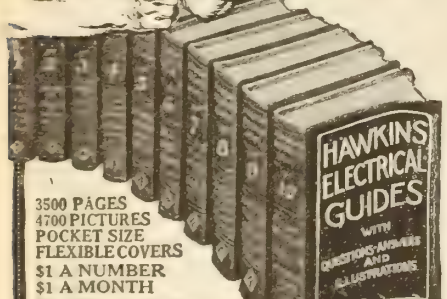
A REQUEST FOR CHANGE OF ADDRESS must reach us at least thirty days before the date of the issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered through failure to send this advance notice. Be sure to give your old address as well as the new one.

Get Bigger Pay in ELECTRICITY



You will find in HAWKINS GUIDES just what you need to know about electricity. In simple everyday language—complete, concise, to the point. In questions and answers. A complete standard course in Electrical Engineering. Send for your set today to look over.

HAWKINS ELECTRICAL GUIDES



3500 PAGES
4700 PICTURES
POCKET SIZE
FLEXIBLE COVERS
$1 A NUMBER
$1 A MONTH

Magnetism—Induction—Experiments—Dynamos—Electric Machinery—Motors—Armatures—Armature Windings—Installing of Dynamos—Electrical Instrument Testing—Practical Management of Dynamos and Motors—Distribution Systems—Wiring—Wiring Diagrams—Sign Flashers—Storage Batteries—Principles of Alternating Currents and Alternators—Alternating Current Motors—Transformers—Converters—Rectifiers—Alternating Current Systems—Circuit Breakers—Measuring Instruments—Switch Boards—Power Stations—Installing—Telephone—Telegraph—Wireless—Bells—Lighting—Railways. Also many modern Practical Applications of Electricity and Ready Reference Index of the 10 numbers.

Shipped to you FREE. Not a cent to pay until you see the books. No obligation to buy unless you are satisfied. Send coupon now—today—and get this great help library and see if it is not worth $100 to you—you pay $1.00 a month for 10 months or return it.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N. Y. Please submit for examination Hawkins Electrical Guides (Price $1 each). Ship at once, prepaid, the 10 numbers, if satisfactory, I agree to send you $1 each seven days and to further mail you $1 each month until paid.

Signature _____

Occupation _____

Employed by _____

Residence _____

Reference _____

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

GOOD INVENTIONS

ENCLOSED LIQUID FUEL COMBUSTION APparatus capable of generating intense heat in pipes and confined passages for heating parts of internal combustion engines and for other uses; spark ignited; blower operated. Patented October 8th, 1918. Can be inspected at and for sale by H. W. Petrie, Limited, 131 Front St. W., Toronto.

EMPLOYMENT DESIRED

STATIONARY ENGINEER, SECOND-CLASS, requires position; thoroughly experienced with water-tube and return tubular boilers, Corliss and all classes of stationary engines compressors, electric motors and generators; heating systems and hydraulic. Apply, mentioning "Power House," to No. 67062, A. Wright, 298 Bathurst St.

MACHINIST—WITH DRAUGHTING EXPERIence, wants work of any kind. N. Ryckman, No. 174372, 5 Foxley St. Phone Parkdale 3254w. Mention "Power House."

ENGINEER—SEEKS POSITION. ALL ROUND steam and motor experience; British Board of Trade certificate. Apply, mentioning "Power House," to Herdman, 9 Tecumseh St., Brantford, Ont.

RETURNED SOLDIER — EXPERIENCED painter, electrician and elevator operator, or other suitable employment; desires work at once. Apply mentioning "Power House," to Pte. (163466) Ira Charles Winckler, 83 Carlton St., Toronto.

RETURNED SOLDIER WANTS WORK—ANY kind; used to steam heat boilers. Apply, mentioning "Power House," to W. Greenfield (33065), 34 Brock Ave., Toronto.

RETURNED SOLDIER. CHAUFFEUR-MECHanic, must have work. Truck preferred. Reliable, steady, married. Reference. J. Koster, No. 195289. Phone Park. 7758. Mention "Power House."

BELTING

4½—4-PLY NEW CANVAS STITCHED BELTing at 30 cents per foot. We carry a complete stock of belting, pulleys and mill supplies. Apply, mentioning "Power House," to N. Smith, 138 York St., Toronto.

LEATHER AND RUBBER BELTING, USED, but in good condition; at about half new price. Apply, mentioning "Power House," to Tarshis & Sons, 400 Front St. East, Toronto.

WE HAVE A QUANTITY OF NEW RUBBER belting to sell at less than half price; will ship C.O.D., subject to inspection; new circular saws, good second-hand leather and rubber belting, wire cable, vises, chain blocks, garden hose, steam hose, rubber packing; send us your requirements; our quotations will surprise. Apply, mentioning "Power House," to The York Belting Co., 115 York St., Toronto, Ont.

SITUATIONS VACANT

WANTED—A1 GENERAL BLACKSMITH FAMiliar with mine and mill work; permanent position. Apply, mentioning "Power House," stating experience and wages wanted, to Moose Mountain, Ltd., Sellwood, Ont.

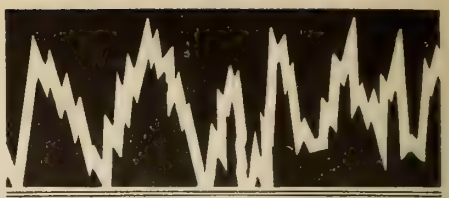
EQUIPMENT

THE JOHN INGLIS CO., LTD., ENGINEERS and boilermakers. Write us for prices. 14 Strachan Ave., Toronto. Mention "Power House."

WE BUY IDLE EQUIPMENT OR MACHINery; call or write. Apply, mentioning "Power House," to H. W. Petrie, Ltd., Toronto.

GRATE BARS

ALL STYLES TO ORDER—PROMPT DELIVery. The E. T. Lansdowne Foundry Co., 37 Niagara St., Toronto. Mention "Power House."



A Regulator that REGULATES!

If you could actually *see* the temperature fluctuations that take place with many so-called regulators, the result would be similar to the zig-zag lines shown above. This is not temperature regulation! But when you consider the complicated construction of the average regulator, and that it operates by such uncertain mediums as water, compressed air or electricity, the wonder is that the variations are not even greater.

SARCO

Temperature Regulator

has no complex mechanisms or other unreliable factors. Its very simplicity insures positive operation.

It is entirely self-contained and self-operated. Requires no outside force such as air compressors, water supply or electricity. Has no leather or rubber diaphragms or other perishable parts.

Its positive and dependable action makes Sarco the favorite regulator for delicate manufacturing processes, as well as for room control. Suitable for operating steam, water and gas valves.

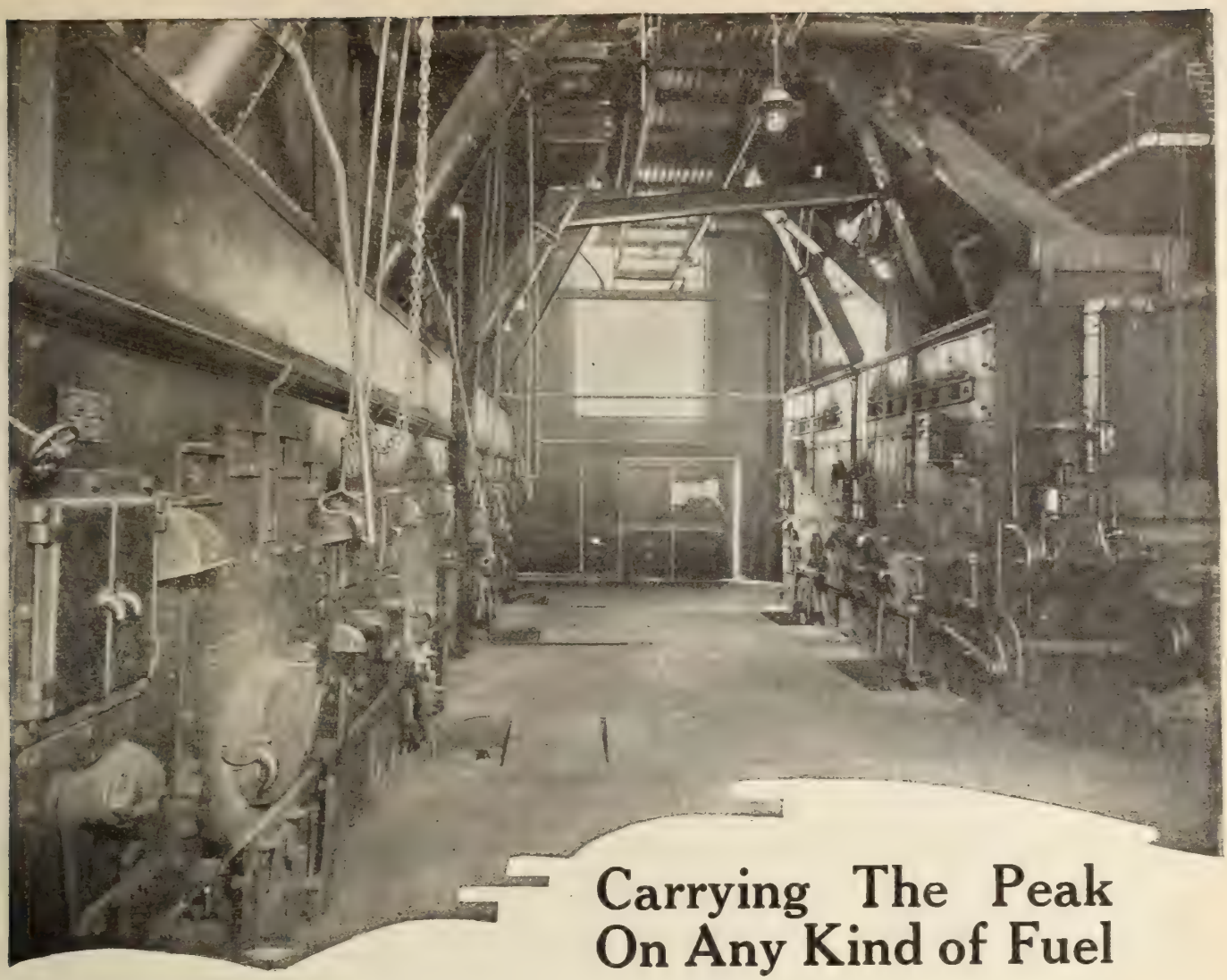
Costs less than others to start with and less to install. Costs nothing for upkeep.

Sold on 30 days' trial with the privilege of return if you are not satisfied. Write nearest branch for Booklet J-52.

SARCO CO., INC.

239 Broadway, New York

Buffalo Philadelphia
Chicago Detroit



Carrying The Peak On Any Kind of Fuel

A difficult Problem was solved at the Spicer Mfg. Corp., South Plainfield, N.J.

Four boilers can easily carry heavy overloads and maintain the steam pressure at 175 lb. gauge regardless whether bituminous, straight anthracite or a mixture is being burned by their six

DETROIT "V" Type STOKERS

Four of these stokers (at the left) were installed under the 150 horsepower boilers in 1916. Their satisfactory performance in burning the poor quality coals available at that time, resulted in a repeat order for two additional Detroit Stokers (at the right) with Detrick Flat arches for the 300 horsepower boilers that were installed in 1918. The plant was designed by Henry R. Kent & Co., Engineers of New York City.

Detroit "V" type Stokers save coal and labor. They will burn low quality coals smokelessly on natural draft up to 200% boiler rating. Constantly increasing repeat orders are indisputable evidence of satisfactory performance under widely varying operating conditions.

Consultation with our engineers regarding your specific combustion requirements is invited. Catalog "P" gives full details. Write.

Detroit Stoker Company

Detroit, Mich.

BRANCHES:

Chicago	Cincinnati	Pittsburgh	Philadelphia
Cleveland	New York	Atlanta	Boston

SAVE COAL

Republic

CO_2 RECORDERS

Less Worry—Less Expense

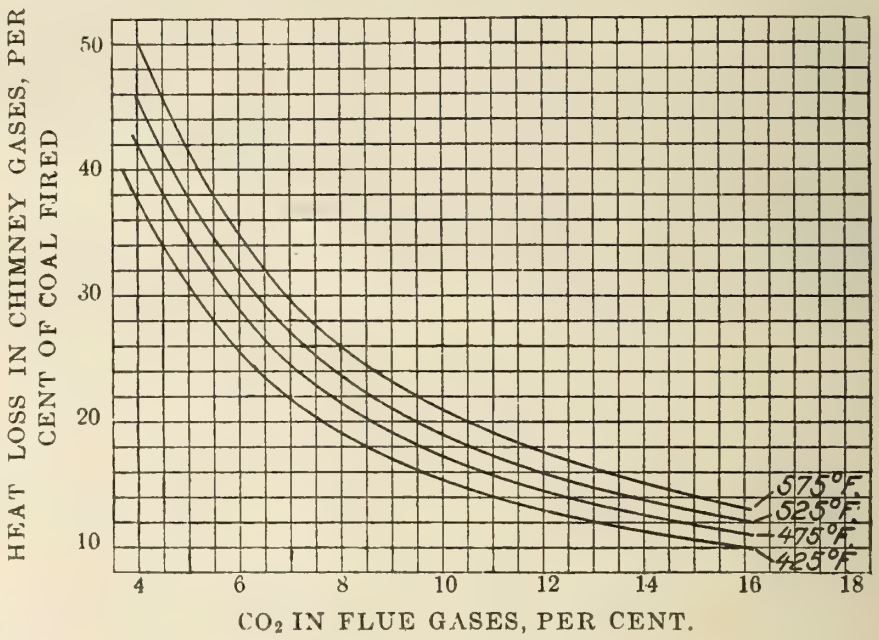
HAVING the CO_2 Recorder as a guide, the fireman or operator realizes that it is less work and worry to produce a given amount of steam with a good fire than with a poor one. Since it is always necessary to produce the required amount of steam for operation, he will welcome the possibility to produce the necessary amount of steam with the least possible amount of energy and **expense.**

The **Republic** CO_2 Recorder has been developed to operate continuously under all boiler room conditions. This enables the operator to observe the conditions of combustion at all times and to obtain the **highest efficiency** from his furnace.

THE chart shown here demonstrates the relation between the percentage of CO_2 in the flue gases and the heat losses through the smoke stack, showing the importance of observing and recording the CO_2 contents in the flue gases.

These curves were prepared by the Bureau of Mines at Washington, and we believe that they are absolutely reliable; the most up-to-date and exhaustive that it is possible to find.

By a reference to this chart it will be seen how the reduction of CO_2 shows the tremendous wastes that are going on in every plant to-day.



What is your percentage of CO_2? If you do not know, then you should know. If you do know, then refer to this chart, find out what your percentage of waste is, and the result, we feel sure, will be that the average CO_2 carried in your plant will be increased at once.

Aside from its other advantages, the fuel you can save with a Republic CO_2 Recorder should decide you to at once investigate its possibilities in your plant. Let us get together on this question!

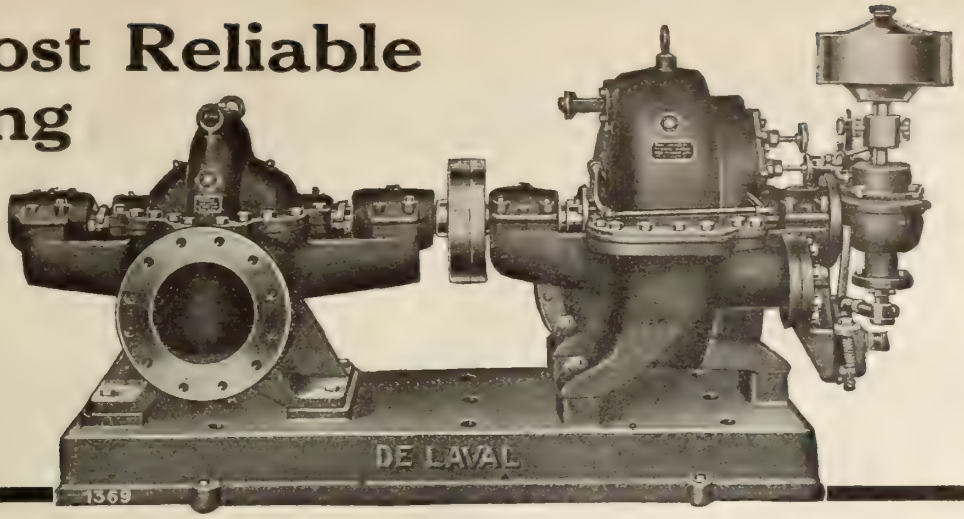
Republic Flow Meters Company of Canada, Limited

Eastern Representative:
The Mason Regulator & Engineering Co., Limited
185 Dagenais St., MONTREAL

Republic System

145 Wellington Street West
TORONTO

The Most Reliable Pumping Unit



THE De Laval centrifugal pump driven by the De Laval steam turbine represents the simplest, most reliable, and most economical method for handling liquids. There are no valves and no rubbing surfaces, except the bearings, which are automatically oiled. All internal working parts are accessible upon lifting the casing covers, and without disconnecting piping. The unit occupies only a small fraction of the space taken by a reciprocating pump, and requires only light foundations. Little attention is required further than to see that the oil wells are kept filled. The exhaust steam is free of oil and can be used for heating or industrial purposes.

If you are interested in pumping apparatus, ask for our new Bulletin B-100

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LTD., 73 King St. W., Toronto
THE E. LAURIE COMPANY 243 Bleury St., Montreal, Que.
TAYLOR ENGINEERING COMPANY, LTD. Vancouver, B.C.

133

This Engineer Gets Value from "Power House" advertisements

"I read the advertisements regularly and to me their instructive value is ahead of any magazine of the same class I have ever read. POWER HOUSE is many miles in advance of other papers that I am a subscriber to at present.

TELL THE OTHER FELLOW!

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co

27 COTE ST MONTREAL, CAN.

H. W. Petrie, Ltd.

New and Used
Power Plant Equipment

Steel Tanks
Any Capacity, Any Purpose
Automatic Engines
Up to 450 H.P.
Steam Engines
Slide Valve, High and Slow Speed Types
Vertical Engines

For half a century the reputation of the House of Petrie has been growing among the buyers of Power Plant Equipment throughout Canada. Now the name of Petrie is synonymous with **quality** and **service.**

Test Petrie service on rush shipments!

H. W. PETRIE, LTD.
Toronto and Hamilton.

What Will Santa Claus Bring Our Politicians ?

"SANTA'S POLITICAL STOCKING" is the title of J. K. Munro's feature article in MACLEAN'S December 15th issue. Mr. Munro thinks old Kris Kringle should bring Premier Meighen a "cap that will pull down over his ears, so that he can't hear what his Cabinet colleagues are saying about him"; a hobby horse for Crerar; a tin sword for Ballantyne; a "white plume" for Lapointe; a case of grape juice for Rowell, and a pair of long trousers for Mackenzie King.

Mr. Munro also sizes up the East Elgin farmers' victory, and lets you know its real significance.

Dr. Wilfred T. Grenfell, C.M.G.

THE famous physician of Labrador has contributed a striking piece of graphic fact-fiction for the Christmas issue—"Deeds of 'Derring Do'." which describes the brave fight waged by Skipper Loveday, his crew and wife—in the dismantled Silver Queen. They expected to find a watery grave that Christmas week, but the wife's dauntless spirit put so much courage into the men that they won a fearful fight against the December gales.

Christmas Issue of Maclean's, December 15th

"THE EMANCIPATION OF POLLY MacCRAE"
By F. B. M. Collier.
The so-human story of two spinster sisters in Old Ontario and how the crippled one won a husband.

"THE JEST OF CIRCUMSTANCE"
By Gertrude Arnold.
Phyllis lands in a Canadian city, fresh from England, and there is no fiancé to meet her. The girl ultimately finds happiness just as the Christmas Carols commence—but how?

"OUR GOLDEN FLOOD ROARS EAST"
By Nicholas North.
Every few minutes a train loads up at one of our many mammoth grain elevators, taking our wheat to the seaboard.

"THE CITY OF PERIL"
By Arthur Stringer.
The largest instalment yet published of this sensational dramatic serial of Bolshevistic plotting in New York.

"—AND ALL POINTS NORTH."
By Nellie L. McClung.
A gripping story of the pioneer men and women of the Peace River country—many even out of the reach of railroads, telephones and doctors. Read what trained nurses are doing in the pioneer settlements.

"OF CHRISTMASES AND GOVERNORS"
By Colonel George Ham.
The "Colonel" has spent Christmas in some peculiar places. His experiences form the foundation of a great story. Also, Col. Ham tells of the human side of some of our Governors-General.

"WHO GETS OUR PAPER PROFITS?"
By Agnes C. Laut.
The real facts of our paper, pulp and sulphite products, and some information as to where the biggest slices of the melon go.

"THE YULETIDE GLOW"
By Charles Christopher Jenkins.
What converts Scrooges into human beings, 'round about December each year? Get in a crowd with "Jenk" and you'll find out.

"BUTTERED SIDE UP"
By C. W. Stephens.
The hero of this story loses his job a few days before Christmas. But he doesn't lose the girl, and lands a real job Christmas Eve.

"ORATORS I HAVE ENJOYED"
By "Margot" Asquith.
The wife of the ex-Premier tells what she thinks of Lloyd-George, as an orator, and others.

Review of Reviews Section

"The War Spirit in the World"—By Sisley Huddleston.
"The Irresistible Thing"—By Sir Gilbert Parker.
"German Universities Hard Up"—By Allen W. Porterfield.
"The Bleeding Statues of Tipperary"—By Edwin E. Slosson.
"A Modern Burton"—By Charles A. Merrill.
"Lansdowne's Memories"—By Marquis of Lansdowne, K.G.
"Flesh and Blood Inspired Barrie"—By William de Wagstaffe.
"Doctors Dupes of Fashion?"—London Lancet.

SECURE YOUR COPY EARLY---THE SUPPLY IS LIMITED.

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

DECEMBER 15th ISSUE *On All News-stands* **20c**

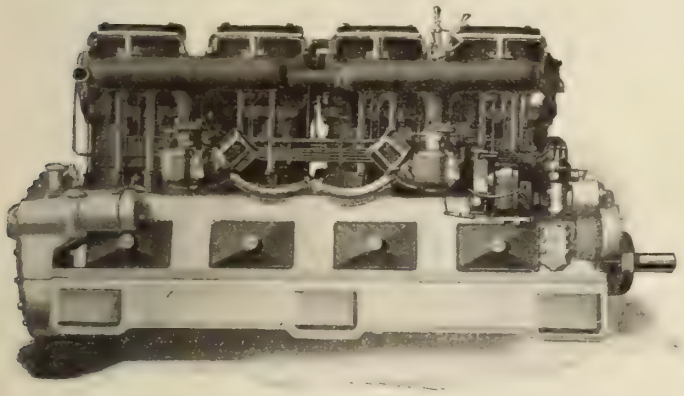
Or Send $3.00 for a Year's Subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto, Canada

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Save One Thousand Per Cent.!

If the average reserve power plant costs $200 per H.P. and you can buy a Sterling high-duty gasoline engine for $20 per H.P. ? ? ? Figure it yourself!

And the Sterling consumes no fuel while standing by.



Model GC 8 cylinder engine developing 300 H.P. at 1500 R.P.M., rated for continuous emergency duty at 200 H.P. at 1200 R.P.M., capable of turning dependably at the higher speed. List price, $4,750, F.O.B. Buffalo.

STERLING ENGINE CO. Buffalo, N.Y.
Dept. C-4

12 to 300 H.P. for emergency for driving centrifugal pumps and electric generators, speeds to 1500 R.P.M.

Gates Refractories
Limited

Furnace Linings

Special Shaped Firebricks

Contractors for
All kinds of Power Plant Brickwork and other Power Plant Refractory Work.
Estimates on All Jobs.

EXPERTS ON REPAIR WORK

Gates Refractories, Limited
382 St. James St. Montreal
Toronto Office: St. James Chambers, Church and Adelaide Sts.

WILLIAMS' SUPERIOR DROP-FORGED WRENCHES

Better tools make better workmen—

And you can't buy a better wrench than a Williams

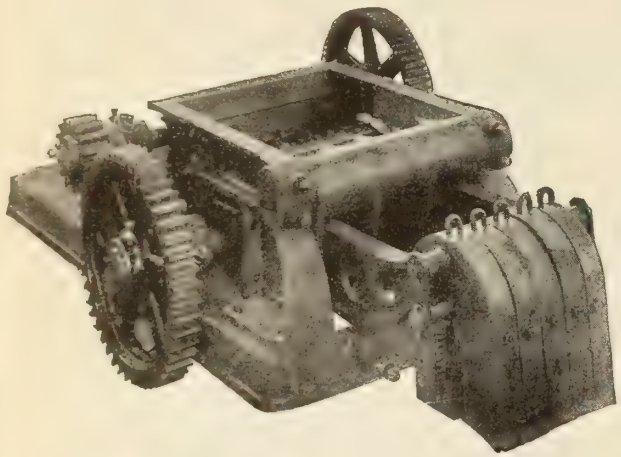
J. H. WILLIAMS & CO., LTD.
"The Wrench People"
Formerly the Canadian Branch of the Whitman & Barnes Mfg. Co.
78 Thorold Road St. Catharines, Ont.

"MEAD-MORRISON"

Single Roll

COAL CRUSHER

Made in Canada



Capacity Single Roll Crusher, 50 to 70 tons an hour.

Capacity Double Roll Crusher, 100 to 150 tons an hour.

McCASLIN CONVEYORS
GRAB BUCKETS
SKIP HOISTS
COAL HANDLING MACHINERY

Dependable Service

AGENTS:
Harvard Turnbull, Toronto.
Kelly Powell, Winnipeg.
Robert Hamilton, Vancouver.
Ferguson and Palmer, London, Eng.

CANADIAN MEAD-MORRISON CO
LIMITED
285 BEAVER HALL HILL
MONTREAL
WORKS WELLAND ONT.

Co-operation

NORWALK AIR & GAS COMPRESSORS

At the Norwalk plant tabulated record is kept of all standard and special compressor construction, so that it is possible to give patrons quick, accurate and complete co-operation when needed. When you require a part you can get it with minimum delay and expense. But you will not need any replacement until long after the time when you would ordinarily expect to make them. Norwalk design and quality take care of that.

We will send you Bulletins on Norwalk Compressors for air, oxygen, hydrogen, acetylene or carbonic acid gas if you will state which ones interest you.

THE NORWALK IRON WORKS CO.
Pioneer Builders of Compressors
South Norwalk -- Conn.

A. S. Leitch Company, Toronto
Canadian Sales Representative

QUALITY YORK SERVICE

York Uniflow Engines for Ice Making and Refrigerating Plants

One of the most important considerations in an Ice Making or Refrigerating Plant is the type of prime mover. An economical ice plant should have a dependable motive power, and one which will maintain a reasonable economy when called upon to operate over a range of from ¼ to 1¼ times the normal load.

It is well known among refrigerating engineers that the best compressor economy is obtained when evaporating pressures are carried as high, and condensing pressures as low, as possible. Even well balanced plants are forced to meet extreme seasonal conditions, with evaporating pressures varying from 20 to 30 pounds and condensing pressures from 85 to 225 pounds. These pressure variations and seasonal requirements of the Trade impose load factors of corresponding variation on the engine operating the compressor.

The Uniflow Steam Engine presents itself as the best solution of this difficulty

York Mfg. Co., York, Pa.

Canadian Representative:

Canadian Ice Machine Company

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.
CALGARY: 605 Second St.

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

With our wishes for Christmas Happiness and New Year Prosperity, we add a word of thanks to all DURABLA friends.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

The ANDERSON
PRESSURE OIL FILTER

THE high price of oil is serious; and yet fully 50 per cent. of the oil bought in this country is wasted—lost on wipers.

By placing drip-pans beneath the machinery and passing the oil thus collected through an Anderson Pressure Oil Filter, this waste can be practically eliminated.

The Anderson Filter cleanses and purifies the oil by a treatment identical to that of the refiners. It comes from the filter in a pure, clean state, fit for the finest bearings.

Write for fuller particulars of the Anderson Pressure Oil Filter.

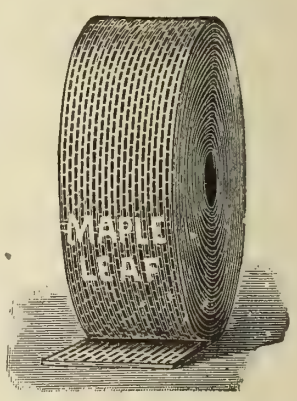
The V. D. Anderson Co.
1935 West 96th St., Cleveland, Ohio

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

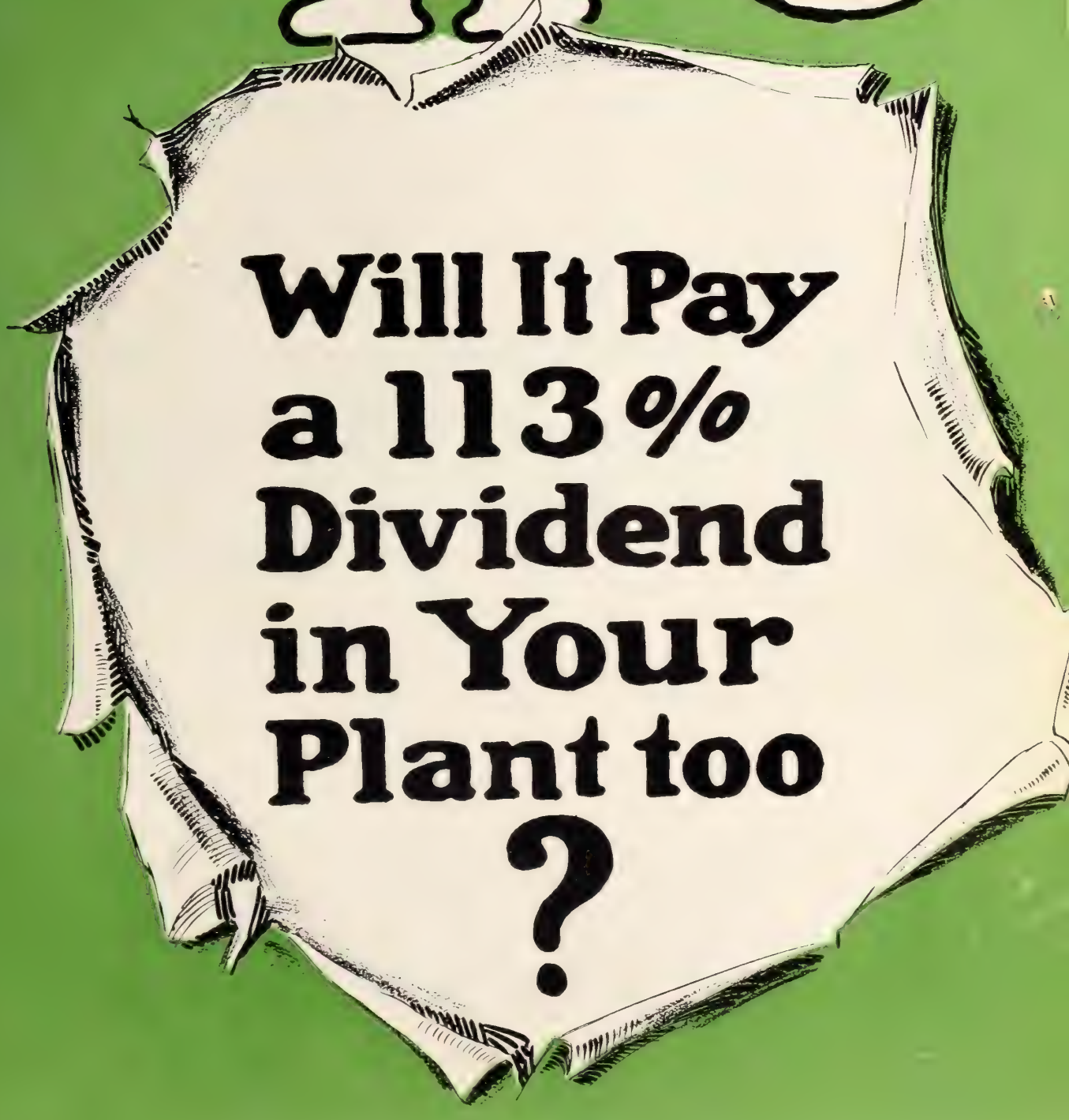
Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

Jones "A-C"



Will It Pay a 113% Dividend in Your Plant too ?

Is This

Hand Fired—

Labor: 5 men per shift	$ 18,000.00
Coal: 4½ tons per B.H.P.	121,500.00
*Annual Cost	$139,500.00

*Assuming a boiler plant consisting of six 250 H.P. boilers (a plant of average size) operated 24 hours a day, 300 days a year. One boiler held in reserve. Labor calculated at 50 cents per hour for the two 12 hour shifts. Coal estimated at $6.00 per ton.

There Is Only
Yet It Means an Annual

The two plants compared above would be alike but for one big exception —Jones Stokers.

The cost of installing Jones Stokers in the plant now hand fired would be $17,000.00—and the saving (repairs and depreciation liberally taken into consideration) would be $19,250.00 yearly.

Think of it, Canadian power users; 113% on the investment. What equipment can you install that will yield as great a return?

This vast economy is not the only advantage to be gained by Jones Stoker firing. There are many more that pay a separate dividend in increased production and **satisfaction.**

Your Plant?

Stoker Fired—

Labor: 3 men per shift	$ 10,800.00
Coal: (12% saving)	106,900.00
Depreciation: (10%) (a liberal estimate)	1,700.00
Repairs: (5%) (a liberal estimate)	850.00
†Annual Cost	$120,250.00
Annual *Saving*	19,250.00

†Assuming same plant capacity, fuel and labor costs as in hand fired plant with which comparison is made.

One Difference
Dividend *of* 113%

Boiler capacity is increased 50 to 100%. Increased load demands, sudden plant expansion, the call for quick steam and continuous operation will not necessitate an increase in the size of the boiler plant.

Such is the flexibility, the **reserve power** of Jones Stokers, "A-C" and "Standard."

And when the man with the shovel is replaced by Jones "A-C" Stokers, the engineer will know the feeling of security that comes from ability to burn every grade of coal—always the cheapest coal available—thereby making an additional saving, a saving not taken into consideration in the cost comparison above.

The next page outlines the comprehensive engineering service now placed at the disposal of Canadian plants.

An Engineering Service That Goes Beyond Mere Stoker Building

Designing and building a mechanical stoker is one thing—properly installing it another. Both are vital elements of stoker success.

The mechanical superiority of the Jones Stoker has been proved beyond question, but Jones engineering goes farther than merely building a super-stoker. The reorganization of this Canadian company permits following out the Jones standard of maintained service to a greater extent than ever before.

To the wealth of experience gained in installing the Jones Stoker in hundreds of prominent Canadian plants, has been added the engineering resources of the Under-Feed Stoker Company of America. The new company offers a service that begins when plans are taking shape and does not end when the stoker installation is completed.

Every Jones salesman is a trained engineer willing to make a survey of your firing problem and recommend a solution—without implying any obligation.

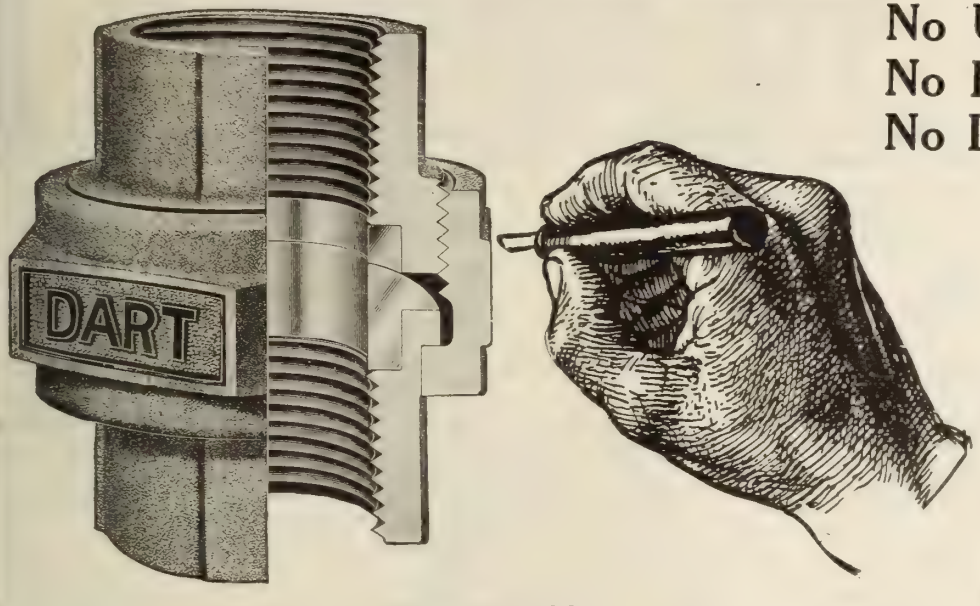
Have You Read the Catalogs Describing Jones "A-C" and "Standard" Stokers?

Under-Feed Stoker Company

of Canada, Limited

81 VICTORIA ST., TORONTO

Bronze to Bronze
(Face to Face)



No Upkeep Cost
No Replacement Cost
No Loss From Leaks

No Deterioration Here

Make Your Next Order

DART UNIONS

They Are Really Economical and Trouble-proof

Manufactured by

Dart Union Co. Limited, Toronto

FOR REFRIGERATING EQUIPMENT

USE

P⊛H WROUGHT PIPE

GENUINE WROUGHT IRON ∴ STEEL
LAPWELD ∴ BUTTWELD

SPECIAL REDRAWN PIPE for AMMONIA PURPOSES

WROUGHT PIPE BENDS
ALL KINDS AND SIZES

FLANGED PIPE JOINTS
ALL TYPES

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office:
100 Church Street, TORONTO, Ont.

HINTS TO BUYERS

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

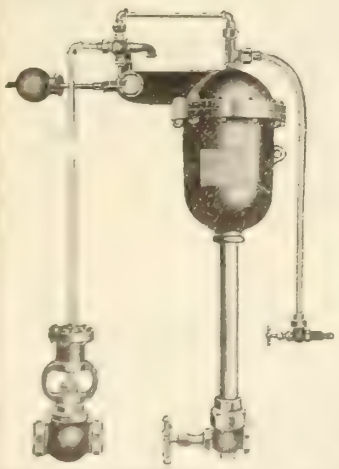
SCANDINAVIA BELTING

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

Tuck's Genuine Packings
Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.
Trial Orders Solicited—Our Packings Do the Rest
Insist Upon Having the TRADE CAOUTCHOC TRADE MARK Packing Bearing Our MARK
TUCK & COMPANY, LIMITED
London Liverpool Cardiff, Etc.
Canadian Representative:
Wm. J. Brown, 117 Youville Square - - - Montreal, Que.
Stocks carried in all sizes TEL. No. MAIN 2387

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE
THE E. S. MANNY Co
27 COTE ST MONTREAL, QUE



The Safe Way
Vigilant Water-Feed Regulators
There need be no worry on the part of you or your men in feeding boilers.
The "Vigilant" will automatically hold the water level at middle gauge—the safe, desirable point at which the boiler contains the maximum steam liberating surface.
Write for full particulars to-day?
The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.

CRANE MALLEABLE FITTINGS
CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST. PATRICK ST
MONTREAL
BRANCHES: Toronto, Winnipeg, Vancouver.
SALES OFFICES: Halifax, Quebec, Ottawa, Calgary.

Largest manufacturers of white metals in the world
Solder
Wire Solder
Ingot Metals
DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings
Lead Wool
Lead Sheets
Lead Traps
and Bends
HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

'Bishop's Adamant' Gauge Glasses

Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rod

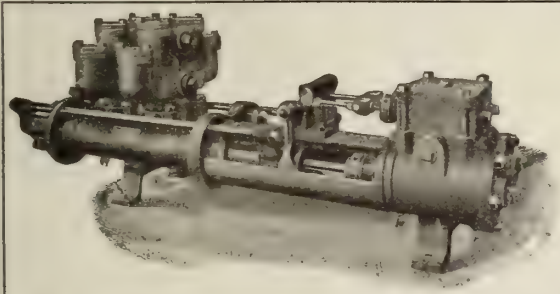
S. & C. BISHOP & CO., St. Helens, Lancashire.

LADD
WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

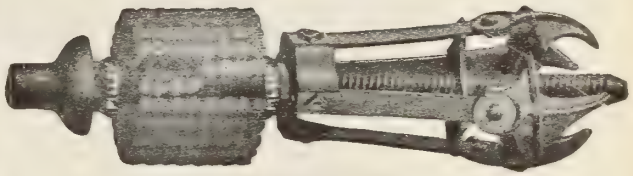
THE GEORGE T. LADD COMPANY
First National Bank Building
PITTSBURGH - - PENN., U.S.A.



PUMPS
that give
Better Service Longer Service

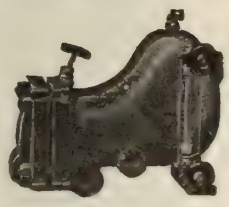
THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

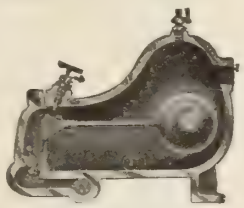


McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



Send for Catalogue

THE GARTH COMPANY
26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

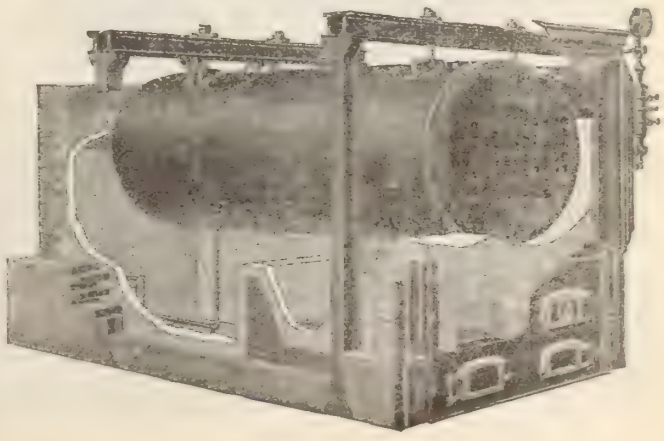
BUILD YOUR NEXT BOILER FURNACE LINING LIKE THIS

With Betson's Plastic Fire Brick it is easy for anyone, even without experience. No special forms or tools are necessary to lay up a one-piece, jointless furnace lining that is air and gas tight and free from the destructive effects of gases getting back of the fire brick lining, or expansion and contraction. No separate fire brick, tiles or blocks, and no clay mortar joints to give way.

Write for informing pamphlet.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6 - Rome, N.Y.

Canadian Distributor
International Chemical Co.
44-6 Lombard St., Toronto, Ontario, Canada



MONCRIEFF'S
"UNIFIC" GAUGE GLASSES

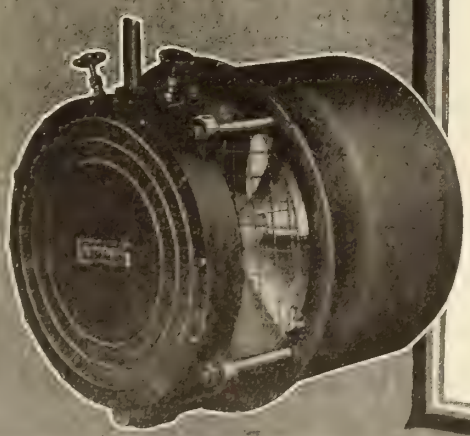
The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts. It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal

REGISTERED COPPUS U.S. PAT. OFFICE

In Public Buildings



Municipal engineers **demand** efficiency—and **insist** on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the **highest** standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save you money." Write for Blower Catalog.

"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal:
Mason Regulator & Eng. Co., 135 Dagenais Street
Agents for Vancouver:
Frank Darling & Co., Limited, 1142 Homer Street
Agents for Toronto:
Arthur S. Leitch Co., 1001 Kent Building
Agents for Calgary:
W. J. Yeo & Co., 413 McLean Block

COPPUS TURBO BLOWER

WEIR PRODUCTS

Single Acting Simplex Feed Pumps

Turbine Rotary Feed Pumps

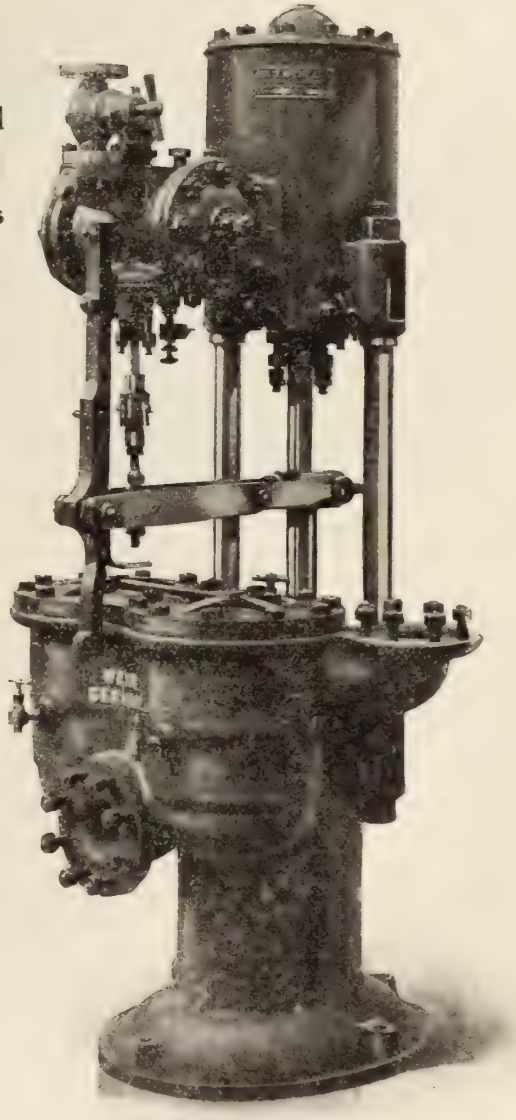
Compound Feed Pumps

General Service Pumps

Direct Contact Heaters

Multiflow Heaters

Evaporators and Distillers



Every Part Is Interchangeable

Weir Products are built to absolute standards. Were a part of any pump in Canada replaced by a part of any pump of the same type from anywhere else in the world the same highly efficient service would result.

Building all parts of Weir Products to absolute standards results in two great advantages: First—They give uniform results. Second—Repairs can be made promptly.

If you are considering the installation of power plant auxiliaries, write for full particulars of the various Weir Products in which you are interested.

G. & J. WEIR (CANADA) LIMITED

Sales Engineers

PEACOCK BROTHERS, LIMITED, MONTREAL

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Empire Mfg. Co., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIRCRAFT
Ministry of Munitions, London, England.

AIR COMPRESSORS
Holden Co., Ltd., The, Montreal.

AIR DRILLS
Holden Co., Ltd., The, Montreal.

AIR HOSE
Holden Co., Ltd., The, Montreal

AIR HOISTS
Holden Co., Ltd., The, Montreal.

AIR METERS
[illegible] Co.

AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

AMMONIA VALVES AND FITTINGS
Can Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

ARCHES, COMBUSTION CHAMBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal
Can. Mead-Morrison Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BALLCOCKS
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.
Mueller Mfg. Co., Ltd., The.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

BEARINGS
Lyman Tube & Supply Co., Ltd., Toronto.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Northern Electric Co., Ltd., Montreal.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. [illegible] Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell-Bar Boico Supply, Ltd., Toronto.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. General Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, LINK
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. MacLaren, Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

BOILER COMPOUNDS
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER FITTINGS
Empire Mfg. Co., London, Ont.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FITTINGS
Can. Steam Boiler Equipment Co., Toronto.
Crane Ltd., Montreal
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER MOUNTINGS
Sexton Boiler Setting Co., W. R., Toronto

BOILER HOUSE ACCESSORIES
Can. Steam Boiler Equip. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
Can. Steam Boiler Equip. Co., Toronto.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
International Chemical Co., Toronto, Ont.

BOILER FEED REGULATORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Northern Equipment Co.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Eng. Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER METERS
Bailey Meter Co.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Can. Mead-Morrison Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Eng. Co., Montreal.
Ministry of Munitions, London, England.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Gates Refractories, Ltd., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
Sexton Boiler Setting Co., W. R., Toronto

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., George W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERMAKERS' TOOLS
Holden Co., Limited, The, Montreal.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Ministry of Munitions, London, England.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

BOILER TUBE
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FINISHERS
Empire Mfg. Co., London, Ont.

BRASS FOUNDERS
Empire Mfg. Co., London, Ont.
McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALKING HAMMERS
Holden Co., Ltd., The, Montreal.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Standard Mach. & Supplies, Ltd., Montreal, P.Q.

CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont,
Jeffrey Mfg. Co., Montreal, Canada.
Lyman Tube & Supply Co., Ltd., Toronto.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.

CHAINS, SILENT
Morse Chain Co., Ithica, N.Y.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHEMICAL AND EXPLOSIVES
Ministry of Munitions, London, England.

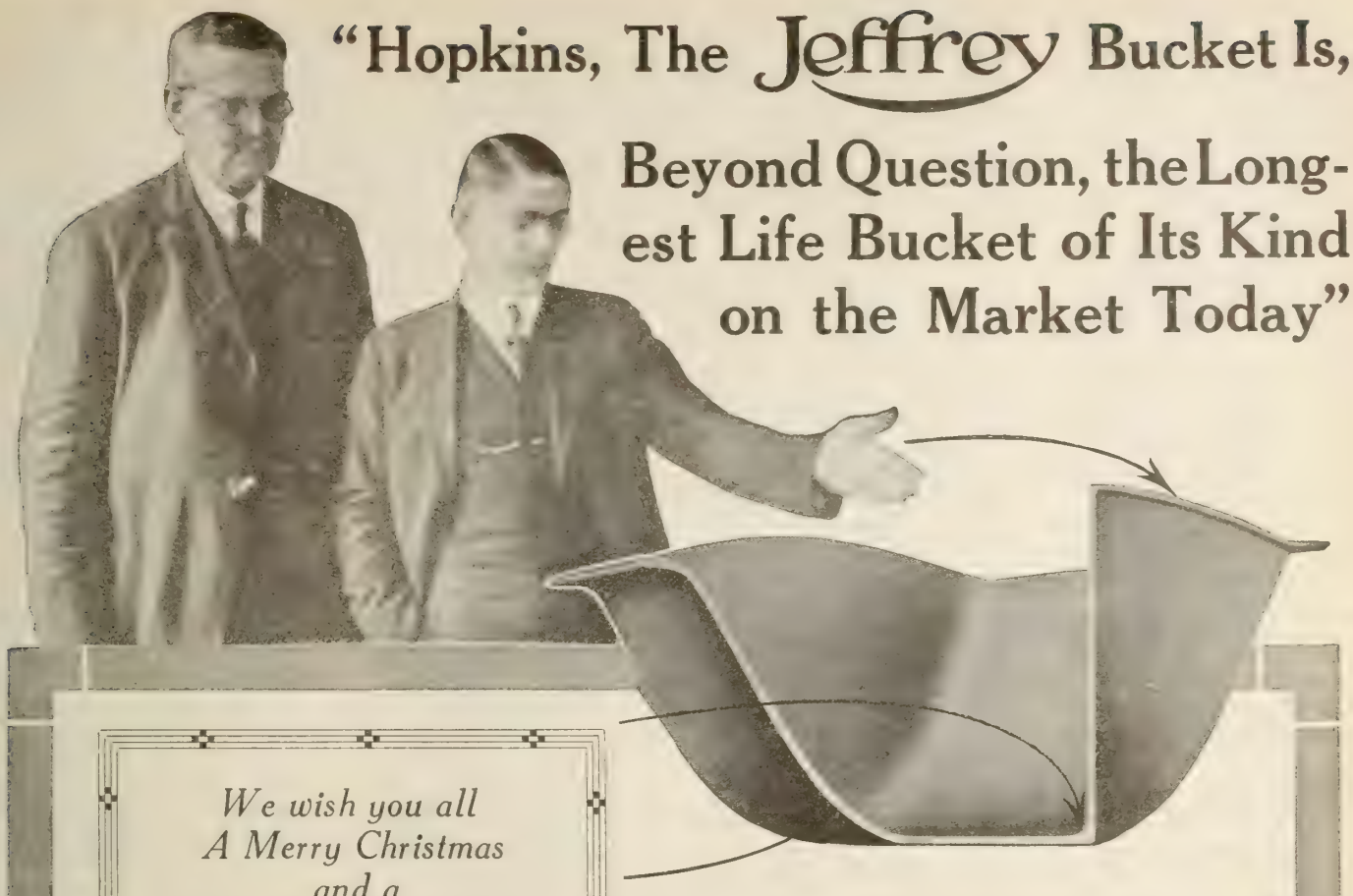
CHIMNEYS
Arthur S. Leitch Co., Toronto.

CHIMNEYS, RADIAL BRICK
Leitch Co., A. S., Toronto.

CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

"Hopkins, The Jeffrey Bucket Is, Beyond Question, the Longest Life Bucket of Its Kind on the Market Today"



We wish you all
A Merry Christmas
and a
Happy and Successful
New Year

"THE efficient bucket design of The Jeffrey Pivoted Bucket Carrier is one of the most important improvements that have been responsible for its remarkable success.

"The Bucket outline gives the greatest capacity for complete discharge of materials, with minimum shock to the conveyers as a whole, and with minimum wear to the Bucket's Hardened Tripping Cams.

"The bucket section plainly shows surfaces, edges and corners which have been re-inforced where long experience has dictated. You will notice too, that there are no obstructing rods running across the buckets."

Catalog No. 210-4 completely illustrates and describes the Jeffrey Carrier and features many important installations.

Let us send your copy.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd. Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Lyman Tube & Supply Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Holden Co., Limited, The, Montreal.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Norwalk Iron Works, South Norwalk, Con.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

COMPRESSORS, ACETYLENE
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, GAS
Norwalk Iron Works, South Norwalk, Con.

COMPRESSORS, CARBONIC ACID GAS
Norwalk Iron Works Co., South Norwalk, Con.

COMPRESSORS, ROTARY
Escher, Wyss Co., Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., George W., Toronto.

CONDENSATION (COMBINED)
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STORES
Ministry of Munitions, London, England.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Ministry of Munitions, London, England.

CONVERTERS, ROTARY
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, McCASLIN GRAVITY BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
J. C. Wilson Mfg. Co., Ltd., Belleville.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Holden Co., Limited, The, Montreal.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Jeffrey Mfg. Co., Montreal, Can.
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIAPHRAGMS, PUMP
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIESEL OIL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Mason Regulator & Eng. Co., Ltd., The, Montreal.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Can.

DRILLS, ELECTRIC
Holden Co., Limited, The, Montreal.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
Ministry of Munitions, London, England.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd, Toronto

ELECTRIC GRINDERS
Holden Co., Limited, The, Montreal.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Lincoln Electric Co. of Can., Ltd., Toronto

ELECTRIC TOOLS
Holden Co., Ltd., The, Montreal.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Can.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg Co., Montreal, Que.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Can. H. W. Johns-Manville Co., Toronto.
Cole, Ltd, Geo. W., Toronto
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Busch-Sulzer Bros., Diesel Engine Co., St. Louis, Miss.
Holden Co., Limited, The, Montreal.

ENGINES, DIESEL OIL
Busch-Sulzer Bros.—Diesel Engine Co., St. Louis, Mo.
Holden Co., Limited, The, Montreal.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co. The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, OIL, GAS AND STEAM
Holden Co., Ltd., The, Montreal.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
American District Steam Co., North Tonawanda, N.Y.
Direct Separator Co., Syracuse, N.Y.
B. B. Badger & Sons Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, Ltd., T., St. John, N.B.
Jas Morrison Brass Mfg. Co., Toronto.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

FERROUS AND NON-FERROUS METALS
Ministry of Munitions, London, England.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
E. J. Phillip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Ltd., Montreal.
Betson Plastic Fire Brick Co., Rome, N.Y.
International Chemical Co., Toronto, Ont.

FIRE BRICK MORTAR
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FOUNDRY WORK
Norwalk Iron Works Co., South Norwalk, Con.

Showing ease with which Plibrico is laid in place.

PLIBRICO SAVES COAL

by making your furnace air and gas-proof.
Plibrico can be installed by inexperienced labor. Plibrico also makes an excellent material for baffle construction and repairs.

A High Grade Refractory

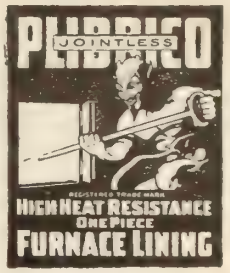
Shipped in steel containers only. Warehouse stock carried in principal cities for immediate shipment.

Write for book on furnace building.

Manufactured exclusively by

JOINTLESS FIRE BRICK CO.

Offices and Factory: 1130-1150 Clay St., Chicago, Ill.
Beveridge Paper Co. Ltd., Montreal. Shell Bar Boico Supply Co., Ltd., Toronto, Canadian Representatives.



Trade Mark
Reg. U.S. Pat. Office.

STATIONARY
120 to 3300 B.H.P.

MARINE
600 to 3000 SHAFT H.P.

BUSCH-SULZER DIESEL

AMERICAN DESIGNERS & BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER BROS.-DIESEL ENGINE CO.
ST. LOUIS, U.S.A.

NEW YORK
No 60 BROADWAY.

SAN FRANCISCO
RIALTO BUILDING.

Tycos

TEMPERATURE INSTRUMENTS
INDICATING • RECORDING • CONTROLLING

In hundreds of power plants Tycos instruments meet the ultimate test—unusual service. The strength and the mechanical worth of the instruments — the skilled advice given in their application all mean the satisfactory solution of extraordinary as well as ordinary temperature problems.

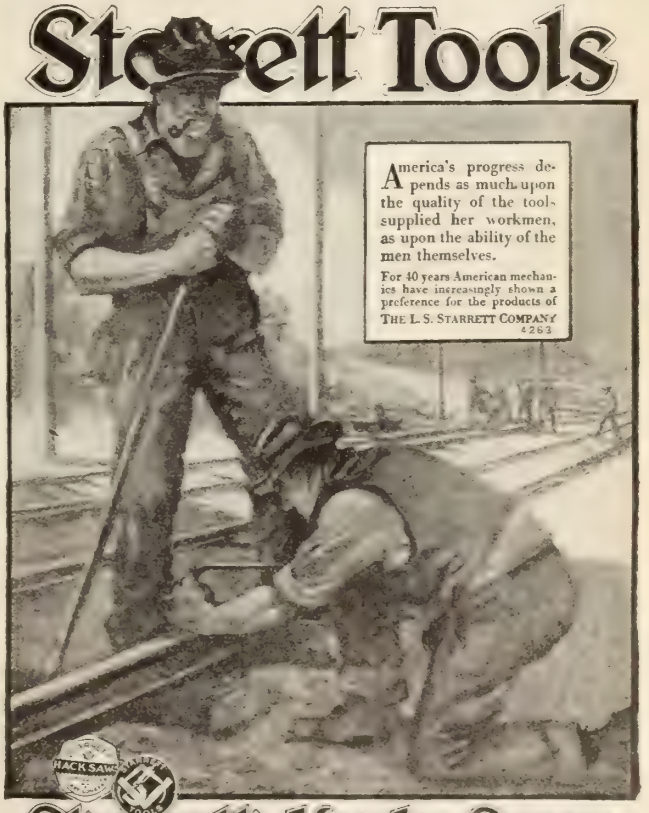
Angle and Straight Stem Thermometers
Indicating and Recording Thermometers
Hydrometers Hygrometers
Engraved Stem Thermometers
Temperature and Pressure Regulators Pyrometers
Vacuum, Pressure and U Gauges.

Let Tycos catalogs and Tycos engineers be your guides in temperature needs. Request literature and specific advice—no obligation.

Canadian Branch:
110-112 CHURCH STREET
TORONTO, ONT.

Taylor Instrument Companies
ROCHESTER, N.Y.
There's a Tycos or Taylor Thermometer for Every Purpose

Starrett Tools


America's progress depends as much upon the quality of the tools supplied her workmen, as upon the ability of the men themselves.
For 40 years American mechanics have increasingly shown a preference for the products of THE L. S. STARRETT COMPANY
4263
HACK SAW

Starrett Hack Saws

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, IRON PIPE, ENAMELWARE
Empire Mfg. Co., Ltd., London, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracurse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.

FLEXIBLE JOINTS
Holden Co., Limited, The, Montreal.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOOR LIGHTING, ELECTRIC
Holden Co., Limited, The, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

FLOW METERS
Bailey Meter Co.

FLUE GAS COLLECTORS
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL EXPANDERS AND ROLLERS
Holden Co., Limited, The, Montreal.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont
Joinless Fire Brick Co., Chicago, Ill.
Pyro Products Co., Toronto, Ont.

FURNACES, BOILER
Gates Refractories Ltd., Montreal

FURNACES, SMOKELESS
Babcock & Wilcox Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont
Joinless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GASOLINE ENGINES, SEMI-
Holden Co., Limited, The, Montreal.

GAS ENGINES, SEMI-DIESEL TYPE
Holden Co., Limited, The, Montreal

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Holden Co., Limited, The, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.
Republic Flow Meters Co. of Canada, Toronto, Ont.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
W. J. Wall, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Lyman Tube & Supply Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C., Belleville.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, PUMP.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

GOVERNORS, STEAM PUMP
Northern Equipment Co., Erie, Pa.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Babcock & Wilcox, Ltd., Montreal.
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. S. Sexton Boiler Setting Co., Toronto.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING AND STATIONARY
Can. Steam Boiler Equip. Co., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Can. Steam Boiler Equip. Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. S. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTS, CHAIN
Lyman Tube & Supply Co., Ltd., Toronto.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont
Goodyear Tire & Rubber Co., Toronto.

HOSE COUPLERS
Holden Co., Ltd., The, Montreal.

HOSE, RUBBER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Valve Engineering Company.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

HYDROGEN COMPRESSORS
Norwalk Iron Works Co., South Norwalk, Con.

ICE BREAKING MACHINES
Schmidt & Co., B. L., Davenport, Iowa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works, S. Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INDICATING THERMOMETERS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

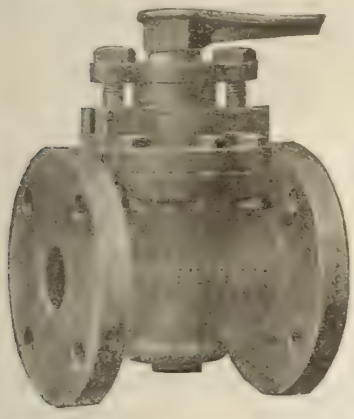
LUBRICATORS, FORCE FEED
Holden Co., Limited, The, Montreal.
Jeffrey Mfg. Co., Montreal, Canada.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

HOMESTEAD
Quarter-Turn Valves

—simplicity

Simplicity is the dominant feature of Homestead Valves. Simplicity of design and simplicity of construction. This is why they are so effective and dependable.



Instead of the six to ten turns of wheel necessary to ordinary globe or gate valves, a quarter-turn only is required to change a Homestead from absolute tightness to a straight, unobstructed flow, or vice versa.

Made in Straightway, Threeway and Fourway patterns for air, steam, water, oil, gas and acids.

Homestead Valve Mfg. Company

Homestead, Pa.

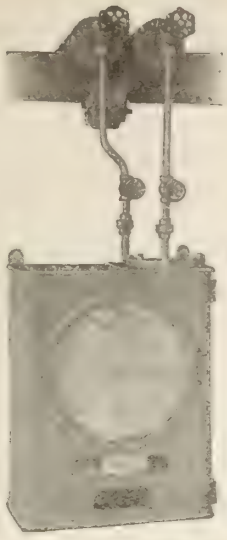
Power House
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

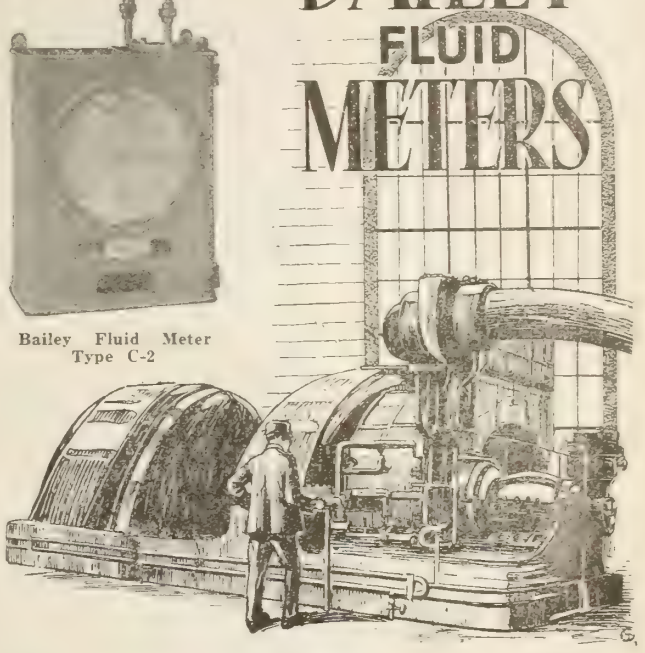
Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House



BAILEY FLUID METERS



Bailey Fluid Meter Type C-2

Accurate Measurement of All Consumption

Bailey Fluid Meters enable you to continuously check the steam flow to your turbines, auxiliary power drives, heaters, evaporators, heating kettles, heating systems, drying coils, kiers, vacuum pans and all other process work, and keep you accurately informed of the steam consumption of every unit using either live or exhaust steam.

Bailey Meters are equally dependable for measuring hot or cold water, air, gas or other fluids. Made in types to meet all conditions.

Bulletins upon request.

Bailey Meter Company

2001 E. 46th St., Cleveland, O., U.S.A.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION
PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon-

MACHINERY, MINING (COMPRESSORS)
Holden Co., Limited, The, Montreal.
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.

MACHINE TOOLS
Ministry of Munitions, London, England.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS, GAS
Republic Flow Meters Co. of Canada, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal.
Republic Flow Meters Co. of Canada, Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS, WATER
McAvity, T., & Sons, Ltd., St. John, N.B
Republic Flow Meters Co. of Canada, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Ministry of Munitions, London, England
Sturtevant Co., Ltd., B. F., Galt, Ont

MOTOR BOATS, ETC., ETC.
Ministry of Munitions, London, England.

MOTOR VEHICLES
Ministry of Munitions, London, England.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
Superheater Co., Ltd., The, Montreal.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
E. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd. Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Hoyt Metal Co.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE GOVERNORS
Northern Equipment Co.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

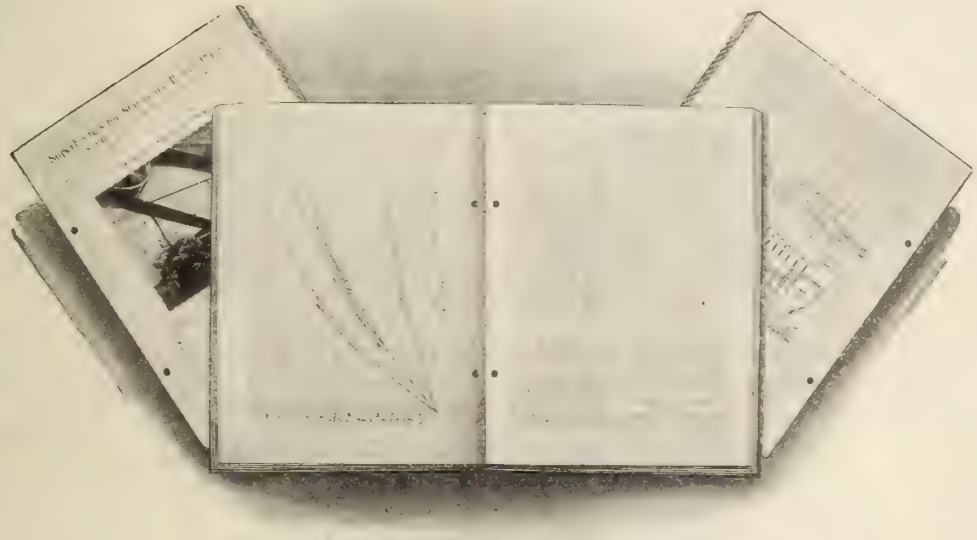
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

ELESCO

SUPERHEATERS

MADE IN CANADA



Bulletin T-5

Here Is Some Valuable Data

Bulletin T-5 contains valuable data on the important subject of superheated steam. Everyone interested in any way in more economical power production needs a copy.

FREE — For the Asking.

THE SUPERHEATER COMPANY, LIMITED
TRANSPORTATION BUILDING
MONTREAL

Works at SHERBROOKE, QUEBEC.

Designing Engineers and Manufacturers of ELESCO Steam Superheaters and Pipe Coils for all purposes

USE THIS COUPON

The Superheater Company, Limited, Transportation Building, Montreal

Please send your Bulletins T-1, T-2, T-5 and T-6

Name ..... *Position* .....

Company ..... *Address* .....

Darling Bros Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Republic Flow Meters Co. of Canada, Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto

REGULATORS, BOILER FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, FEED WATER
Northern Equipment Co.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Hoyt Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SOOT CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Farnsworth Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOMETERS, RECORDING
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.
Holden Co., Limited, The, Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Lyman Tube & Supply Co., Ltd., Toronto

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co. Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Gutta Percha & Rubber, Ltd., Toronto.
Kerr Engine Co., Walkerville, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Valve Engineering Company.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

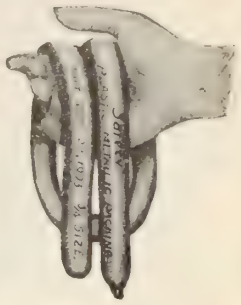
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.

VACUUM GAUGES (MERCURIAL)

C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Hoyt Metal Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES AIR

H. Mueller Mfg. Co., Ltd., Sarnia.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER

Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE

Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES (IRON), STANDARD EXTRA HEAVY

Crane's Limited, Montreal.

VALVES, MULTIPORT

Pratt & Cady, Hartford, Conn.

VALVES, NON-RETURN STOP

Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP

Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP

Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR

Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B
Sarco Company, Inc., New York.

VALVES, REDUCING

Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES, RELIEF

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING

H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, STANDARD, GLOBE, ANGLE AND CHECKS

Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Pratt & Cady, Hartford, Conn.
Penberthy Injector Co., Windsor, Ont.

VALVES, STEAM

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, VACUUM REGULATING

Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVE CHAIN WHEEL

Mason Reg. & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford.

VALVE DISCS

Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co. Windsor, Ont.

VALVE RESEATING MACHINES

Darling Bros., Montreal.

VISES AND CUTTERS, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.

VISES, CHAIN, PIPE, ETC.

J. H. Williams & Co., Brooklyn, N.Y.

WASTE

Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAUGES

Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.
W. J. Wall, Montreal.

WATER GAUGES STANDARD, EXTRA HEAVY AND AUTOMATIC

W. J. Wall, Montreal.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER REGULATORS, FEED

Northern Equipment Co.

WATER METERS

Bailey Meter Co.

WATER SOFTENING SYSTEMS

Wm. B. Scaife & Sons, Pittsburgh, Pa.

WATER SUPPLY SYSTEMS

Empire Mfg. Co., Ltd., London, Ont.

WATER HEATERS AND WHISTLES

Empire Mfg. Co., Ltd., London, Ont.

WATER WHEELS

Hamilton Co., Wm., Peterboro, Ont.
J. C. Wilson Mfg. Co., Ltd., Belleville

WELDING COMPOUND

Shell Bar Boico Supply, Ltd., Toronto.

WELDING SERVICE

Electric Welding Co., Montreal.

WELDING SUPPLIES

Holden Co., Limited, The, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto

WELDING WIRE

Lincoln Electric Co. of Can., Ltd., Toronto

WHISTLES

Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati.
Jas. Morrison Brass Mfg. Co., Toronto.

WHEEL TANKS (LUBRICATING OIL AND GASOLINE)

Bowser & Co., Ltd., S. F., Toronto, Ont.

WINDOW SCREENS

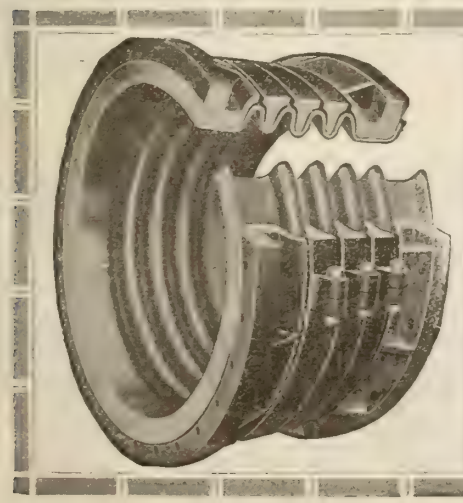
Holden Co., Ltd., The, Montreal.

WRENCHES, PIPE

Williams Machinery Co., A. E., Toronto.

WRENCHES, CHAIN PIPE, DROP FORGE, ETC.

J. H. Williams & Co., Brooklyn, N.Y



BADGER

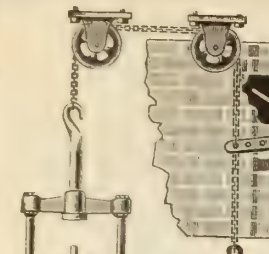
SELF-EQUALIZING EXPANSION JOINTS

Prevent leaks in all pipe lines

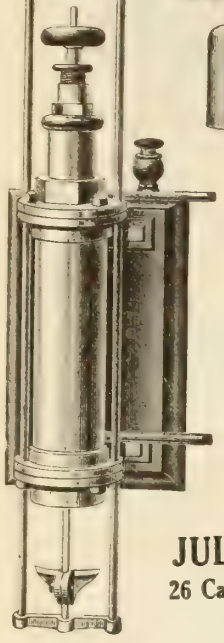
E. B. Badger & Sons Co.

101 PARK AVE. PITTS. ST. & S. MICHIGAN AVE.

NEW YORK BOSTON CHICAGO



Save Fuel



Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1920 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY

26 Canal Street BOSTON, 14, MASS.

Agencies:
83 Barclay St., New York City.
174 North Market Street, Chicago, Ill.

FOR REMOVING SCALE

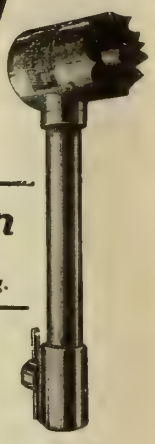
from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

★



Frank Gilman

(SOLE MAKER)

9, Westfield Road Birmingham Eng.

INDEX TO ADVERTISERS

A

Anderson Co., V. D. 48
Audel, Theo. 40

B

Badger & Sons, E. B 67
Bailey Meter Co. 63
Betson Plastic Fire Brick Co.. 55
Bishop Co., S. & C. 55
Brown, Wm. J. 54
Busch, Sulzer Bros. 61
Buyers' Directory .....
58, 60, 62, 64, 66, 67

C

Canadian Fairbanks-Morse Co.. 39
Can. Mead-Morrison Co., Ltd... 46
Chaplin-Fulton Mfg. Co..... 54
Coppus Engineering & Equipment Co. 56
Classified Advertising Section.. 40
Crane Limited 54

D

Darling Bros. 54
Dart Union Co..... 53
D'Este Co., Julian 68
De Laval Steam Turbine Co.... 43
Detroit Stoker Co. 41
Dominion Belting Co. 48
Durabla Mfg. Co. 47

F

Federal Engineering Co. 54

G

Gate Refractories 45
Garta Co., The 55
Gilman, Frank 68
Goldie & McCulloch 14
Goodyear Tire & Rubber Co... 8
Green's Economizer 7

H

Hamilton, William 6
Holden Co., Ltd., The 63
Homestead Valve Mfg. Co. ... 63
Hoyt Metal Co. 54

I

Imperial Oil, Limited 3

J

Jeffrey Mfg. Co. 59
Jenkins Bros. 10
Jointless Fire Brick Co. 61
Ladd Co., G. T. 55
Leitch, The Arthur S.....

L

Inside back cover
Leonard & Sons, Ltd., E. 12
Lunkenheimer Co. 5

M

McLaren's, D, K..Inside front cover
Manning Co., E. S. 43, 54
Mason Regulator & Engineering Co. .....Front cover
Ministry of Munitions 9
Morrison Brass Mfg. Co., as. Outside back cover
Moncrieff Ltd., John 55
Murphy Iron Works 11

N

Northern Equipment Co. 12
Norwalk Iron Works Co. 46

P

Page-Hersey Tubes, Ltd. 53
Peacock Bros., Ltd. 57
Petrie, H. W. 43
Pilley Packing & Flue Brush Mfg. Co. 55

R

Republic Flow Meters 42
Robb Engineering Co. 7

S

Sarco Co., Inc. 41
Scaife & Sons Co., Wm. B.... 68
Shell Bar Boico Supply Co.... 6
Sexton Biler Setting Co., W. R. 13
Smart Turner 55
Starrett Co., L. S. 61
Sturtevant, F. B. 4
Steel Mill Packing Co..... 67
Sterling Engine Co. 45
Superheater Co., Ltd., The..... 65

T

Tagliabue, C. J. 11
Taylor Instrument Co., The ... 61

U

Under-Feed Stoker Co. of Canada, Ltd. 49, 50, 51, 52

V

Victoria Foundry Co. 54

W

Wall, W. J. 55
Watson & McDaniel Co. 55
Williams & Co., J. H. 45
Worthington Pump & Machine Co. 1

Y

York Mfg. Co. 4

WATER

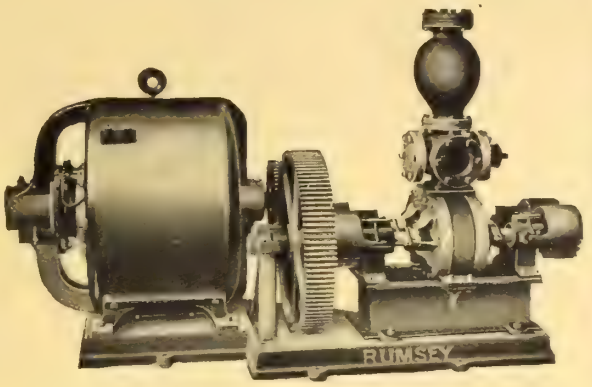
WE-FU-GO AND SCAIFE

PURIFICATION SYSTEMS SOFTENING & FILTRATION FOR BOILER FEED AND ALL INDUSTRIAL USES

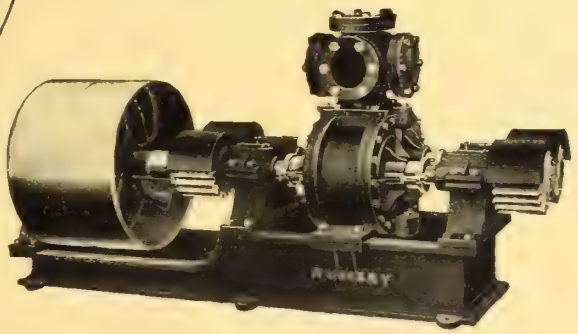
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

RUMSEY ROTARY PUMPS

SENECA FALLS, NEW YORK

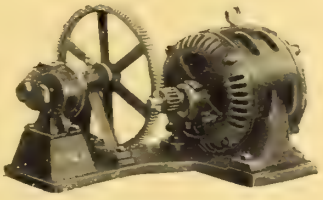


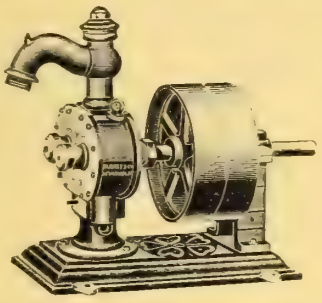
Rumsey Electric Rotary Fire Pump. Designed for general service as well as fire duty. For fire service, 100 pounds pressure is recommended and for general service 75 pounds.



Rumsey Power Rotary Force Pump. Designed for water supply, oils or special liquids for elevations up to 170 feet and pressures up to 75 pounds. A moderately-priced pump of large capacity.

Rumsey Rotary Power Force Pump. A light duty machine designed for returning oil to reservoir from drip pan, also for pumping lubricants for cutting tools, lathes or other light work where a small pump is required.





Rumsey Rotary Power Force Pump. An inexpensive pump of large capacity for elevations up to 80 feet. For handling water, oil, paint, varnish or special liquids.

Sectional View of Heavy Service Rotary Pump, showing the arrangement of the packing strips with which the toes of the cans are provided.

RUMSEY ROTARY PUMPS

RUMSEY Rotary Pumps are the popular choice for all kinds of general pumping. If you want a compact, convenient pump — a pump that costs little and operates economically—get a Rumsey. Rumsey Hand and Rotary Force Pumps will handle almost any liquid that flows—water, oil, paint, varnish, gasoline, grease, tar, ink, extracts, sizes, soaps, chemicals and commercial liquids of all kinds. Liquids corrosive to iron or bronze are excepted.

Would you like to know the results that well-known users are getting with Rumsey Pumps? If so, write us to-day.

THE ARTHUR S. LEITCH CO.

1001-2 Kent Bldg., Toronto, Ont.

May your Christmas be a happy one and may the New Year come to you laden with Prosperity.

The James Morrison Brass Mfg. Co., Ltd.

93-97 Adelaide Street W., Toronto, Ont.

J. A. COOK & SON LIMITED
STATIONERS
77 BAY ST.
TORONTO